Charting the Course of Conceptual Change and the Influence of Self-Efficacy

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Abstract

Although self-efficacy has been identified as important for conceptual change, other factors, such as one’s knowledge and interest, are also thought to influence self-efficacy (Linnenbrink & Pintrich, 2003) and are requisite for developing more complex representations of a domain (Murphy & Alexander, 2002). 84 undergraduate preservice teachers completed measures of domain knowledge, topic interest, and self-efficacy for teaching at three points throughout the semester. Additionally they wrote about their conceptions of the relation between the concepts of reading, comprehension, and learning at each time point. Findings indicate that preservice teachers’ knowledge, interest, and beliefs about reading as a domain are related. Additionally, profiles of preservice teachers emerged that help explain patterns in their conceptualizations across the three time points. These findings highlight the importance of students’ cognitive and motivational changes in relation to learning about reading theory over the course of a semester and what impact these changes have on self-efficacy for teaching reading.

Keywords: conceptual change, self-efficacy, preservice teachers, reading
Charting the Course of Conceptual Change and the Influence of Self-Efficacy

The notion that affective, situational, and motivational aspects impact learners (Pintrich, Marx, & Boyle, 1993) has brought attention to the “warming trend” in conceptual change research. Sinatra (2005) posited that self-efficacy, in particular, plays a crucial role in conceptual change; however, research examining this relation over time is limited. Other variables, such as one’s knowledge and interest, are also thought to influence self-efficacy (Linnenbrink & Pintrich, 2003) and are requisite for developing more complex representations of a domain (Murphy & Alexander, 2002). Elementary preservice teachers, who often have difficulty reframing naïve theories of reading to more scientific representations (Herrmann, 1988) offer a specific area in which to explore these relations. As Murphy and Alexander (2008) point out, learners’ knowledge, interest, and beliefs are woven together with conceptual change. Thus this study strove to capture the complexity of this relation and determine if preservice teachers exhibit discernible patterns in their knowledge, interest, and beliefs that relate to products of conceptual change.

**Theoretical Framing**

Conceptual change, or the restructuring of prior knowledge (Vosniadou, 2007), is the subject of several theoretical models (see Dole & Sinatra, 1998 for a review). For several years these models focused solely on the cognitive aspects of the learning process (Sinatra, 2005). More recently, Dole and Sinatra have introduced the Cognitive Restructuring of Knowledge Model (CRKM) which considers affective and motivational factors in the learning process. The CRKM describes the interaction between characteristics of the learner and the message, and further, how those interactions between learner and message create a type of engagement ranging from low cognitive engagement to high metacognitive engagement. Learner characteristics
outlined in the CRKM include the nature of learners’ existing conception, also known as prior knowledge, and their motivation to engage with the message. As the current study seeks to explore profiles of preservice teachers and how they explain conceptual change for core reading concepts the learner characteristics are under investigation. After establishing profiles, future research framed by the CRKM should address the interaction between profiles of learners and the messages with which they interact throughout their preservice training.

A major goal of teacher education programs is to develop expertise for both teaching and the domains that will be taught. At the heart of developmental models of expertise and research on higher-order thinking is the investigation of individual differences in conceptual change (Murphy & Alexander, 2008). The Model of Domain Learning (MDL) considers the changes in knowledge, interest, and strategy use, their interactions, and how those individual characteristics and their interactions changes as individuals develop competence and expertise within a domain (Alexander, Murphy, Woods, Duhon, & Parker, 1997). This framework is desirable for the current study because it highlights the developmental nature of individual factors contributing to conceptual change. It is worth noting that an individual would not be expected to gain expertise in just one semester. Rather, the MDL suggests that knowledge should increase and changes in interest and strategy use should occur (Alexander et al., 1997).

