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From Worldviews to Classrooms: Framing Evolution Acceptance in Pre-Service Science Teachers in the Southeastern United States

Amanda Glaze
Georgia Southern University, aglaze@georgiasouthern.edu

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Abstract
Research demonstrates that teachers' acceptance or rejection of evolution impacts whether they teach evolution in their classrooms. Furthermore, factors such as religiosity and nature of science understanding impact acceptance or rejection. What is absent from the literature is an exploration of experiences that inform choices made regarding acceptance or rejection, experiences that illuminate the counter-intuitive relationships demonstrated in quantitative studies. For this reason, we explore the lived experiences that inform the worldviews of Pre-Service Secondary Science Teachers (PSSTs) and how those worldviews might inform their acceptance or rejection of evolution. Coding and pattern analysis informed themes within the data explaining how worldviews and evolution intersect, influencing acceptance or rejection. Themes included framing of experiences by worldviews, levels of commitment to religiosity, lack of consistent exposure to evolution, conflicting and coping, and the fact that PSSTs are already thinking about whether to teach evolution before they enter the classroom. Exploring these interactions and the process by which PSSTs negotiate acceptance or rejection provide insights for support and rich preparation in order to ease the process and positively impact the teaching of evolution, and other controversial topics. Understanding how PSSTs think about evolution can inform teacher education and science education, using understanding of our past and present to impact the future.

Keywords
evolution education, acceptance, worldview, teacher education

Introduction

When it comes to areas of controversy between the scientific community and the public--such as the conflict that surrounds the acceptance of evolution--we often disregard that individuals' beliefs and understandings of the world are connected on a level that precedes their time in the classroom. Where existing research focuses primarily on statistical explanations of acceptance or rejection, we are missing the background--the deeper understandings of why and how people, especially educators, develop in terms of their understandings and choices to accept or rejection evolution. A person's life experiences interact, intersect, and diverge to construct the lenses through which they view the world and against which they interpret new experiences and information—in essence— their worldview. Where these lenses are in agreement, there exists a range of acceptance; where there is discord, levels of rejection. The latter is demonstrated in misinterpretation of facts, integration of fiction, and rejection of scientific concepts despite overwhelming evidence, all used as methods to reconcile new experiences with conflicting lenses.

Evolution is defined in science as descent with modification. The processes and mechanisms by which the modifications occur are seen by scientists as applying to all living things. These changes are explained as occurring within populations, what some might refer to as micro-evolution, and the changes that result in the emergence of new species, what some refer to as macro-evolution. While many people can agree that changes do occur in living things, there is a great deal of public discourse and conflict when it comes to the longer-term impact of evolution and common ancestry (Pobiner, 2016). It is the matters of human evolution and emergence of new species that cause the greatest conflict among the public and a large part of that is connected with the concept of worldview (Glaze, 2013).

The public controversy surrounding evolution is deeply rooted in personal contention between scientific understandings and the internal worldview held by an individual (Ogunleye, 2009). We are reminded, where science intersects with beliefs, that "worldview is the overall perspective from which one sees and interprets the world" (Shuumba, 1999; p. 333). Thus, it is solely in the mind of the individual that these conflicts between science and the internal world are resolved. Worldview conflicts can be openly observed in the Southeastern United States, where culture and beliefs often go head-to-head against scientific knowledge and practice, where each day, in classrooms around the region, teachers make key decisions about what to teach, and how or whether they teach topics such as evolution (Goldston & Kyzer, 2009). It is in these classrooms, where the next generations of thinkers are shaped, that students learn whether they trust or distrust science, understand the nature of science, and discern the underpinning theories of science, including evolution.

It is imperative to understand not just what impacts science teachers' acceptance or rejection which impacts their choices to teach evolution, but the experiences that lead them to their positions and ideas about approaching evolution in the classroom. Therefore, it is critical that we explore their experiences at a time when we still have access and ability to teach them all. Pre-service secondary science teachers represent a transitory position of student to teacher. For these reasons, it is important to science and teacher education that we understand how pre-service secondary science teachers make decisions to either accept or reject evolution and how acceptance or rejection impacts classroom choices whether, and how, to teach evolution. Therefore, this study explored the lived experiences of pre-service secondary science teachers educated in the Southeastern United States, with respect to what influences acceptance or

rejection of evolution as a scientific theory and identify substantive categories of influence, seeking to answer the following question: What experiences do pre-service teachers see as influencing their thinking about evolution?

