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Participatory Concept Mapping as an Integration Tool in Mixed Methods Research: Exploring Preservice Teachers' Epistemic Cognition and Teaching Orientation

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Abstract: Our goal for this article is two-fold: 1) to examine the efficacy of participatory concept mapping as an integration tool for mixed methods research (MMR), and 2) to explore, using concept mapping, pre-service teachers' epistemic cognition (EC) and its relationship to teaching orientation (TO). Using a combined developmental and dimensional framework, preservice teachers' (N=48) concept maps about their (EC) and (TO) were investigated. Analyses revealed that the majority of the participants were consistent with the EC profiles of either: 1) absolutist, 2) multiplist, or 3) evaluativist. Participants' EC and TO were clearly linked and implications for learning, instruction, and teacher education are discussed. Finally, concept mapping was deemed an effective tool for MMR especially as it pertains to integration.

Keywords: *Mixed methods research, concept mapping, integration, teachers' epistemic cognition, teaching orientation.*

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Introduction

Our goal for this article is two-fold: 1) to examine the efficacy of participatory concept mapping as an integration tool for mixed methods research (MMR), and 2) to explore, using concept mapping, pre-service teachers' epistemic cognition (EC) and its relationship to teaching orientation (TO).

The current study offers a number of significant and novel additions to the fields of educational research and methodology. To our knowledge, concept mapping has not been considered within the context of MM and its focus on integration, an area currently considered a key to rigorous MMR, will provide additional guidance for educational researchers (McCrudden, Marchand, & Schutz, 2019). In addition, our study includes teachers' beliefs about literacy knowledge and knowing; an understudied area of teachers' epistemic cognition (Bendixen, 2016). Finally, we investigate the possible relations between teachers' EC and TO which should add important understanding to this area of study (Fives & Buehl, 2016).

Concept Mapping as an Integration Tool

Concept mapping is a method of visual representation of knowledge and this approach has been useful in both learning and research areas. According to Novak and Canas (2006), "Concept maps are graphical tools for organizing and representing knowledge" (p. 1). Concept mapping has been valuable in both quantitative (Davies, 2011) and qualitative research arenas (Daley, 2004). For example, in qualitative research, concept mapping helps the researcher focus on and see the participant's meaning as well as their connections across concepts or bodies of knowledge. In addition, they help with data reduction, creating categories/coding schemes, and in analyzing themes (Olafson, Feucht, & Marchand, 2013; Wilson, Mandich, & Magalhaes, 2016). In quantitative research, concept maps provide visual and detailed comparisons of participants' understanding that can be converted into statistical analysis techniques (Trochim, 1989).

Concept mapping has begun to be considered in MMR as well. "In mixed methods research, an investigator combines at least one quantitative method and one qualitative method in a way that potentially maximizes the strengths and minimizes weaknesses of each respective method" (McCrudden et al., 2019, p. 1). According to Burke, O'Campo, Peak, Gielen, McDonnell, and Trochim (2005), concept mapping incorporates several quantitative and qualitative methods

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into a single process. For instance, concept mapping can provide valuable participant input during interviews and allows for the exploration of complex ideas and interrelationships in a relatively short amount of time (Daley, 2004). For the purposes of the current article, we will also provide evidence that concept mapping offers a means for MM integration.

In MMR, integration is the process of mixing or explicitly interrelating the qualitative and quantitative strands of a study and it is considered to be at the heart of quality MMR (Greene, 2007). Integration can happen at one or more points in a study: 1) at the level of design, 2) during data collection, 3) during data analysis, and/or 4) during interpretation (Creswell & Plano Clark, 2018). It has been well established that genuine integration in most MMR studies has been a struggle and more work needs to be done in this area (Plano Clark, 2019; Guetterman, Creswell & Kukartz, 2015). To support integration, Maxwell, Chimel, & Rogers (2015) recommend that "collecting data on the same sample, or subset of, the quantitative sample, also can facilitate integration" and this was done in the current study (p. 237).

Given the state of MMR and recommendations for improvement, we propose that participatory concept mapping is a useful tool for MMR integration. In our study, participants generated concept maps during one-on-one interviews with the guidance of a knowledgeable researcher to represent their epistemic cognition and teaching orientation. This method allows for participants to give immediate input regarding their beliefs and through discussion with the researcher, new connections and patterns arose and were included in the concept maps. In other words, participatory concept mapping provided a vehicle for the identification of concepts and connections based on how the participants framed their beliefs/experiences (Wheeldon & Faubert, 2009). In addition to concept mapping as an integration tool in MMR, the resulting concepts maps provide interesting and important insights into preservice teachers' EC and approaches to teaching.

Epistemic Cognition and Teaching Orientation

One of the most important ways to support students' EC is to understand and support teachers' EC (Kang, 2008). Indeed, Buehl and Fives (2016) contend that "the need for teachers to engage in epistemic cognition is exponentially higher than it is for students as teachers both learn and design contexts for the learning of others" (p. 248). The purpose of the current study was to explore preservice teachers' EC in general and in the domains of science and language arts.

A number of conceptual frameworks support this study in terms of its rationale and data analyses including those related specifically to the development and dimensions associated with EC (i.e., Hofer & Bendixen, 2012; Kuhn & Weinstock, 2002), and the role of EC in teaching orientation related to science (i.e., Kind, 2016) and English literature/language arts (i.e., Reznitskaya et al., 2012).

Our use of the term teaching orientation (TO) is an adaptation from its use in the science education literature (Kind, 2016). For the purposes of the current study, TO is defined as individuals' knowledge and beliefs about the process and goals for teaching in general and for teaching in specific subjects. Further understanding EC and its links to TO will add important clarity in terms of learning and instruction and will provide useful information for teacher education. We propose, and will provide evidence to support, that concept mapping is a valuable tool in both uncovering preservice teachers EC and TO and aiding in more fully understanding key aspects of integration in MM analyses.

Literature Review

In the following section, theoretical and empirical literature will be reviewed in the areas of epistemic cognition (EC), teaching orientation (TO), and MMR integration to support the purpose and methodology for the current study.

Epistemic Cognition

Definition. There are a variety of definitions that exist regarding individuals' cognition about knowledge and knowing including epistemic resources (Hammer & Elby 2003),

personal epistemology (Hofer & Pintrich 2002), and epistemic cognition (Greene et al., 2010). Even though not all of the authors reviewed in this article use the same terms and definitions, (EC) will be used as it captures the majority of the work that will be cited and it is consistent with more recent discussion regarding definitional accuracy. According to Greene et al. (2010), EC focuses on students' cognition and it "emphasizes knowledge and the processes involved in its definition, acquisition, and use" (p. 143).