Both the CRKM and the MDL identify key individual characteristics that influence conceptual change; namely knowledge, interest, and beliefs. Although other constructs are part of each model, it is knowledge, interest, and beliefs that have been most often investigated, thus having the most empirical support for their impact on learning (Murphy & Alexander, 2008; Sinatra, 2005). The current study aims to investigate the interactions of constructs over time in order to determine if particular profiles of knowledge, interest, and beliefs influence conceptual
change. First, we will review the theoretical underpinnings of knowledge, interest, and beliefs as they relate to the CRKM and MDL.

**Knowledge**

Knowledge is the basis of *existing conceptions* learners hold within the CRKM framework (Dole & Sinatra, 1998). Thus measuring prior knowledge is essential to an investigation of conceptual change, as it gives some indication of existing conceptions and their alignment to the course content. For this study domain and topic knowledge were measured at the beginning, middle, and end of the semester in order to gauge learning that could potentially impact existing conceptions. Therefore, it is of interest to determine whether reading knowledge is related to the conceptualizations at any of the time points.

Prior knowledge is defined two different ways according to the MDL (Murphy & Alexander, 2002). *Domain knowledge* refers to individuals’ breadth of knowledge related to areas such as reading, biology, or music. *Topic knowledge* refers to individuals’ depth of knowledge for specific concepts within a domain. Preservice teachers may have general theoretical knowledge for the domain of reading, as well as knowledge of phonemic awareness, fluency, and vocabulary. According to the MDL, knowledge is hypothesized to increase by the end of a semester, as students develop competence within a specific domain (Alexander, Murphy, Woods, Duhon, & Parker, 1997). Furthermore, this increase in knowledge is hypothesized to relate to conceptual change (Murphy & Alexander, 2008).

Theoretically, this connection between knowledge and conceptual change can be elaborated through the consideration of *higher-order thinking*. Higher-order thinking is defined as, “the mental engagement with ideas, objects, and situations in an analogical, elaborative, inductive, deductive, and otherwise transformational manner that is indicative of an orientation
toward knowing as a complex, effortful, generative, evidence-seeking, and reflective enterprise” (Alexander et al., 2009, in press). Higher-order thinking has often been targeted as a goal of the educative process (e.g., Resnick, 1987). This can be seen in the common application of Bloom et al.’s (1956) taxonomy to course test construction and grading rubrics. In other words, teachers are striving to foster higher-order thinking within specific domains and consider this a reflection of students’ quality of knowledge and expertise within those domains. For this reason one indicator of conceptual change might be its relation to knowledge at different time points in the semester. At the beginning of the semester knowledge might not be related to the students’ explanations of abstract domain concepts, but by the end of the semester there should be some relation between reading domain knowledge and preservice teachers’ explanations of abstract reading concepts. Such a change in the relation between knowledge and abstract conceptualization may be an indicator of conceptual change brought on by higher-order thinking.

**Interest**

As mentioned above, *motivation to process* is one of the key learner characteristics under consideration in the CRKM (Dole & Sinatra, 1998). Motivation to process is influenced by several factors: dissatisfaction, personal relevance, social contexts, and need for cognition. A combination of these factors is expected to affect the engagement necessary for conceptual change to occur. Personal relevance is related to the broader motivational construct of *interest*. The type of interest reflected by personal relevance is individual interest, or one’s commitment and involvement in a particular activity or area of study (Hidi, 1990).

The MDL suggests that individual interest often starts low in acclimation and interacts with knowledge during a semester-long course (Alexander et al., 1997). This notion has been challenged by more recent findings from studies empirically testing the MDL within domains.
For example, a study of engineering undergraduates’ knowledge, interest, and strategy use during one semester found relatively little change in students’ individual interest which suggests that changes within one semester may be difficult to detect. (Dinsmore, Alexander, & Loughlin, 2008). However, interest is assumed to be necessary for conceptual change to occur according to the CRKM (Dole & Sinatra, 1998). Therefore, it is expected that if interest is dynamic across the beginning, middle, and end of the semester conceptual change may be more likely to occur.