Background

The goal of science education today is the establishment of a scientifically literate society (Cavagnetto, 2010; Dillon, 2009; Laugksch, 2000; National Research Council, 2011; Zeidler & Sadler, 2011). Cobern (1994a) points out that one cannot have literacy without consideration of worldview: "No person, including any scientist or science educator, and no segment of culture, including the community of scientists and educators, uses a single knowledge source" (p. 15). These internal and external sources join together to form an individual's worldview. According to Cobern (1991), "worldview refers to the culturally-dependent, generally sub-conscious, fundamental organization of the mind. The organization of a person's worldview manifests itself as a set of presuppositions or assumptions, which predispose one to feel, think, and act in predictable patterns" (p. 3). Therefore, the worldview is the lens through which we view the world, as well as the filter through which we process all other information that enters our realm of discovery. It allows us to evaluate new information and organize what we experience in a continuum with that which has already been experienced.

The formulation of a worldview is one that takes place from birth and is deeply rooted in the surroundings of the individual, including existing cultural practices, interactions with family and peers, and development of identity and the incorporation of knowledge into this closely held belief system (Beauchamp & Thomas, 2009; Sfard & Prusak, 2005). It is for this reason that concepts, like evolution, that come into direct conflict with a person's worldview are often rejected based on incongruence rather than upon a preponderance of the evidence. To accept a conflicting and even offending theory would be to directly reject one's most closely held beliefs and, in turn, the identity that defines the self. As Hansson and Lindahl (2010) posited, "school and home have different cultures that interact within the student; when they align we get acceptance, when they diverge we get rejection" (p. 899).

The problem with evolution lies in the fact that even if people know and understand the concepts and supporting evidence, they may simply reject the theory based on the dissonance it causes with their accepted worldview. We can reject things and still understand them; likewise, we can accept things we do not truly understand (Nehm & Schonfeld, 2007; Smith, 2010a) One thing that is known about people and evolution is that an individual's choice to accept evolution, as well as how they teach or will teach evolution, is complicated (Smith, 2010b). Griffith and Brem (2004) explain that "there is evidence that teachers experience internal and external conflict over teaching evolution" (p. 792) and Smith (2010b) adds that "each individual-both teacher and learner- entering the classroom bring with him or her a personal naive psychology, a cognitive ecology of factors that impact learning" (p. 544). These factors are likely to vary based on the individuals involved, but there should be some sharing of culture among persons from similar backgrounds, allowing for generalization of studies of these factors as well as group-wide applications of responses to address them.

Methodology

A narrative qualitative methodology, framed using the theoretical underpinning of worldview, was selected for this study based on compatibility with the research question**.** The ability to tell their story in their own words enabled participants to describe their experiences with evolution and share how those experiences have shaped their present feelings and thoughts about evolution teaching and learning. Participants in this study, upper-level undergraduate college students, had completed their core courses and had begun study in a regional college of

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education. Students completed an initial online survey and were given the opportunity to be chosen for interview if they were undergraduates, had completed their core biology coursework, and were listed as science education majors. These participants were already matched with their level of acceptance of evolution (very low, low, moderate, high, very high) based on their participation in a previous study by the author (Glaze, 2015).

The primary interview protocol consisted of questions that explored religiosity, family background, socio- cultural constructs, and individual's individual perceptions, as well as content knowledge and understanding of the nature of science. The interview selection process brought up a number of participants' concerns relative to the topic of evolution. First, many students were unwilling to share their views about, or even discuss, evolution when asked if they wished to participate in the interview. Of the 142 students who had previously participated in a research study by the author, only 24 provided their contact information when asked whether they would be willing to be interviewed regarding their ideas about evolution. From those 24 volunteers, ten were selected for interviews, with the pool being grouped by level (very low, low, moderate, high, very high) and two participants randomly selected to represent each level. Interviews took place on the campus of the institution and consisted of one hour-long session with each participant and up to four fifteen-minute supplemental interview sessions to address any questions or clarifications required during the transcription process. What follows is a summary of the impressions from each level and how these stories impact science teaching and learning.

Discussion

Grouping of participants by levels of acceptance provided a means for exploring common threads shared by the participants. These experiences, and the storytelling that accompanied the retelling, revealed their thoughts and expectations regarding their own experiences surrounding evolution and their perceptions of evolution in light of their personal experiences. Those who had the greatest levels of acceptance of evolution based on their MATE scores were both above 95% on a 100% scale, which would imply greater knowledge and understanding of both evolution and the nature of science. Despite this, they held similar, if not the same, misconceptions as individuals at the other levels of acceptance (Nehm, Kim, & Sheppard, 2009). An interesting commonality within this group was the ability to separate scientific knowledge of evolution from personal religious beliefs. Similar to participants in Griffith and Brem's (2004) study, these high acceptance participants fell into what the authors describe as the "scientist teachers" category in their mode of coping with teaching evolution. In both cases, they were brought up as highly engaged and active participants within the Christian Fundamentalist religious culture of the Southeastern United States; however, both experienced distancing events that pushed them to adopt anti-fundamentalist beliefs as adults.