Theoretical Framework. For the purposes of the current study's framework and analyses regarding epistemic cognition, we are using a combined developmental and dimensional approach similar to the one described by Barzali and Weinstock (2015) (Table 1).

Table 1. Combined Developmental and Dimensional Framework of Epistemic Cognition (adapted from Barzilai & Weinstock, 2015, p. 145)

Dimensions	***Absolutism***	***Multiplism***	***Evaluativism***
Nature of knowledge	Facts which can be right or wrong	Personal opinions	Theories, arguments, interpretations
Structure of knowledge	Only one account	Multiple equally right accounts	Multiple right accounts, some of which can be more right than others
Justification of knowing	Appeal to reality	Appeal to personal preferences and judgments	Coordination of theory and evidence, better explanation of data, appeal to shared norms and standards
Certainty of knowledge	Knowledge is certain/Certainty is an achievable goal.	Knowledge is fundamentally uncertain	Knowledge is fundamentally uncertain but it is possible to improve the degree of certainty.
Attainability of truth	Truth is attainable.	Truth is unattainable.	A degree of truth is attainable.
Expertise	Reliable experts can know for certain	Experts differ in their opinions and cannot know for certain.	One needs to consider and evaluate multiple expert opinions.

The model of Kuhn and colleagues (Kuhn & Weinstock, 2002) highlights the patterns that are central to many of the developmental theories associated with EC. In general, the pattern of EC development has been described as occurring in three distinct forms of thinking about the nature of knowledge and the process of knowing. In the first form (i.e. absolutist), views about knowledge are very simple and dichotomous; truth is judged based on an objective, external reality. The relativistic nature of knowledge (i.e. multiplist) is the focus in the second form of thinking where each claim is considered equally legitimate and, therefore, cannot be judged beyond mere opinion. The third form of epistemic thinking integrates the objective and subjective nature of knowledge (i.e. evaluativism) and considers how differing viewpoints can be judged based on established criteria (Kuhn & Weinstock 2002). It is important to note that evaluativistic views of knowledge are qualitatively distinct from the previous two forms of thought. There are a number of empirical studies that support Kuhn's forms of EC (Hofer & Bendixen, 2012).

In addition to the epistemic positions described in the Kuhn model, particular dimensions of EC have been deemed important in their own right (Greene et al., 2010; Schraw, Bendixen, & Dunkle, 2002) and also in terms of how they may be incorporated with the developmental positions (Barzali & Weinstock, 2015). For example, in developing their scenario-based assessment of EC, Barzali and Weinstock (2015) characterized the three previously described core epistemic positions along the lines of the key EC dimensions including: the source of knowledge (internal vs. external), the nature of knowledge (facts vs. opinion vs. theories), the structure of knowledge (one correct account vs. multiple perspectives), the justification of knowing (reality vs. personal preferences vs. coordination of theory and evidence), the certainty of knowledge (certain vs. uncertain vs. degrees of certainty), the attainability of truth (attainable vs. unattainable vs. attainable to a degree), and the role of experts (experts can or cannot know for certain). For the purposes of the current study, we will be using this combined framework to investigate EC in preservice teachers.

Domain-Generality and Domain-Specificity. There has been some debate in the past regarding whether or not individuals can possess both EC that cuts across disciplinary domains (i.e., domain generality) and EC that is specific to a particular academic domain such as science or history (i.e., domain-specificity) (Hofer & Bendixen, 2012). In sum, there is a fair amount of evidence and consensus for both the domain-generality and the domain-specificity of EC and this is the stance taken in the current study (i.e., Barzali & Weinstock, 2015; Muis, Bendixen & Haerle, 2006). For instance, we measured domain-general aspects of EC using the Epistemic Beliefs Survey developed by Schraw et al. (2002) and also utilized open-ended essays to examine preservice teachers' EC pertaining to the academic domains of science and English literature (Middle/Secondary level)/language arts (Elementary-level).

Teachers' Epistemic Cognition and Teaching Orientation

Research and theory on teachers' EC and its influences on learning and instruction is an established and vigorous area of inquiry (Buehl & Fives, 2016). In addition to more general EC and its influences on TO, there has been research in the area of specific academic disciplines including science and English/language arts (ELA).

Science. In general, the bulk of research in the area of teachers' EC and TO in science has been at the secondary level. EC and TO's held by current teachers are presumed to be influenced by their own experiences in science learning and are quite naïve (Kang, 2008).

Educational reform movements in science call for more inquiry-based and argumentation-based learning (Sandoval, 2005). For example, Lehrer et al.'s (2008) framework of the epistemology and pedagogy of scientific inquiry includes teachers selecting appropriate scientific material for "ready accessibility to initial" and sustained inquiry, and opportunities for students to "struggle with arranging material means to serve inquiry" (p. 526). Their study of sixth-grade students during a year-long ecology unit provided support for their framework and the improvements made by the participating students in terms of their EC about the nature of science.

English/Language. Students' use of language and their participation in language arts (i.e. reading, writing, speaking, and listening), more specifically, are considered to be central vehicles for learning. Interestingly, very little research has been done on EC and literacy at the elementary level as the main focus has been English Literature at the secondary level (Bendixen, 2016).

Learning to read and write at the elementary level entails not just the mechanics of these tasks but also students' involvement in the process of becoming literate. As students acquire "literate epistemologies" they "learn about language, knowledge, and themselves as literate individuals" (Johnston et al., 2001). Discourse in the classroom, or the interactions and language used by individuals in groups, is also a key component in literacy development (Gee, 1996). One direction that research has taken in the area of language arts is to examine students' EC about literacy and how that may be influenced by teachers' EC and the classroom environments they create.

For example, Johnston et al. (2001) investigated the EC of fourth-grade teachers and their students during small and large group interactions around books that the students were reading and their writing. Two teachers who were determined to encourage different modes of classroom discourse and epistemological orientation, and their students, were selected to be the focus of the analyses. Drawing on the work of Nystrand et al. (1997), Perry (1970), and Belenky et al. (1986) one classroom was categorized as "monological" and "received" where the teacher was viewed as the primary source of knowledge related to literacy and where little teacher–student or student–student discussion occurred. Students' views about literacy in this classroom focused on technical competence and lack of agency/engagement in their own writing.