Self-efficacy

Dole and Sinatra (1998) described self-efficacy beliefs as another aspect of motivation that may drive conceptual change. The term self-efficacy stems from Bandura’s Social Cognitive Theory, which emphasizes that individuals are self-organizing, self-regulating, proactive, and reflective when defining their own learning and behavior. In fact, efficacy beliefs influence how people feel, reason, motivate themselves, and act (Bandura, 1993). Self-efficacy is task specific, and one is more likely to choose to work on tasks in which one feels competent (Pajares, 2002). This is especially important in relation to preservice teachers, as a novice teacher is more or less likely to guide his or her future teaching experiences based on their domain specific experiences and beliefs.

As preservice teachers gain competence within the reading domain they would be expected to report increased self-efficacy for teaching reading. This expectation stems from what Bandura (1986) referred to as mastery experiences, or past successes completing particular tasks. In contrast, if one is not successful in gaining competence, self efficacy would be expected to decrease. While self-efficacy is a task-oriented type of belief, epistemic beliefs are more domain-specific in nature (Greene, Azevedo, & Torney-Purta, 2008).

Epistemic beliefs
Epistemic beliefs have been hypothesized to have an effect on the processing and engagement necessary for conceptual change to occur (Pintrich, Marx, & Boyle, 1993). Epistemic beliefs are individuals’ beliefs about knowledge and knowing that influence their learning and metacognition (Greene, Azevedo, & Torney-Purta, 2008). A great deal of research on epistemic beliefs has emphasized a continuum from naïve to sophisticated or simple to complex, where more sophisticated beliefs are desirable because they indicate students’ willingness to construct knowledge and engage in processing leading to conceptual change (Dole & Sinatra, 1998; Hofer & Pintrich, 1997). Thus we would expect preservice teachers who consider theoretical knowledge for reading to be uncertain, complex, or negotiated to be more likely to exhibit change in their conceptualization of broad domain concepts.

Furthermore, a recent review of studies examining teachers’ epistemic beliefs about a particular domain and their pedagogical approaches found that teachers taught their students strategies that stemmed from their own epistemic beliefs about the domain (Maggioni & Parkinson, 2008). For example, history teachers may feel that history is a set of facts they taught memorization strategies, whereas, on the other hand, others may feel that history is a construction of meaning they taught strategies for analyzing and interpreting sources. Teachers may have knowledge of the domain and feel capable of teaching reading to students whether they hold so-called naïve or sophisticated beliefs about the nature of knowledge and knowing for the domain. For this reason, there may not be any relation between epistemic beliefs and knowledge or epistemic beliefs and self-efficacy.

**Purpose**

Knowledge, interest, and beliefs are central to conceptual change as described by the CRKM and development of domain competence and expertise as described by the MDL. This
study seeks to capture change in these variables over the course of a semester by asking: (a) Do beliefs about contextualized knowledge, reading knowledge, and interest predict change in elementary teachers’ self-efficacy for teaching readers over time? and (b) How do the preservice teachers’ profiles of knowledge, interest, and self-efficacy relate to their conceptualizations of reading?

In regards to the first question, it is hypothesized that beliefs about contextualized knowledge, reading knowledge, and interest predict change in elementary teachers’ self-efficacy for teaching readers over time. Specifically, participants with greater knowledge for reading topics and interest will show greater change in their self efficacy beliefs. For the second question, it is hypothesized that distinct profiles of knowledge, interest, and self-efficacy will emerge and that there will be some descriptive power in those profiles when interpreting the conceptualizations of domain concepts.

Method

Participants

Data were collected three times during spring semester 2009 from four different sections of a language and reading course required for state teacher certification. Participants were 84 undergraduate students (92% female) from two mid-Atlantic universities. They were primarily of sophomore (59%) and junior standing (41%) and Caucasian (91%). The course content consisted of theoretical underpinnings of language development and reading acquisition from birth through the elementary school years. Participation was voluntary and participants were recruited during class and offered extra credit for their time. Alternative opportunities for extra credit were provided by the instructors.