Those in the high acceptance group demonstrated in part, an ability to reconcile or manage their personal beliefs and their scientific beliefs. In effect, they straddled the line between the categories of being scientists and selective teachers (Griffith & Brem, 2004). They both embraced science and were supportive of the teaching of evolution, yet they still had questions due to their experiences with religion and beliefs about God. Two high acceptance participants reported being religious or in search of an active religion but did not report being literalists in terms of their religious practice. This position allowed them to either find ways to support their personal beliefs with evolution as evidence, or completely separate the two as being parts of two separate entities. The high acceptance participants in this study were characterized by the acknowledgement of the presence and interjection of a higher power in the process of evolution while still accepting evolution as truth, a position mirroring that of high- ranking scientists such as Francis Collins, formerly of the human genome project and head of the National Institutes of Health, who have reconciled their religious beliefs and scientific understandings.

Participants in the moderate acceptance range demonstrated the ability to rationalize some belief in evolution with their religious beliefs; however, more instances of selective belief in aspects of evolutionary theory occurred with much less certainty than the higher acceptance groups. The moderate acceptance group exhibited similar behaviors to those demonstrated among weak creationists in Brem, Ranney, and Schindel's (2003) study of coping. These participants were more likely to explore all sides of the evolution argument than any other group. Most notably, they reported to be highly involved in family, church, and community**,** and were more likely to report having mentors or peers to whom they looked for answers about matters of science and religion.

Another trait in this group was the ability to believe in creationism as well as accepting some aspects of evolution. An exception to the co-belief in religion and evolution held by these participants was human evolution, where the participants explained human origins with creation stories, specifically Genesis creation. This group tended to see science and religion as complimentary to one another, where the two fit together to provide explanation. Like selective teachers, they chose to believe parts, but not all, of evolution (Griffith & Brem, 2004). A common theme was the explanation of creation through scientific terms, such as recognizing that a "day" to a higher being does not have to be twenty-four hours and finding compatibility in that the events of the seven-day creation follow the same pattern as scientific explanations of the origins of the universe and life**,** with evolution as the mechanism by which God changes life on Earth. This group was also more likely to see creationism as an equal to scientific evolution, both in their own beliefs and in the classroom.

The low acceptance level group tended to be more deeply conscious of the conflict between their own religious beliefs and their understanding of science. One participant's worldview occupied a precarious position between science and religion, as she was the daughter of a minister in a Baptist church. Although these participants accepted science as universal and evidence driven, comments were made regarding the lack of proof for evolution, especially the concept of evolution as "only a theory," drawing on the lay term of theory as something that is not necessarily based on evidence. Again, the idea of science being tasked with "proving" indicates underlying struggles with scientific knowledge as being self-correcting and tentative. These individuals were more likely to avoid teaching evolution unless required by the school itself and made more comments about teaching creation stories to help students decide what to believe. Those in the low acceptance level struggled more with negotiating the key concepts of evolution in light of their religious beliefs, more frequently making comments regarding evolution that were inaccurate. For instance, one participant mentioned that laws and theories are well proven in one statement, then noted that evolution is a theory without evidence or support in another, suggesting unrecognized or unresolved conflict between his beliefs and understandings of science. Representatives of this group exhibited the most acknowledged internal conflict and seemed more eager to explore the different avenues of discussion of beliefs than other groups.

The participants with the lowest scores on acceptance of evolution held that a literal interpretation of their religious text was not only warranted, but served as a primary tenet of their core beliefs. Participants made comments regarding the Bible not as a book written by men to explain God, but written by God as the living Word of God, through which they were given instructions about all that has been and will be in this world. This caused direct conflict between what they accepted in their religious beliefs and what they had been taught about evolution. The lowest scoring participants were unable or unwilling to reconcile or manage their religious and scientific beliefs; therefore, they rejected evolution as wholly false. It is notable that there is no zero score for acceptance, but there is a score representative of disagreement with each of the statements respective to evolution and agreement with all those that are contrary to evolution. For

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individuals who rate a score of 20 there was no other option for belief or acceptance but to actively reject anything to do with supporting evolution. These lowest scoring individuals were highly aware of the internal tension between the two. For the most part they coped with the tension by ignoring the conflict and avoiding evolution altogether, even in discussion.