In contrast, the other classroom was identified as "dialogical" and "constructed" where literacy knowledge was viewed as complex and context-bound and the role of the teacher was viewed as more of a guide than the sole authority. Not surprisingly, students in this classroom had a stronger sense of themselves as writers and stressed the value of shared knowledge production with their peers (Johnston et al., 2001).

Within this domain, some of our questions are aimed generally at teaching orientations toward language arts/English literature and some are aimed more specifically at the domain of poetry and its interpretation in the classroom. According to Certo, Apol, Wibbens, and Hawkins (2012), preservice teachers have limited experiences with reading and writing poetry and it is often forgotten or narrowly taught in schools including teacher education. Similarly, there is a "national neglect of poetry carried over to national standards." According to experts in the field, poetry provides unique and important opportunities for expanding knowledge but it is often overlooked.

We also see poetry as understudied and a very interesting one in terms of its role in EC and TO. We also think that the use of concept mapping will help elaborate on the EC of teachers and this will include preservice teachers' participation as researchers to reflect on what their EC is and how it may relate to their teaching orientation.

Mixed Methods Research and Integration

As was previously discussed, MMR merges qualitative and quantitative methods. In addition, integration is considered to be the "defining feature" in high-quality MMR (Guetterman, Crewell & Kukartz, 2015, p. 145). Moving away from more generic approaches in MM data analyses, additional and specific strategies and data analysis techniques that are tied to particular MM designs have developed (Creswell & Plano Clark, 2018; Hesse-Biber & Johnson, 2015). Further, discussions around various and new software applications that effectively combine quantitative and qualitative data including NVivo and MAXQDA have further advanced the field (Guetterman, Creswell, & Kukartz, 2015).

With all of the advancements taking place in MMR, how to integrate quantitative and qualitative data has still been challenging and needs greater attention by researchers (Plano Clark, 2019). Indeed, Bryman (2007) stated that authentic integration:

> has not been touched upon to any significant extent in the burgeoning literature in this field. In genuinely integrated studies, the quantitative and qualitative findings will be mutually informative. They will talk to each other, much like a conversation or debate, and the idea is then to construct a negotiated account of what they mean together. (pp. 20-21)

With the aforementioned literature review in mind, the current study has two main purposes: 1) to examine the efficacy of participatory concept mapping as an integration tool for MMR, and 2) to explore the EC and TO of preservice teachers.

Method

Generally, the current study's design would be considered explanatory sequential where data collection is a two-phase process with the quantitative phase happening first followed by the qualitative. The main goal is for the qualitative portion to further explain and interpret the quantitative portion. Typically, the quantitative is more of the focus with the qualitative playing a lesser role (Creswell & Plano Clark, 2018).

More specifically, this study's design would be considered a "variant" of explanatory-sequential because the quantitative strand is not emphasized as much as the subsequent qualitative strand (Creswell & Plano Clark, 2018). In addition, our study would be viewed as "an advanced mixed methods design" because something has been added to the basic explanatory sequential design, that of concept mapping in the data collection and analysis phases (Creswell, 2015). Data collection and analyses were completed in two phases (see Figure 1).

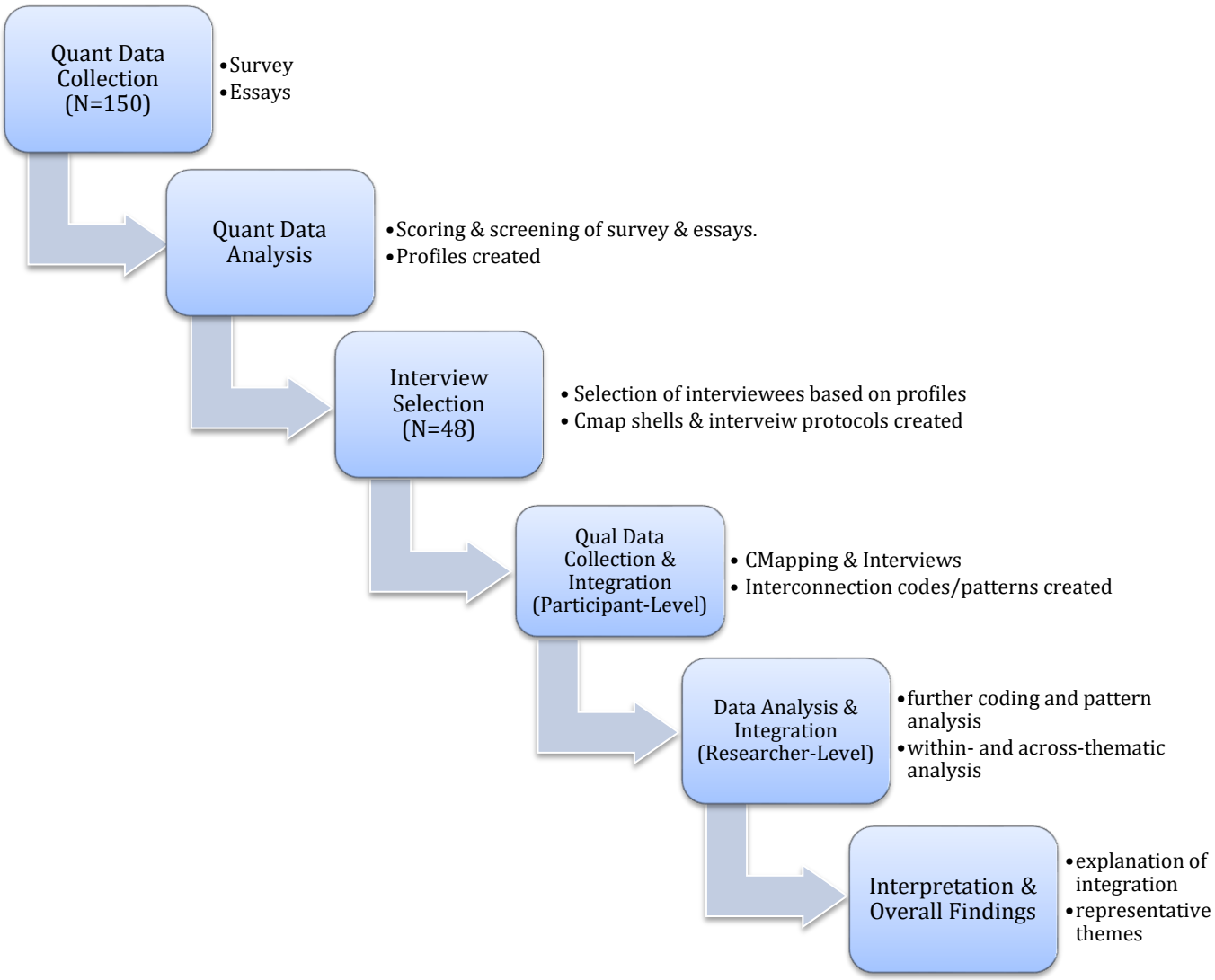

Figure 1. Phases of Data Collection and Analysis for Concept-Mapping Study

Phase 1- Quantitative

Participants: Participants were 150 pre-service teachers (99 females, 51 males). The majority of the sample was Caucasian with a mean age of 23.5 years.