Measures
**Domain and topic knowledge.** A domain and topic knowledge test was administered at all three time points. This measure consisted of 6 multiple-choice items that assessed participants’ breadth and depth of reading knowledge. An example of one of the items for this measure appears below:

If three-year-old Grayson calls the dentist the *tooth brushing man* he is demonstrating which unique aspect of semantic development?

a. Overextension  
b. Underextension  
c. Abstract reasoning  
d. Word invention

Correct responses were scored a one and incorrect responses were scored a zero. Items were summed to create a total score at each time point with a possible score between zero and six. These summed scores were used in all subsequent analyses. The means and standard deviations across the three time points for the knowledge measure was 2.92 (.91), 3.41 (1.12), and 3.41 (1.17) respectively.

**Domain interest.** A domain interest measure was administered at all three time points. Participants were presented with topic keywords from the course and asked to indicate their interest in that topic by marking a slash on the 100-mm scale. The left-hand side of the scale was labeled *Not interested* and the right-hand side of the scale was labeled *Very interested*. An example of a topic keyword participants rated is *Phonemic Awareness*.

A principal components analysis was run in order to create component scores for each individual at each time point for domain interest. After examination of the resulting scree plots for each principal components analysis, it was determined that a one factor solution was appropriate for all three time points. The variance explained by the domain interest component for each time point was 32.22% (Cronbach’s α = .79), 38.95% (Cronbach’s α = .84), and 36.94% (Cronbach’s α = .84) respectively. The only items from the scale that did not load highly were
the participants’ interest in nativism and bilingualism, particularly at time points one and two. Resulting component scores were calculated with the regression method and were used for all subsequent analyses. These component scores have a mean of zero and a standard deviation of 1.00.

**RTSES.** The Reading Teacher Sense of Efficacy Scale (Haverback & Parault, 2009) was also administered at all three time points. Participants completed this adapted version of the Tschannen-Moran and Woolfolk-Hoy (2001) Teacher Sense of Efficacy Scale (TSES). The measure was employed in this study as it has been shown to have high rates of overall reliability rates ranging from Alpha .95 to .86 and has been used and accepted in studies of preservice teacher efficacy (Fives, Hamman, & Olivarez, 2007; Tschannen-Moran & Woolfolk Hoy, 2007). The 16 original TSES items examining teacher efficacy in engagement and instructional practices were adapted to be domain specific. For example, the question “How much can you do to motivate students who show low interest in school work?” was changed to “How much can you do to motivate students who show low interest in reading?” Each participant in this study completed this new, reading specific, 16-item version of the teaching efficacy scale. Responses to each question remained on a nine-point Likert scale as used in the original TSES and measured “How much can you do?” from “nothing” to a “great deal.”

As with the domain interest measure, a principal components analysis was run in order to create component scores for each individual at each time point. After examination of the resulting scree plots for each principal components analysis, it was determined that a one factor solution was again appropriate for all three time points. This is consistent with the findings of Haverback and Parault (2009). The variance explained by the self-efficacy component for each time point was 66.81% (Cronbach’s α = .97), 71.36% (Cronbach’s α = .97), and 64.99%
(Cronbach’s $\alpha = .96$) respectively. Resulting component scores were calculated with the regression method and were used for all subsequent analyses. These component scores, like the domain interest scores, have a mean of zero and a standard deviation of 1.00.

**Conceptualization exercise.** A drawing and explanation exercise was administered at all three time points. Directions for the exercise were as follows:

How do you think reading, comprehension, and learning are related? Draw the following shapes to create a representation of this relation. You may choose to do this any way you wish.

Participants were presented with a triangle labeled *Reading*, a circle labeled *Comprehension*, and a square labeled *Learning*. Below the space provided for drawing, participants were instructed to explain their representation and given six lines to write about their drawing.

The terms *reading*, *comprehension*, and *learning* were chosen as broad concepts from the course that students were encouraged to consider and even define for themselves throughout different units of the course. For this study, it was especially important to see if students’ consideration of these concepts changed and especially their consideration of how these concepts relate to each other as this represents the guiding belief system for understanding the psychology of reading and teaching component processes to elementary school students. Furthermore, the exercise was presented as a drawing and explanation in order to focus and concretize the task (Alexander & Dochy, 1995). The exercise was left as open-ended as possible to allow for responses that reflected individual knowledge and beliefs about the concepts.