Conclusion

Scientific literacy within our society is, and will continue to be, the goal of science education for future generations (Association for Science Teacher Education, 2013; National Academy of Sciences, 2008; National Research Council, 2011). What is often overlooked is that, to build a scientifically literate society, we must assess the scientific health of those who will be on the front lines of preparing that society. There is no better place to begin than with pre-service secondary science teachers whose ideas about teaching and learning will influence the students they teach. Understanding the lived experiences that contribute to pre-service secondary science teachers' worldviews enables understanding of the processes by which students make decisions about science. In turn, those decisions, whether positive or negative, impact their scientific literacy and subsequently that of their future students. Charting the thought processes of these individuals is imperative to understanding whether they accept or reject evolution, which elements of evolution (microevolution, macroevolution, common descent, human evolution) they struggle with, and where they fall in the continuum between acceptance or rejection.

The literature supports that acceptance or rejection of evolution influences what and how teachers address the topic in their classrooms (Alters & Alters, 2001; Bowman, 2008; Catley, 2006; Veal & Kubasko, 2003). Thus, entering this study, it was expected that there would be factors influencing pre-service science teachers regarding their ideas about evolution (Goldston & Kyzer, 2009; Griffith & Brem, 2004; Moore & Kraemer, 2005; Trani, 2004). In keeping with prior studies with teachers, the pre-service secondary science teachers in this study who had high acceptance expressed more inclination to teach evolution in its entirety and teach it with the same fervor as other topics in biology such as cells and genetics (Griffith & Brem, 2004). Those on the opposite end of the spectrum noted reluctance to teach evolution and noted that it would only be taught if mandated by state requirements (Goldston & Kyzer, 2009).

Van Koevering's (1999) findings of criticism by outside sources such as administrators, family, and community were also supported by this study. Although these pre-service teachers have yet to enter the classroom, they already reported feeling pressure to teach or not teach evolution and regarding their own ideas and acceptance of evolution. It was also found that the desire to fit in with the overarching ideals and expectations of their worldview realms often led them away from acceptance to avoid fear and conflict (Brem, Ranney, & Schindel, 2003; Fowler & Meisels, 2010).

In keeping with statements made by Sinatra et al. (2003), rationality often had no place in the process of acceptance or rejection of evolution among participants in this study. Those participants who were low or very low in the spectrum of acceptance were still very knowledgeable about the concepts associated with evolution. Therefore, it cannot be assumed that those who do not accept rejection are in some way uninformed or conceptually illiterate (Nehm & Schonfeld, 2007). As such, knowledge alone does not warrant acceptance, rather worldview is used to sort and sift that knowledge so that segments that are in agreement can be saved while those that create tension can be ignored or discarded (Akyol, Tekkaya, & Sungur, 2010; Deniz & Donnelly, 2011).

In retrospect, worldview does not have to be built with truth; rather, truth is whatever is embraced by the individual, regardless of whether it is validated by current scientific understandings. As Sinatra et al. (2003) explained, the difference between belief and acceptance

is that beliefs can be based on fact or fiction, and are a matter of what the individual believes or feels based on their experiences. Conversely, acceptance is based solely on the evaluation of extant evidence and should occur despite emotion. Acceptance should occur in tandem with requisite scientific skepticism, recognizing sound scientific theory as the best possible explanation of events with our capacity for understanding at a given moment in time. Therefore, people are neither easily able to differentiate between that they accept nor what they believe, nor are they willing to admit that their beliefs might be based on something other than fact (Sinatra et al., 2003). Despite scientific evidence and clear personal definitions held about science, religion, and the separation of the two, most often when in conflict religion made the greatest impact on acceptance or rejection. Participants, when faced with a choice between long-held beliefs and new information, often opted to hold fast to the former to avoid disassociation with what they viewed as a part of identity or worldview, a result similar to those reported by Wiles (2008).

Studies by Goldston and Kyzer (2009) and Meadows, Doster, and Jackson (2000) found that teacher acceptance played a role in what would be taught in that teacher's classroom. This finding was paralleled by pre- service secondary science teachers in this study who were already thinking of how their own ideas about evolution and those that would come to light with their future students. Comments were often made regarding not only personal conflicts with evolution, but also expected conflicts that future students might have with evolution and how the pre-service secondary science teacher would deal with those conflicts. This included conflicts with religious beliefs and ideas such as creationism, which led some participants to express willingness to teach both evolution and other, non-scientific ideas relative to evolution (mostly creationism) in order to allow students a choice in what to believe. Although participants expressed that they would be willing to teach evolution if mandated as part of the curriculum, there was reluctance to teach evolution on the part of others based solely on their own perspectives, supporting similar results found by McGinnis and Simmons (1999).