Materials: Participants completed a domain-general EC survey and two domain-specific essay questions. To measure EC, the Epistemic Beliefs Inventory (EBI) (Schraw, Bendixen, & Dunkle, 2002) was administered. The EBI is an established instrument with a high degree of validity and reliability (for a validation study of the EBI see Schraw et al, 2002). Three dimensions of the EBI were used: 1) Structure of knowledge (i.e., knowledge consists of simple discrete facts vs. knowledge is interrelated and complex), 2) Certainty of knowledge (i.e., absolute knowledge exists vs. knowledge is uncertain), and 3) Views of authority (i.e., authorities have access to otherwise inaccessible knowledge vs.

authorities can be questioned) (see Appendix A for sample items). Items on the scale are formatted on a five-point Likert scale the internal consistency was at an acceptable level (Cronbach's alpha = .60). An EC score was obtained by combining the items representing the 3 EBI dimensions. Higher EBI scores represent views of knowledge as more uncertain and complex while low scores indicate views of knowledge and knowing as certain and simple.

Participants were also given two essay tasks where the response required them to choose a side to an inconclusive argument between two students regarding dinosaur extinction and poetry interpretation (see Appendix B for the essay items). To add to the reliability of the essay scoring, all essays were scored by two raters and were put into the category of Absolutist, Multiplist or Evaluativist. Interrater agreement on the dinosaur essay was 75% and on the poem essay it was 87.5%. All disagreements were discussed and 100% agreement was reached for all essays.

Based on the EBI, essays scores, and combined developmental/dimensional framework described previously (i.e., Barzilai & Weinstock, 2015), participants were given an overall EC profile of: Absolutist, Multiplist, Evaluativist, or Mixed (one or more categories present).

Procedure. The EBI and essays were administered in small groups of participants and it took approximately an hour to complete. Participants were fulfilling a research requirement for their educational psychology course.

Phase 2 – Qualitative

Our goal for Phase 2 was to select a diverse and clear subsample of profiles from the larger pool of participants in Phase 1 for interviews and concept mapping to gain additional information in terms of EC and TO.

Participants. Participants in the selected subsample (N=48; 36 females, 12 males) had a mean age of 25.1 years and the majority of them were Caucasian. These preservice teachers stated that they were planning to teach either Elementary (N=25), Middle School (N=4), Secondary (N=18), or Community College (N=1).

Materials. Selected survey (6 EBI items) and essay (dinosaur extinction and poetry interpretation) responses collected from Phase 1 were embedded in each individualized concept map shell and were used to initiate the interview protocols (see Figure 2 for a sample concept map). The researcher and participant jointly constructed a concept map representing the participant's EC in general, their EC pertaining to science/language arts, and their beliefs about science/language arts teaching. Additional open-ended interview questions were given and responses were added to the concept maps pertaining to teaching orientation TO and the potential relationship between EC and TO (see Appendix C for the interview questions). Concept maps were constructed on large sheets of paper using colored markers.

Procedure. The one-on-one interviews lasted approximately 90 minutes and were audio-taped. Each interview began with a concept map shell that included participants' responses to the six EBI items and their responses to the dinosaur extinction and poetry interpretation essays. This gave us the chance to follow-up on, and add more detail to, the quantitative data we had collected. Concept maps were constructed to represent participants': 1) domain-general and domain-specific EC (science and English), 2) TO, and 3) views on how their EC and TO may be related.

After the interviews were complete, all of the paper versions of the concept maps were converted to digital files using CmapTools software (Canas, Carvajal, Carff, & Hill, 2004) (with the help of the audio-taped interviews and field notes). CmapTools is a software program that supports the construction and modification of concept maps (Figure 2).