Only the written responses were coded. This decision was made after a preliminary look at the drawings and their explanations. The explanations were found to contain more detail, and in some cases, did not match with the drawing (e.g., an overlapping drawing was explained as a sequential process). The coding scheme was adapted from the SOLO taxonomy developed by Biggs and Collis (1982). Scores ranged from one to five, corresponding to the following levels:
No description or incorrect description of the components was scored as 1. Inadequate explanation of the theorized relations, but knowledge of some component(s) was scored as a 2. Knowledge of several components and aspects relevant to the topic, but not integrated with each other was scored as a 3. Knowledge of several aspects relevant to the topic and integrated in a meaningful way was scored as a 4. And knowledge of several aspects integrated with applied examples was scored as a 5. Half points were awarded for responses that were considered in between categories.

Three raters were used to build inter-rater reliability for the conceptualization exercise. At one site, the first author and another trained research assistant scored the conceptualization exercises reaching an agreement of 67%. For the data from the second site, the first and second authors scored the conceptualization exercises reaching an agreement of 80%. The combined agreement across the two site and three raters was 72%. All disagreements were resolved in conference.

CAEB. Finally, at the third time point, participants complete the Connotative Aspects of Epistemological Beliefs (CAEB; Stahl & Bromme, 2007). The CAEB is designed to measure people’s epistemic beliefs about their knowledge of a particular domain or topic. The primary advantage to the CAEB is that it measures connotative and associative aspects of epistemic beliefs as opposed to only examining denotative and functional aspects (Greene, Azevedo, & Torney-Purta, 2008). Participants were asked to discriminate between opposing adjective pairs about reading knowledge (e.g., knowledge as objective versus knowledge as subjective) on a 100 millimeter line. Responses are scored by measuring how many millimeters their mark is away from the left end of the line, resulting in a possible response value of zero to 100.
A principal components analysis was run in order to create component scores for each individual on the CAEB. After examination of the resulting scree plot, it was determined that a two factor solution was appropriate, consistent with Stahl and Bromme (2007). The two components accounted for 38.46% of the total variance (Cronbach’s $\alpha = .76$). The first component, Certainty, accounted for 24.19% of the variance, while the second component, Construction, accounted for 14.26% of the variance. The resulting components loadings are included in Table 1 with loadings over .40 in bold. However, unlike Stahl and Bromme (2007), the items did not load similarly onto a texture and variability component. One reason for this may be that the texture and variability components are more appropriate for science domains; however, this study focused on the domain of reading. Perhaps consideration of structure and accuracy of knowledge and consideration of stability and dynamics are related to student training in the scientific method. Comparatively, reading is a domain with a different composition. The two factors, certainty and construction, may lend themselves to the nature of reading.

Again, resulting component scores were calculated with the regression method and were used for all subsequent analyses. These component scores, like the domain interest scores, have a mean of zero and a standard deviation of 1.00.

**Procedure**

All materials were distributed during class, with permission of the instructors. Participants completed paper and pencil packets at the beginning of the semester, during the week of midterm exams, and during the last week of classes. Either the first or second author distributed the packets to those who agreed to participate, read through the instructions, and answered any questions. Participants completed the domain and topic knowledge measure, the domain interest measure, the TSES, and the conceptualization exercise at all three time points.
The CAEB was also administered at time point three, because epistemological beliefs for the domain were not expected to fluctuate during a single semester.

**Results**

A bivariate correlation table of all the relevant variables (i.e., reading domain and topic knowledge, domain interest, epistemic beliefs, self-efficacy, and scores on the conceptualization exercise) are included in Table 2. Findings revealed that self-efficacy was correlated to reading knowledge at various points. Specifically, self-efficacy at time one was correlated to reading knowledge at time three ($r=.33; p<.01$). Also, self-efficacy at time three was correlated to reading interest at all three testing time points ($r=.24; p<.05; r=.31; p<.01, r=.26; p<.05$). Reading knowledge and conceptualization were also correlated at time three ($r=.27; p<.05$). These findings will be explicated in the discussion section.