Regarding their science training, all pre-service teachers recalled being taught at least some aspects of evolution in their educational careers, mostly at the high school level, but usually only mentioned in their university science courses. Like the findings reported by Aguillard (1998), several of the participants were critical of what they were being taught, especially at postsecondary level where they felt that what they were given was little more than scientific propaganda meant to discredit religious ideas. What was not supported in this study was the idea that more science meant greater acceptance (Rutledge & Warden, 2000). All the pre-service secondary science teachers in this study shared similar, science-heavy backgrounds and, in their post-secondary experiences, they had the same professors for many of the same classes; yet the range of their acceptance was wide.

Much like the participants in past studies (Jorstad, 2002; Nadelson, 2007; Wiles 2008; Woods & Scharmann, 2001), the pre-service teachers in this study often justified their acceptance or rejection of evolution based on personal conceptions and misconceptions rather than evidence. Pre-service teachers wrote off evolution as just a theory suggesting little more than an idea that has no support, while others accepted evolution as an evidence- backed model (Bishop & Anderson, 1990). Although understanding of science and the nature of science and its practices were discussed, they were often ignored in part or whole when in contention with the more deeply-held beliefs associated with the participants' worldviews. Unlike participants in some prior studies (Aguillard, 1998), students in this setting had no required courses that specifically covered evolution**;** rather, it was a side discussion that was touched upon only briefly during courses such as genetics. While it is noted that many introductory level courses can contain evolution content, in this sample it represented a small fraction of formal instruction and was not covered in depth. Reconciliation of personal religious beliefs was a key coping mechanism for secondary pre-service science teachers that allowed them to accept parts of evolution, and with two participants' complete acceptance (Dotger, Dotger, & Tillotson, 2009;

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Sanders & Ngxola, 2009). This mirrored results recorded in a number of studies on religion and evolution (Meadows, Doster, & Jackson, 2000; Shipman et al., 2002; Trani, 2004). Those participants who were able to approach evolution with an open mind and use their reasoning skills to negotiate conflicts with their beliefs and scientific understandings were more likely to accept evolution (Griffith & Brem, 2004).

In this study, pre-service secondary science teachers' worldviews centered mostly on family and religious experiences, which were often viewed as inseparable. This supports similar findings about the power of these relationships in the literature (Demastes, Good, & Peebles, 1995; Woods & Scharmann, 2001). As Winslow et al. (2011) noted, "acceptance of evolution is an extended journey of discovery, not just a matter of presenting facts and evidence" (p. 1040). Pre-service secondary science teachers held fast to the lessons and ideals of their parents, friends, and mentors who, in most cases, held negative opinions about evolution. In some cases, the conflict between the worldview and evolutionary ideas challenge the foundation of the participant's worldview if acceptance occurred, thus forcing rejection as suggested by Hansson and Lindahl (2010). These findings further support the idea of worldview as the experiences that define people and as a major force in decision-making situations. Thus, it is the lens through which the world is evaluated and judgment made (Beauchamp & Thomas, 2009; Sfard & Prusak, 2005).

Worldviews are complicated and play an important role in how we see ourselves and craft our understandings of the world around us. The worldviews of the pre-service secondary science teachers in this study reveal their complicated nature with each individual's decision to accept or reject evolution. Whenever an individual has a new experience or encounters new knowledge, this information must pass through sophisticated terrains, fitting into or changing as it goes to fit into the existing ecology or it is left out of the individual's worldview altogether. It is for this very reason that we cannot ignore the presence and power of beliefs shaped by the individual's culture in the classroom, especially in regard to evolution (Hokayem & BouJaoude, 2008, p. 395). The results of this study conducted in the southeastern United States also suggest that we cannot ignore the role that religion plays in the acceptance or rejection of evolution. Aspects of religiosity proved to be barriers to acceptance of all, or parts of evolutionary theory, namely human evolution. The conflict between science and religion is strongly internal but is pushed by external cultural forces in this study.

Pre-service secondary science teachers represent a unique position occupying a space, an important position, somewhere between that of student and teacher. Based on the interviews with these future teachers, it is clear that a need for specific preparation exists for teaching controversial topics such as evolution. Although some participants demonstrated moments of confidence and acceptance of evolution, the prevalence of misconceptions about evolution, what constitutes evidence, and important aspects of nature of science represent areas that weaken teaching the theory of evolution to their students, perpetuating today's current issues surrounding evolution. If teachers are to serve as the mediators between science and the general public, it is of greatest importance that the science they teach include evolution and that it be represented thoroughly and accurately.

Furthermore, this study highlights that pre-service preparation should include discussion of evolution within the realm of the socio-cultural nature of learning, with a focus on helping pre-service teachers see science, evolution and other controversial issues associated with scientific knowledge through worldviews of others rather than simply as contradicting their beliefs and labeling them as wrong. As Asghar, Wiles, and Alters (2010) noted, "science teachers must be aware of broader social, philosophical, and religious contexts that may influence student thinking about evolution" (p. 68). They should also be made aware, in their methods courses, of the legal precedent surrounding the teaching of evolution and creationism in public schools so that they

know what boundaries exist (Moore, 2004; 2007). Finally, the teaching of evolution should be done, at all levels, and with respect for the different beliefs held by students and teachers alike. Only by negotiating the conflict, rather than exacerbating or ignoring it will there ever be a widespread change with respect to teaching and learning about evolution in the classroom.