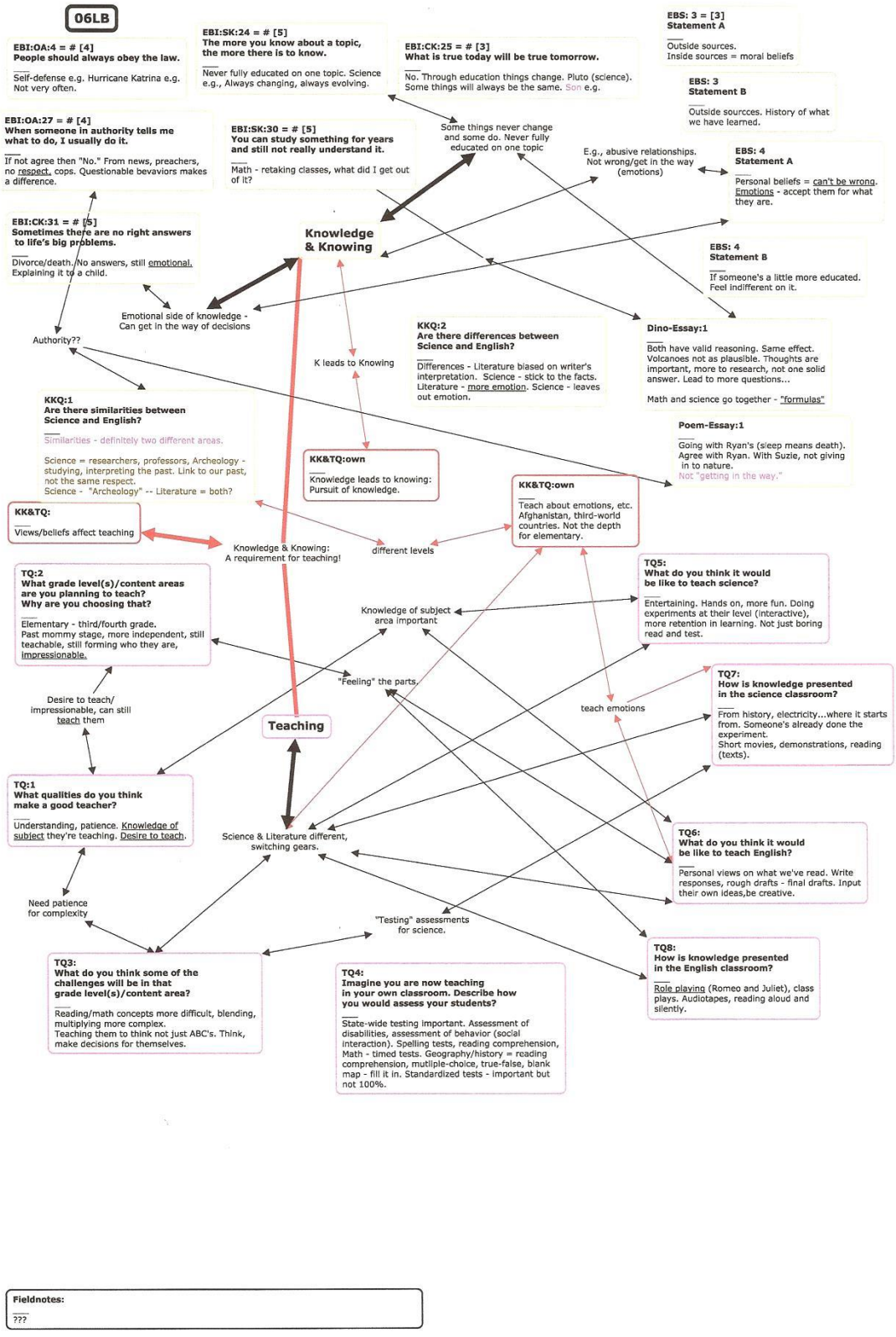

Figure 2. Sample Concept Map

Data Analysis

Our goals for analyses included capturing the preservice teachers' EC and OC along with integration at the participant and researcher levels. Analysis of the concept maps occurred at two levels: within each concept map and across the concept maps. Using a modified version of the constant comparative method and keeping the combined developmental/dimensional framework of EC in mind, categories and themes/subthemes were developed from open and axially coded concept maps (Fram, 2013). As discussed previously, the participants co-constructed the concept maps and thus made and recorded inferences and meta-inferences regarding their EC and TO. For example, in Figure 1,

there is a statement in the upper right-hand corner of the concept map: "Some things never change and some do. Never fully educated on one topic." This is an example of a meta-inference made by the participant during the interview and it also represents participant-level integration between the EBI Source of Knowledge item response (quantitative) and their dinosaur essay response (qualitative).

In addition, participants elaborated on their EBI responses and dinosaur/poem essays, and responded to open-ended interview questions about the domains of science and English/language arts (see Figure 2). Finally, inferences and meta-inferences were made by the researchers within and across the concept maps and MAXQDA was used for data storage, coding, and theme development.

The following analysis steps were taken with the data described above (researcher notes and memos were recorded at all steps):

1) A preliminary read of individual concept maps was done to get an overall sense of EC profile and TO.
2) Coding and recording of elaborations on the EBI, dinosaur/poem essays, and interview responses were completed.
3) Recording of inferences and meta-inferences generated by participants about their EC and TO. EC profiles were also determined.
4) Codes, inferences, and meta-inferences were used to develop themes/subthemes by aggregating similar codes and inferences together.
5) A thematic analysis was completed across the concept maps and representative themes were retained and recorded.

Results

Our purpose was to examine the efficacy of participatory concept mapping as an integration tool for MMR and to explore the EC and TO of preservice teachers. The following section will describe the results that were found including how concept mapping performed as an integration tool. In addition, the themes and subthemes that were derived from the analyses will be described along with illustrative participant inferences/quotes/statements related to EC and TO.

Concept Mapping as an Integration Tool

Participatory concept mapping exceeded our expectations in terms of its structure encouraging participants to be a part of the analysis. Expanding upon the quantitative portions of the data participants gave us additional detail that the EBI items wouldn't have given us on their own. For instance, some participants stated they were a bit confused by the items and some of the profiles shifted after a more complete picture of their dimensions of EC were given. Interestingly, the discussion regarding the view of authority items (e.g., "If someone in authority tells me to do something, I usually do it.") showed the greatest variance in the profiles. For example, some participants looked more multiplistic in their other EBI responses (source and structure of knowledge) but when it came to the authority items their thinking became more absolutist. Others were fairly consistent across all of their concept maps (usually multiplistic) and this gave us more confidence in categorizing them into a particular profile.

More generally, the inferences and meta-inferences participants made as a part of the concept mapping was a key to integration. Interestingly, as researchers, our concept of what integration entails was expanded as well. This technique certainly allowed the quantitative and qualitative pieces of the study to come together more clearly and it also allowed for a stronger integration of *all* data points in the study. In essence, the results indicate that participants went beyond their typical role and became "research collaborators" in terms of their contributions to the integration components of this study (Burke et al., 2005).

Epistemic Cognition and Teaching Orientation

Profiles. After the analysis of the concept mapping was complete participants were again placed in one of the four Profile groups: Absolutist (N=8), Multiplist (N=24), Evaluativist (N=6), or Mixed (N=10). The Mixed profile included participants who could not be easily classified into the three EC profile categories. Most of these individuals showed aspects of two of the profiles (Absolutist/Multiplist or Multiplist/Evaluativist) and, for the sake of brevity, will not be specifically included in the remaining sections.

Domain differences. There was plenty of evidence to support that participants saw a number of domain differences in science and English/language arts in terms of EC and TO. Science was viewed as *more true* and based on research so students should have exposure to the facts/evidence. The domain of English/language arts was divided in terms of the more *structured/rigid* side of English – that of grammar, sentence structure, spelling etc. versus the more *open/opinionated* side of reading stories and creative writing.

For most, the specific area of poetry and its interpretation, was on the far end of the subjectivity continuum and this is where student opinion was most valued (e.g., *Any student opinion would be OK…no definite answer*.). In other words, participants felt that *since we don't know what the author meant everyone has a right to their own opinion.*

Theme 1: Knowledge is Complex/Changing – Teachers Should be Open to New Knowledge and (Some) Student Opinion.