**Effects of beliefs about contextualized knowledge, reading knowledge, and interest on change in elementary teachers’ self-efficacy for teaching readers over time**

To investigate this question a repeated measures ANOVA was run with self-efficacy as the within-subjects variable and beliefs about contextualized knowledge, reading domain and topic knowledge, and domain interest as covariates. To help specify a model to test, since domain and topic knowledge and domain interest were collected at all three time points, we wanted to see if there were within-individual differences in knowledge and interest across the three time points. Two repeated measures ANOVAs yielded a significant difference for the repeated measure of time for domain and topic knowledge with means and standard deviations of 2.92 (SD = .91), 3.41 (SD = 1.12), 3.41 (SD = 1.17); ($F = 13.50; df = 2, 58; p < .01$), but not for domain interest with associated means of 64.87 (SD = 10.75), 67.51 (SD = 11.47), 71.52 (SD = 10.86); ($F = .16; df = 2, 58; p = .84$). As expected, there was little change in individuals’ domain
interest over the course of the semester, so the model was simplified to only include domain
interest from the first time point, but to include all measures of domain and topic knowledge at
all three time points.

The resulting within-subjects and covariate effects are included in Table 3. These
analyses yielded no significant relations. Possibilities for why no significant differences were
found are examined in the discussion section below.

**Effects of preservice teachers’ profiles of their beliefs about contextualized knowledge,
domain and topic knowledge, domain interest, and self-efficacy on their conceptualization
of reading, comprehension, and learning**

To investigate this question, we created profiles of the participants’ domain and topic
knowledge, domain interest, epistemological beliefs, and self-efficacy using a hierarchical
cluster analysis. Using this method, a three cluster solution was identified using coefficients
from the agglomeration schedule. This yielded groups with 51 participants in cluster one, one
individual in cluster two, and four individuals in cluster three. While these clusters were not
optimal in terms of the number of participants per group, this analysis did identify interesting
cases for us to examine more closely. Further, since preliminary analyses indicated very little
change in participants’ scores on the conceptualization exercise, we decided to take a more
descriptive approach to examining these profiles and their resulting conceptualizations of reading
comprehension and learning in the discussion section. The means for all clusters and the
standard deviations (except the standard deviations for cluster two) are provided in Table 4 for
reading knowledge, domain interest, epistemic beliefs, and self-efficacy.

**Discussion**
The relation found between self-efficacy and reading knowledge supports past findings from Schoon and Boone (1998) who found a relation between science preservice teacher efficacy scores and science knowledge. In this study, self-efficacy beliefs at time one correlated with reading knowledge at time three. In addition, self-efficacy at time three was correlated with reading interest at all three testing time points. This correlation is consistent with Pajares’ (2002) notion that self-efficacy is domain specific and that one is more likely to choose to work on tasks in which one feels competent. Preservice teachers with higher self efficacy beliefs for teaching reading also had a greater interest in topics within the domain. This is important, as preservice teachers who are interested in reading topics and have higher efficacy for teaching reading may be more likely to pursue further training in teaching reading as part of their education and certification.

Effects of beliefs about contextualized knowledge, reading knowledge, and interest on change in elementary teachers’ self-efficacy for teaching readers over time

One of the explanations we pose as to why there were no significant effects of within-subject differences over time for self-efficacy and the effects of the covariates is that the nature of change over time for self-efficacy is complex and does not appear to be linear. Figure 1 displays a random sample of 30 participants’ self-efficacy at all three time points. Further analysis of self-efficacy is necessary to uncover the nature of these relations.

Effects of preservice teachers’ profiles of knowledge, interest, and self-efficacy on their conceptualization of reading, comprehension, and learning

The typical profile demonstrated by the preservice teachers in this study included moderate domain and topic knowledge, moderate interest, and moderate self-efficacy throughout the three time points (Table 4). Their epistemic beliefs about the certainty and construction of
reading knowledge were moderate as well. These students had varying patterns of conceptual change (with some showing no change) as indicated by their conceptualization exercises across the three time points.