Suggestions for Further Study

This study has limitations that impact generalizability to other populations, including sample selection, researcher subjectivity, interpretation of meaning, and inferences. Therefore, it is important that further studies be conducted with similar samples to provide additional support for the findings reported here. Additional studies examining pre-service secondary science worldviews differ from samples of pre-service science teachers at larger public universities, in urban settings, in different regions of the United States, and those with more diverse student populations are needed. It is clear that teacher preparation programs need to improve pedagogical treatment of evolution as well as the nature of science with respect to what constitutes evidence and the tentative, self-correcting tenet of scientific knowledge. We concur with researchers who suggest the need for methods and science courses that better illustrate the nature of science as well as evolution courses that address misconceptions through interactive approaches that will allow students to explore their own beliefs while following similar paths of scientific discovery regarding evolution (Catley & Novick, 2008; Dagher & BouJaoude, 2005; Colburn & Henriquez, 2006).

It is also important that these programs be assessed to determine whether they work and, if so, how they work to improve understanding and acceptance of evolution while minimizing misconceptions (Crawford et al., 2005; McKeachie, Lin, & Strayer, 2002). This study gave insights into the lived experiences and worldview of pre- service science teachers regarding evolution. This was one of only three studies that have specifically explored aspects of evolution in the southeastern United States. This region has demonstrated unique characteristics that warrant further study, including disturbing statistics regarding the likelihood of educational misinformation and lack of instruction regarding evolution (Bowman, 2008). It is also home to the largest group of Fundamentalist Christians in the United States (Kincheloe & Pinar, 1991) whose literalist interpretation of the Christian Bible and evangelical dogma make them less likely than all other Christian groups to accept evolution (Baker, 2013).

It is likely other regions of the United States have differences, further detracting from the generalizability of results from one region or setting to another. For this reason, further study of evolution across the regions of the country is needed to clarify the picture of evolution in the United States. There is further need of study of the treatment of evolution and perceptions of evolution among private school students and teachers, especially in religious schools, to examine if and how they approach the teaching of evolution. Each study conducted contributes and serves to provide information that moves researchers one step closer to untangling the complexity of teaching and learning evolution.

References

Aguillard, D. W. (1998). An analysis of factors influencing the teaching of biological evolution in Louisiana public secondary schools (Doctoral dissertation or master's thesis). Available from ProQuest Dissertations & Theses database. (UMI No. 9922044)

Akyol, G., Tekkaya, C., & Sungur, S. (2010). The contribution of understanding of evolutionary theory and nature of science to pre-service science teachers' acceptance of evolutionary theory. Procedia Social & Behavioral Sciences, 9, 1899-1893.

Alters, B. J., & Alters, S. M. (2001). *Defending evolution: A guide to the creation/evolution controversy*. Sudbury, MA: Jones & Bartlett.

DOI: 10.20429/ger.2018.140201

Asghar, A., Wiles, J. R., Alters, B. (2010). The origin and evolution of life in Pakistani high school biology. *Journal of Biological Education*, 44(2), 65-71.

Baker, J. O. (2013). Acceptance of evolution and support for teaching creationism in public schools: the conditional impact of educational attainment. *Journal for the Scientific Study of Religion*, 52(1), 216-228.

Beauchamp, C., & Thomas, L. (2009). Understanding teacher identity: an overview of issues in the literature and implications for teacher education. *Cambridge Journal of Education*, 39(2), 175-189.

Bishop, B., & Anderson, C. (1990). Student conceptions of natural selection and its role in evolution. *Journal of Research in Science Teaching*, 27(5), 415-427.

Brem, S. K., Ranney, M., & Schindel, J. (2003). Perceived consequences of evolution: College students perceive negative personal and social impact in evolutionary theory. *Science Education*, 87(2), 181 – 206.

Bowman, K. L. (2008). The evolution battles in high school science classes: **W**ho is teaching what? *Frontiers in Ecology and the Environment*, 6(2), 69-74.

Catley, K. M. (2005). Darwin's missing link-a novel paradigm for evolution education. *Science Education*, 767-783. doi: 10.1002/sce.20152.Catley, K. M., & Novick, L. R. (2009). Digging deep: exploring college students" knowledge of macrobiology time. *Journal of Research in Science Teaching*, 46, 311-332.