There was one main theme that was apparent both within and across the concept maps – the view that the structure of knowledge is fairly complex and it is most always changing. Many of the participants noted that, for them, these two dimensions of EC overlapped and that this belief also was linked to TO in that teachers need to be aware of the complexity and changing aspects of knowledge and *stay up-to-date* for themselves and for their students. Similarly, many felt that there is *always more to learn* in most any subject and this was one main reason why they thought teaching would be exciting (e.g., *to teach you need to always gain knowledge*).

Valuing and encouraging students to have their own thoughts and opinions was also highly valued by most; especially in the subjective area of poetry interpretation (e.g., *When you look at poems, there's so much room for personal interpretations. You have to accept there is no right answer sometimes.*).

Analyses revealed three additional themes and subthemes that centered on the EC profiles and links to TO and they are described in the next section.

Theme 2: Absolutist – Teacher as Content Expert.

In general, the idea that that are some certain truths or *knowledge that won't ever change was apparent*. Strong views of respecting and following authority were held in this profile as well (e.g., *Parents and bosses tell me what to do, they are my superiors*) and that laws are place for good reason (e.g., *Obey the law 99% of the time*.). In other words, most people *in authority are there for a reason and are educated and experienced*. This stronger view of authority was also linked to the need for teachers to have a place of authority in the classroom as content experts. Interestingly, this role of teacher as content expert seemed daunting to a few participants and one stated that she was *afraid I will not know the correct answers* to students' questions.

Use of basic assessments (i.e., *fill-in the blanks, multiple-choice tests, and essays*) was the focus as well along with the avoidance of *teacher bias* and *emotion clouding judgment*. Science was viewed as *based on research and facts* so students should, in turn, do *more research to find out what the experts say*. Finally, the factual/rigid side of English/language arts (i.e., grammar/spelling) was mentioned and that because of this rigidity, *English would be hard to teach*.

Theme 3: Multiplist – Teacher Should be Unbiased and Adjusting.

This profile was the most varied and inconsistent in terms of EC and TO but the main pattern of multiplistic thinking was apparent. In general, knowledge was viewed as uncertain and that it came mainly from personal experiences. Knowledge and knowing was based on *individual interpretation/opinion* and several participants inferred that this was directly linked to their view that teachers needed *adjust teaching* and *teach differently to individual students.*

Science was considered to be *just made up of theory* and, in this case theory, meant merely a collection of different opinions. Similarly, because poetry was *completely relative*, teachers should *not put their biases in* to students' debates because *students need to have their own opinions*. In fact, the "debates" that were described in the two essay prompts (dinosaur and poetry) were viewed quite negatively by some of the participants in this profile and the teacher's role should be *to make the students stop arguing*.

Theme 4: Evaluativist – Teaching Should Be Dynamic and Discussion-Based.

A smaller number of participants (N=6) fit squarely in the evaluativist profile and their TO's were quite distinct. In terms of their EC, the view that *knowledge as truth doesn't exist* was prevalent and scientific theory was viewed as *consensus based on reputable sources*.

In general, these participants also saw knowledge and teaching as more process-oriented (e.g., *Teachers need to teach as though knowledge is dynamic!*) and felt that discussions and debates should be main activities in the classroom (e.g., *I believe in doing class discussions in both English and science.* and *To have a discussion, one must need to research and come up with own ideas.*). Assessment was viewed as a *strong part of teaching* and should include *whole-person assessment* and move away from standardized assessments because *students aren't standard*.

Finally, it was clear that this EC and TO were linked in that to teach in this more process-oriented way one *needs to invest time* and *embed compassion and ethics*. Indeed, emotion/passion was determined to be a key to changing beliefs in the classroom and the time it takes to teach and learn in this way is a fruitful investment.

Summary

In sum, there were distinguishable patterns of EC and TO detected in the concept maps. The majority of the profiles were consistent in terms of the combined developmental/dimensional framework and clear connections were made to TO. Participatory concept mapping was also an effective means for MMR integration.

Discussion

The following section will discuss the findings of the current study as they relate concept mapping, EC and TO. In addition, implications for MMR, learning, instruction and teacher education will also be included.

Participatory Concept Mapping and MM Integration

As we have stated previously, the value of rigorous integration techniques in MMR is a current focus for educational researchers. In fact, there is a recent special issue devoted to this very topic in *Contemporary Educational Psychology* (McCrudden et al, 2019). In discussing the importance of integration in MMR, Plano Clark (2019) states that:

> Achieving meaningful integration is an important goal in the conduct of mixed methods research. In my experience working with scholars across a wide range of disciplines, I find that meaningful integration rarely happens by chance because the challenge of integration is simply too great. However, researchers that explicitly plan for integration often have a better chance of achieving insights that arise from effectively combining the quantitative and qualitative aspects of the study. Identifying practical strategies that assist researchers in meeting this challenge is a major thrust of the mixed methods literature. (p. 108)

Based on the outcomes of the current study, we feel that we have provided an example of such practical strategies for educational researchers. We found that participatory concept mapping was a successful tool for integration. As was discussed previously, this type of integration happened in the current study during data collection and during analysis. An important component of integration is when meta-inferences are made, or when the quantitative and qualitative data are incorporated into a coherent conceptual framework to provide answers to the research questions (Creswell & Plano Clark, 2018; Teddlie & Tashakkori, 2009). In the current study inferences and meta-inferences were made by both the participants and the researchers and this happened at two points: 1) while the participants were generating their concept maps (expanding on the quantitative findings and also generating new connections within and across EC and TO), and 2) during the researchers' analysis within and across concept maps.

This form of "participant and researcher processing" and meta-inferencing (Burke et al., 2005) was also successful at further integrating all of the data, not just the quantitative and qualitative portions. For example, the participants offered additional insights into their qualitative responses (i.e., responses to open-ended interview questions) as well when given the chance to do so during concept mapping. In essence, the concept mapping technique may offer a more nuanced view of what integration can look like in MMR and would be consistent with recommendations from current literature (e.g., Maxwell, Chmiel, & Roger, 2015, Plano Clark, 2019). Future research should further examine concept mapping as an integration tool.

Knowledge is Complex/Changing – Teachers Should be Open to New Knowledge and (Some) Student Opinion

The idea that most of the participants viewed knowledge as complex and changing was encouraging in many respects (Barzilai & Weinstock, 2015). This view of teacher as ongoing learner may help with teachers being more open to new developments in their field.