One preservice teacher demonstrated a very different profile from the majority of students. Although this student also had moderate knowledge at each time point, her interest fluctuated at each of the three time points (Table 4). At the first time point the student was moderately interested in the course topics. By the second time point her interest had increased substantially, but then by the third time point it dipped far below where it had been at time point one. Her epistemic beliefs indicated that she believed reading knowledge to be quite uncertain and highly constructive in nature, meaning that she considers knowledge to be open, refutable, flexible, etc. Finally, this preservice teacher’s self-efficacy was moderate at the first time point and steadily decreased at time points two and three (although it was still moderate).

Given her profile of moderate knowledge, fluctuating interest, epistemic beliefs oriented towards reading knowledge as uncertain and personally constructed, and decreasing self-efficacy for teaching reading it is not surprising that this preservice teacher’s conceptualizations of reading, comprehension, and learning are different when compared across the three semester time points. At the beginning of the semester, she described the constructs as all related, but described those relations as both hierarchical and sequential. In the middle of the semester, she indicated that they are all linked together, but still maintained a sequential explanation for that linkage. Finally, at the end of the semester, she simply stated a sequence of the concepts without any explanation as to why that sequence would unfold. Perhaps the steady decrease of detail in her descriptions was due to realized confusion about the complexity of the domain and decreasing interest.
A final profile emerged from the cluster analysis that was characterized by low knowledge, low interest, and low self-efficacy. More specifically, knowledge for reading started and remained low at the beginning, middle, and end of the semester, indicating these students did not gain knowledge about the domain of reading during this time. Their interest was low when captured at each point during the semester, but it dipped especially low in the middle of the semester, and recovered slightly by the end of the semester. Preservice teachers within this profile held moderate beliefs about the certainty and constructive nature of knowledge for the domain of reading. Their reported self-efficacy for teaching reading was low at the beginning of the semester and decreased to extremely low by the end of the semester. While there was some change in the stated conceptualizations of reading, comprehension, and learning within preservice teachers fitting this profile, it varied across students.

At the beginning of the semester, preservice teachers in this cluster described the three concepts in the conceptualization exercise as related; however, little explanation was given as to how. In fact, two out of the four did not give any explanation. In the middle of the semester, three out of the four participants felt that they were related. Again, very little explanation was given. However, the fourth participant felt that reading and learning were both parts of comprehension, stating that “it is possible to read something, but without learning there is no comprehension.” At the end of the semester, two of the four continued with the notion that all of the constructs were related. The other two participants changed and stated that the concepts were sequential.

**Conclusions**

In summary, knowledge, interest, and beliefs for the domain of reading were found to be related at different time points during a semester-long course, however, regression analysis did
not reveal effects of knowledge, interest, or beliefs on self-efficacy. Although knowledge, interest, and beliefs were hypothesized to influence self-efficacy, there is some evidence to indicate that self-efficacy might not be linear across the beginning, middle, and end of a semester (Figure 1). Of particular interest was the emergence of three distinct profiles that characterized preservice teachers’ changes (or lack thereof) throughout the course and how those profiles related to conceptualization of key domain terms.

This study lends empirical evidence to Tschannen-Moran and Woolfolk-Hoy’s (2001) discussion about teacher efficacy being an elusive construct, perhaps because of the nonlinearity of their ratings over time. On one hand, reading efficacy was found to be correlated with reading knowledge and interest at various points. On the other hand, when used as covariates reading knowledge, domain knowledge and interest were not associated with changes in self-efficacy beliefs. It is also important to note that while domain and reading knowledge changed, as one would expect over the course of a semester, interest did not change significantly. Finally, it is interesting that such little change in participants’ scores on the conceptualization exercise were found. Perhaps this finding speaks to the notion that it is indeed difficult for acclimated learners, such as preservice teachers, to reframe their theories of reading.