Cavagnetto, A. R. (2010). Argument to foster scientific literacy: a review of argument intervention in k-12 science contexts. *Review of Educational Research*, 80(3), 336-371.

Cobern, W.W. (1991). Worldview theory and science education research, NARST monograph no. 3. Manhattan, KS: National Association for Research in Science Teaching. Retrieved on August 25, 2011 http://www.wmich.edu/slcsp/SLCSP088/slcsp088.pdf

Cobern, W.W. (1994) Worldview theory and conceptual change in science education. A paper presented at the 1994 annual meeting of the National Association for Research in Science Teaching. Retrieved on August 25, 2011 from http://www.wmich.edu/slcsp/SLCSP124/SLCSP-124.pdf

Colburn, A., & Henriques, L. (2006) Clergy views of evolution, creationism, science & religion. *Journal of Research in Science Teaching, 43*(4) 419-442.

Crawford, B. A., Zembal-Saul, C., Munford, D., & Friedrichsen, P. (2005). Confronting prospective teachers' ideas of evolution and scientific inquiry using technology and inquiry-based tasks. *Journal of Research in Science Teaching, 42*(6), 613-637.

Dagher, Z. R., & BouJaoude, S. (2005). Students' perceptions of the nature of evolutionary theory. *Science Education, 89*(3), 378-391.

Demastes, S. S., Good, R. G., & Peebles, P. (1995). Patterns of conceptual change in evolution. *Journal of Research in Science Teaching, 33*(4), 407-431.

Deniz, H., & Donnelly, L. A. (2011). Pre-service secondary science teachers' acceptance of evolutionary theory and factors related to acceptance. *Reports of the National Centers for Science Education*, 31(4), 2.1-2.8.

Dillon, J. (2009). On scientific literacy and curriculum reform. *International Journal of Environmental & Science Education, 4*(3), 201-213.

Dotger, S., Dotger, B. H., C& Tillotson, J. (2009). Examining how pre-service science teachers navigate simulated parent-teacher conversations on evolution and intelligent design. *Science Education*, 552-570. doi: 10.1002/sce.20375

Fowler, S. R., & Meisels, G. G. (2010). Florida teachers' attitudes toward teaching evolution. *The American Biology Teacher, 72*(2), 96-99.

Glaze, A. L. (2013). *Evolution and pre-service science teachers: exploring acceptance and rejection.* Ph.D. Dissertation, The University of Alabama, Tuscaloosa, AL.

Goldston, M. J. & Kyzer, P. (2009). Teaching evolution: narratives with a view from three southern biology teachers in the USA. *Journal of Research in Science Teaching, 46*(7), 762-790.

Griffith, J. A., & Brem, S. K. (2004). Teaching evolutionary biology: Pressures, stress, and coping. *Journal of Research in Science Teaching, 41*(8), 791 – 809.

Hansson, L., & Lindahl, B. (2010). "I have chosen another way of thinking", students' relations to science with a focus on worldview. *Science & Education, 19*, 895-918. doi: 10.1007/s11191-010-9275-6

Hokayem, H., & BouJaoude, S. (2008). College students' perceptions of the theory of evolution. *Journal of Research in Science Teaching, 45*(4), 395 – 419.

Jorstad, S. (2002). *An analysis of factors influencing the teaching of evolution and creation by Arizona high school biology teachers* (Doctoral dissertation). Available through ProQuest Dissertations and Theses database. (UMI No. 3053890)

Kincheloe, J. L., & Pinar, W. F. (Eds.). (1991). *Curriculum as social psychoanalysis: the significance of place*. Albany, NY: State University of New York Press.

Laugksch, R. C. (2000). Scientific literacy: a conceptual overview. *Science Education, 84*(1), 71- 94.

McGinnis, J. R., & Simmons, P. (1999) Teachers' perspective of teaching science-technology-society in local cultures: a socio-cultural analysis. *Science Education, 83*(2), 179-211.

McKeachie, W. J., Lin, Y., & Strayer, J. (2002). Creationist vs. evolutionary beliefs: Effects on learning biology. *The American Biology Teacher, 64*, 189-197.

Meadows, L., Doster, E., & Jackson, D. F. (2000). Managing the conflict between evolution and religion. *The American Biology Teacher, 62*, 102-107.

Moore, R. (2004). How well do biology teachers understand the legal issues associated with the teaching of evolution? *Bioscience, 54*(9), 860-865.

Moore, R. (2007). The differing perceptions of teachers and students regarding teachers' emphasis on evolution in high school biology classrooms. *The American Biology Teacher, 69*(5), 268-271.

Moore, R., & Kraemer, K. (2005). The teaching of evolution and creationism in Minnesota. *The American Biology Teacher, 67*(8), 457- 466.