Participants were also consistent in their view of poetry as being completely subjective and students should be encouraged to have their own opinions in this area of learning. Part of this naïve view of poetry and its instruction could be linked back to the "neglect" that is going on in preservice teacher training and the classroom (Certo et al., 2012). For example, there are a number of ways that poetry can be more objectively analyzed including findings sources of evidence within the text (e.g., Lennard, 2005) and this should be communicated more clearly to those who are learning about it. For instance, Wilson (2007) discusses various strategies for engaging with a poem including finding the speakers' voice, rhetorical patterns, and textual examples to support interpretations. Future research could examine how the EC of poetry more specifically affects learning and instruction.

Absolutism – Teacher as Content Expert

Views of authority are a key component in EC and, based on our results, the importance of putting faith in authority transferred to TO as well. Heavy reliance on authority to support knowledge claims is viewed as less advanced in the EC literature (Barzilai & Wienstock, 2015) and the teacher as a main source of knowledge would fit with a more teacher-centered approach as well. This view is also reminiscent of a monological approach to teaching where only the teacher knows and holds the truth (Reznitskaya, 2012).

Being the content expert and main authority in the classroom seemed to also be a cause for concern in some participants. For example, being "afraid" of not knowing the correct answer could have significant negative effects on a number of things including teacher efficacy (Koksal, 2011).

Multiplism – Teacher Should Be Unbiased and Adjusting

The main tenets of a multiplistic EC are that knowledge is relative and based on opinion and this was apparent in the participants categorized in this profile. This view puts the role of the teacher in an interesting/difficult position (Bendixen, 2016). For example, if every student has a right to their own and equally right view about something, then it

would follow that the teacher needs to accommodate for that and change their teaching strategies to fit individual students. In addition, several participants felt that argumentation among students was unproductive and led to emotions getting in the way. This view was linked to TO in that argumentation and critical thinking would not be necessary if all knowledge is relative (Kuhn & Weinstock, 2002).

In a similar vein, several participants felt that it was unwise for the teacher to impart their biases or judgments on the students. Again, how an effective teacher can avoid making judgments about students thinking, for example, is not a very realistic way of going about teaching (e.g., assessments, teaching strategies).

Evaluativism – Teaching Should Be Dynamic and Discussion-Based

Participants who espoused evaluativistic EC also felt that student-centered and discussion-based teaching and learning was a must. This type of TO is reminiscent of dialogic teaching. According to the research of Reznitskaya & Gregory (2013), dialogic teaching holds great promise for advancements in student learning. In dialogic classrooms: (1) power relations are flexible, (2) learning communities are developed based on equality and various roles in directing classroom communication, (3) open-ended questions are asked and evaluated by members of the group, and (4) teachers are more knowledgeable than their students, but not "the boss," rather a leader of group activities.

It was mentioned by a few participants that teaching in a dynamic way takes a lot of time and this has been discussed in the literature (Bendixen, 2016). For example, research shows that teachers encouraging students to learn the epistemic underpinnings of a subject and then allowing discussion and debates among peers takes time and practice to produce real changes in student learning (Reznitskaya et al. 2012; Ryu & Sandoval, 2012). This notion of extra time, of course, flies in the face of most teachers struggling with not enough time and feeling the need to scramble and rush through daily lessons to get fulfill the learning objectives/standards that have been given to them.

Limitations

There are a few key limitations to the current research that should be considered. In the quantitative portion of the study, we relied heavily on a self-report measure to tap into preservice teachers' EC. While this is a very common approach in the field, there are other ways to capture teachers' EC including classroom observations. In addition, our findings cannot generalize to other populations. It is quite possible that preservice teachers from other regions of the US and other countries may hold differing EC and TO (Hofer & Bendixen, 2016) and future research should continue to examine these differences along these lines.

Implications and Recommendations for Teacher Education

There are a number of implications for teacher education that stem from the current research. We concur with Buehl and Fives (2016) in that the focus of teacher education and preparation should be on both the development of knowledge and beliefs. They further suggest that EC serves as both a focus and a lens when it comes to training teachers. That is, beliefs are both part of what teacher educators seek to influence, or target through teacher education (focus), as well as a filter (lens) through which influencing experiences (teacher education) are under stood. This approach to teacher education needs to be examined in research on teacher learning and in the practice of teacher educators. We would also suggest that more research needs to be done to clarify the links between preservice and practicing teachers' EC and TO (Bendixen & Feucht, 2010).

Another major implication for teacher education that stems from the current study is the need for more teacher training in dialogic teaching and learning that was discussed in an earlier section. Despite its great potential for student learning, dialogical teaching is rare and difficult to achieve in current classrooms (Reznitskaya, 2012). Similar to what our participants did in their concept-mapping, the dialogical approach also includes students making meta-level reflections about their own learning. For example, in dialogic discussions:

> The primary role of a teacher is to help students pay attention to the process and quality of their reasoning—from questions toward judgments—rather than to tell students what the answers should be (Gregory, 2007). Examples of meta-level moves include seeking clarification, connecting ideas across contexts and participants, and reflecting on levels of understanding. (Reznitskaya, 2012, p. 448)

It is our view that teacher education should focus its efforts on training preservice teachers in the processes involved in dialogical learning and instruction. Although dialogic teaching and the argumentation it encourages is discussed predominantly in the area of language arts, we think it has great promise in encouraging student learning at all levels and subject areas (Bendixen, 2016).

English/Language Arts. Understanding teachers' EC in the area of English language arts is a burgeoning area of research. For example, argumentative writing across all subjects is a current focus in national standards and research and teachers and students often struggle with its complexities. Newell, Van Der Heide, and Wynhoff Olsen (2014) looked at the epistemologies of high school English teachers' argumentative writing and found that EC and TO affected their instruction. Although they found differing modes of EC and instruction, all of the teachers benefitted from reflection and discussion of their particular epistemologies of argumentative writing. The authors point out that this

approach to understanding and discussing the epistemologies behind instructional choices with teachers could be used as a model for future teacher education efforts.