The majority of participating preservice teachers demonstrated moderate levels of knowledge, interest, and beliefs at the beginning, middle, and end of the semester. They indicated some knowledge of and interest in reading theory at the beginning of the semester from other classes taken for their degree and certification. It is possible that one course, taken within the context of their program as a whole, was not enough to effect substantial change. Alternatively, measurement of knowledge, interest, beliefs, and conceptualizations may need further refining for future studies in order to better capture the changes that are likely occurring.
The likelihood of change is especially likely given that preservice teachers take this required reading course after a certain sequence of other required courses and right before their first placements within schools. They have knowledge for the domain, but no actual teaching experience against which to test that knowledge. This sample was carefully chosen for this reason. Thus examination of the measures utilized suggests avenues for further study.

For this study, the Conceptualization Exercise was left very open-ended, which allowed for participants to respond in a manner that reflected their individual knowledge and beliefs about the concepts. However, participants may have provided longer responses if they were asked more specific questions, such as how to define the concepts in their own words. Thus, there may be a need for more direct instructions for the Conceptualization Exercise. Furthermore, the CAEB was found to be somewhat confusing to the preservice teachers in this study, and so further modifications to this measure of epistemic beliefs are recommended.

These findings are important for teacher educators and educational researchers. Teacher educators need to be aware of the profiles of their preservice teachers and how such profiles may impact learning and self-efficacy for teaching. As preservice teachers enter their domain-specific courses at the university, sometimes with little knowledge or understanding of the topics, it is important for university professors to gauge not just knowledge, but interest and beliefs in class. In this way it will be possible adjust instruction in a way that optimally interacts with preservice teachers’ knowledge, interest, and beliefs to promote conceptual change. The goal of conceptual change is especially important as preservice teachers struggle to reframe personal experiences with reading into more complex and scientific models of the cognitive, metacognitive, motivational, affective, and social aspects of reading (Herrmann, 1988).
Educational researchers need to continue research on preservice teacher efficacy. As stated, the aforementioned lack of experience within domains may lead preservice teachers’ efficacy beliefs to change and be nonlinear over time. Understanding these differences is important. One area in which researchers should focus is the investigation of whether or not consistent profiles can be established and named for use in further studies of conceptual change within this population. After establishing profiles, the research framed by the CRKM should address the interaction between profiles of learners and the messages with which they interact throughout their preservice training. Such profiles may help researchers better determine specific areas of need and growth within preservice teacher populations.
References


Table 1

*Rotated component loadings for the Connotative Aspects of Epistemological Beliefs (CAEB)*

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<thead>
<tr>
<th></th>
<th>Certainty</th>
<th>Construction</th>
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<tr>
<td>Precise-imprecise</td>
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<td>.20</td>
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<td>Sorted-unsorted</td>
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Table 2

*Intercorrelations Between Variables of Interest*

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<th>RK3</th>
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<th>EB1</th>
<th>EB2</th>
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*Note.* RK = Reading Knowledge Test, Int = Interest, EB = Epistemic beliefs, SE = Self-efficacy, CE = Conceptualization exercise; *p < .05, **p < .01
Table 3

*Results of the Repeated Measures ANOVA for Self-efficacy with Reading Knowledge, Domain Interest, and Epistemic Beliefs as Covariates*

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<td>SE*C2</td>
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*Note.* RK = Reading Knowledge Test, Int = Interest, SE = Self-efficacy, C1 = CAEB score for component 1, C2 = CAEB score for component 2
Table 4

Means and Standard Deviations for Clusters on Reading Knowledge, Domain Interest, Epistemic Beliefs, and Self-efficacy

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<th>Int1</th>
<th>Int2</th>
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</table>

Note. RK = Reading Knowledge Test, Int = Interest, SE = Self-efficacy; Means and standard deviations for interest, epistemic beliefs, and self-efficacy are for the component scores that have a mean of 0 and standard deviation of 1 for the whole sample.
Figure 1

Random Sample of 30 Participants’ Self-Efficacy at All Three Time Points