Nadelson, L. S. (2007). *Pre-service teachers' understanding of evolution, the nature of science, and situations of chance.* (Doctoral Dissertation, University of Nevada, Las Vegas, 2007) Dissertations & Theses: Full Text database, AAT 3261083.

National Academy of Sciences. (2008). *Science, evolution and creationism*. Washington, DC: National Academy Press.

DOI: 10.20429/ger.2018.140201

National Research Council (2011). *A framework for k-12 science education.* Washington, DC: The National Academies Press.

Nehm, R. H., & Schonfeld, I. S. (2007). Does increasing biology teacher knowledge of evolution and the nature of science lead to greater preference for the teaching of evolution in schools? *Journal of Science Teacher Education, 18*(5), 699-723.

Nehm, R.H., Kim, S.Y., & Sheppard, K. (2009). Academic preparation in biology and advocacy for teaching evolution: biology versus non-biology teachers. *Science Education,* 1122-1146. doi: 10.1002/sce.20340

Ogunleye, A. O. (2009). Defining science from multicultural and universal perspectives: a review of research and its implications for science education in Africa. *Journal of College Teaching & Learning, 6*(5), 57-72.

Pobiner, B. (2016). Accepting, understanding, teaching, and learning (human) evolution: Obstacles and opportunities. *American Journal of Physical Anthropology, 159*(61), S232- 274. Doi: 10.1002/ajpa.22910

Rutledge, M. L. & Warden, M. A. (2000). Evolutionary theory, the nature of science and high school biology teachers: critical relationships. *The American Biology Teacher, 62*(1), 23-31.

Sanders, M., & Ngxola, N. (2009). Addressing teachers' concerns about teaching evolution. *Journal of Biological Evolution, 43*(3), 121-128.

Sfard, A., & Prusak, A. (2005). Telling identities: in search of an analytic tool for investigating learning as a culturally shaped activity. *Educational Research, 34*(4), 14-22.

Shipman, H. L., Brickhouse, N. W., Dagher, Z., & Letts IV, W. J. (2002). Changes in student views of religion and science in a college astronomy course. Science Education, 86, 526-547.

Shuumba, O. (1999). Relationship between secondary science teachers' orientation to traditional culture and beliefs concerning science instructional ideology. *Journal of Research in Science Teaching, 36*(3), 333-335.

Sinatra, G. M., Southerland, S. A., McConaughy, F., & Demastes, J. W. (2003). Intentions and beliefs in students' understanding and acceptance of biological evolution. *Journal of Research in Science Teaching, 40*(5), 510-528.

Smith, M. U. (2010a). Current status of research in teaching and learning evolution: I. philosophical/epistemological issues. *Science & Education, 19*, 523-538. doi: 10/1007/s1191-009-9215-5

Smith, M. U. (2010b). Current status of research in teaching and learning evolution: II. Pedagogical issues. *Science & Education, 19*, 539-571. doi: 10.1007/s1191-009-9216-4

Trani, R. (2004). I won't teach evolution, it's against my religion: And now for the rest of the story. *The American Biology Teacher, 66*(6), 419 – 427.

Van Koevering, T. E., & Stiehl, R. B. (1989). Evolution, creation, & Wisconsin biology teachers. *The American Biology Teacher, 51*(4), 200-202.

Veal, W. R., & Kubasko, D. S. (2003). Biology and geology teachers' domain-specific pedagogical content knowledge of evolution. *Journal of Curriculum and Supervision, 18*(4), 334-352.

Wiles, J. R. (2008). *Factors potentially influencing student acceptance of biological evolution* (Doctoral dissertation or master's thesis). Available from ProQuest Dissertations & Theses database.

Winslow, M. W., Staver, J. R., & Scharmann, L. C., (2011). Evolution and personal religious belief: Christian university biology-related majors' search for reconciliation. *Journal of Research in Science Teaching,* Advance online edition. doi: 10/1002/tea.20417

Woods, C. S., & Scharmann, L. C. (2001). High school students' perceptions of evolutionary

theory. *Electronic Journal of Science Education*, *6*(2). Retrieved on September 13, 2011 from E:\EvoResearch\Electronic Journal of Science Education V6, N2, December 2001, Woods and Scharmann.mht

Zeidler, D.L. & Sadler, D.L. (2011). An inclusive view of scientific literacy: Core issues and future directions of socio-scientific reasoning. In Linder, C. Ostman, L, Roberts, D.A., Wickman, P., Erickson, G. & MacKinnon, A. (Eds.*), Promoting scientific literacy: Science education research in transaction*. New York: Routledge / Taylor & Francis Group. pp. 176-1

DOI: 10.20429/ger.2018.140201