Poetry. As was discussed previously, the reading, writing and teaching of poetry is often neglected or treated superficially in schools and this certainly seems to be the case in teacher education (Hanaer, 2007). Future research should examine EC and TO more in the genre of poetry. For example, Certo and colleagues (2012) investigated the effects of a semester-long course that focused on an aesthetic approach to reading, writing and performing poetry with preservice teachers (elementary, middle, and secondary levels). For most of the participants, poetry was fairly foreign to them. As one participant put it "I honestly did not read a lot of poetry in school. Poetry was kind of, you know, just a little bit here and there. I don't feel prepared to teach it at all" (p. 120). Results from the interview study found promising results in terms of changing preservice teachers' experiences and dispositions for the better regarding poetry for themselves and for their future teaching. The authors concluded that preservice teachers need "compelling" experiences with poetry in teacher education to better prepare them for teaching it (Certo et al., 2012).

Science. The implications of EC for learning, instruction, and teacher education has firm grounding in the literature (e.g., Sandoval, 2005). More fine-grained research is needed along these lines to fully understand the experiences of preservice teachers as they train and then transition to being in charge of their own classrooms. With a focus on learning to teach inquiry, Kang, Bianchinni, and Kelly (2013) investigated the transition of preservice science students to science teachers and grouped them according to two types of potential science teachers: 1) Teacher of inquiry but with questions and 2) Inquiry-oriented teacher. Based on their findings, the authors recommended that preservice teachers could benefit from explicit opportunities (e.g., peer review, reflection) to help them "navigate the border between learning and teaching science" (p. 427). We would agree and see this opportunity of helping preservice navigate their transition to teacher as being beneficial for students in all subject areas.

Conclusions

The current study offers a number of important insights into concept mapping in MMR. Participatory concept mapping allowed for participants to become "research collaborators" in contributing more than just responses to questions and, more specifically, they were able to provide valuable detail and integration (Burke et al., 2005). In addition, concept mapping was quite effective at unearthing information about preservice teachers' EC and its links TO to further clarify their importance in learning and instruction.

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Appendix A

Selected Likert items from the Epistemic Beliefs Inventory (EBI) and their corresponding dimensions (*Knowledge & Knowing* area of the concept map in Figure 2).

Structure of Knowledge

"The more you know about a topic, the more there is to know."

"You can study something for years and still not really understand it."

Certainty of Knowledge

"What is true today will be true tomorrow."

"Sometimes there are no right answers to life's big problems."

View of Authority

"People should always obey the law."

"When someone in authority tells me what to do, I usually do it."

Appendix B

Directions for Dinosaur and Poem essays.

Dinosaurs' extinction

During your Earth Science class, the teacher showed a Discovery Channel special reviewing the numerous theories about how dinosaurs became extinct. Two compelling theories were reviewed within the video; a volcanic eruption or a meteorite hitting the earth might have led to the extinction of the dinosaurs.

Volcanoes can cause mass extinction because they release large amounts of carbon dioxide into the atmosphere, which causes dramatic changes in climatic conditions. Moreover, acid rains would form because of the volcanic ash filling Earth's atmosphere, which would cause a disastrous ecological crisis. The enormous volcanic eruption would have initially caused a deadly cooling and later an equally fatal warming of the atmosphere.

These changes are similar to those following the fall of a meteorite. Following a meteorite's impact, enormous clouds of dust are released into the atmosphere masking the light from the sun and causing temperatures to drop to below freezing (an equivalent of a "nuclear winter"), making it impossible for plants to carry out the process of photosynthesis. This would cause the interruption of the food chain across Earth's sphere, and thus a domino effect. Plants would become extinct first, then the herbivores that ate them, and finally the carnivores that fed on the herbivores. This could have happened quickly enough that dinosaurs could not evolve to meet the new conditions.

After class you hear Hannah and Evan debating which theory about the dinosaurs' extinction would be true based on the evidence presented within the two theories. They do not agree with each other. Hannah thinks that dinosaurs died from a meteorite hitting the earth while Evan thinks that the dinosaurs died from a volcanic eruption. They both believe that they are right.

Please address the following questions in your essay.

- Who do you think is right and who is wrong?
- What do you think is the problem?
- How would you solve this problem?
- What position would you take?
- When you join Hannah and Evan's discussion, what would you say to Hannah and what would you say to Evan?

In several paragraphs explain your answers in detail and provide examples from everyday life.

Frost Poem Interpretation

For your American Literature class, the teacher has put the students into groups to present various poems by Robert Frost. The teacher has taught the class how to interpret poetry using various literary criticism techniques. In *biographical criticism*, the poet's life and what the poet has to say about the meaning of his own poem are the most important pieces of information to consider when interpreting a poem. In *formalist criticism*, the structure, words, and other technical features of the poem are the most important in a poem's analysis.

Your group has been discussing the meaning of the last stanza of Frost's poem "Stopping by Woods on a Snowy Evening," which reads as follows:

> The woods are lovely, dark, and deep,
>
> But I have promises to keep,
>
> And miles to go before I sleep,
>
> And miles to go before I sleep.

Your group begins discussing the meaning of the word sleep in this stanza. Susie and Ryan do not agree with each other about the meaning of the word sleep. Susie says that Frost himself said the poem is about giving in to the dark forces of nature. She says they should use biographical criticism and interpret the poem as being about the dark forces of nature. Ryan says that t they should only look at meaning and feeling of the words of the poem, as in formalist criticism. He says that the words in the poem have a dark feeling and that one of the meanings of sleep is death, so they should interpret the poem as being about death. They both believe that they are right.

Please address the following questions in your essay.

- Who do you think is right and who is wrong?
- What do you think is the problem?
- How would you solve this problem?
- What position would you take?
- When you join Ryan and Susie's discussion, what would you say to Susie and what would you say to Ryan?

In several paragraphs explain your answers in detail and provide examples from everyday life.

Appendix C

Interview Questions for EC (In *Knowledge & Knowing* area of the concept map in Figure 2)

1. Are there similarities in science and English?
2. Are there differences in science and English?

Interview Questions for Teaching Orientation (In *Teaching* area of the concept map in Figure 2)

1. What qualities do you think make a good teacher?
2. What grade(s) level(s)/content areas(s) are you planning to teach? Why are you choosing that?
3. What do tou think some of the challenges will be in that grade level(s)/content area(s)?
4. Imagine you are now teaching in your own classroom. Describe how you will assess you students.
5. What do you think it would be like to teach science?
6. What do you think it would be like to teach English?
7. How is knowledge represented in the science classroom?
8. How is knowledge represented in the English classroom?

Interview Question for EC and TO (Red lines on concept map in Figure 2)

1. Do you think your beliefs about knowledge and knowing are related to your teaching beliefs? If so, how?