AN INVESTIGATION OF PRESERVICE TEACHERS' ENGAGEMENT AND PERCEPTIONS OF SCIENCE LEARNING IN OUTDOOR LEARNING ENVIRONMENTS

by

Sara Lynn Salisbury, B.S.

A thesis submitted to the Graduate Council of
Texas State University in partial fulfillment
of the requirements for the degree of
Master of Science
with a Major in Biology
August 2018

Committee Members:

Kristy Daniel, Chair

Michelle Forsythe

Julie Westerlund

FAIR USE AND AUTHOR'S PERMISSION STATEMENT

Fair Use

Duplication Permission

ACKNOWLEDGEMENTS

They say it takes a village to raise a child. I say it takes a village to raise a graduate student. This thesis would not have happened without the love and support of so many people. I cannot adequately express my gratitude in words, but I'll try my best to do so here. Thank you to my advisor Dr. Kristy Daniel for her belief in my abilities, her guidance, and her patience as I continued to learn how to navigate thesis-ing the hard way. Thank you for taking a chance on me, and for helping to open the door to my future. I would also like to thank Dr. Shelly Forsythe and Dr. Julie Westerlund for their dedication, unwavering support, and meaningful input. These three amazing women challenged me and pushed me to grow as a researcher and as a person. Next, to my mother, thank you for always believing in me. No matter where I've traveled, or the crazy life decisions I've made, you've always supported me in every way you could. To my boyfriend, Nick, thank you for loving and encouraging me through this whole crazy process. The late-night pep-talks and breakfasts over video truly kept me going. Here's to the next big steps coming up in Tennessee! Next, to my lab mates (old and new) Jenn, Zach, Austin, Katie, Karen, Leah, and Toni, thank you for the endless laughs, pep-talks, and for generally putting up with my antics and occasional breakdowns. Finally, to all my family, friends, and mentors whom I haven't mentioned here in the biology department, climbing community, and back north, thank you for being my cheerleaders. I'm incredibly blessed to have such wonderful people in my life. I hope to someday return all the love, support, and good deeds you've shared with me.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Figure **Page**

ABSTRACT

Science education programs that use both formal and informal instruction provide students with more engaging experiences than when only using traditional instruction. However, educators often do not know of, or are uncomfortable with using informal resources. Thus, understanding how educators view and experience science learning in informal environments is necessary for increasing the likelihood that these educators will integrate informal science resources into their curricula. The purpose of this study is to investigate relationships amongst preservice teacher engagement during informal, outdoor learning activities, and perceptions about using informal resources during their future teaching career. During this study, preservice teachers (n=5) took part in a one-day, nature-based fieldtrip as part of a General Science education course. During this fieldtrip, they learned science content and how to teach science in a fieldtrip setting. Using a four-dimensional framework of engagement (i.e., behavioral, cognitive, affective, agentic), I analyzed video, eye-tracking, and interview data to identify moments of engagement, preservice teachers' perceptions of the fieldtrip, and their integration ideas for using outdoor learning environments in their future teaching career. Participants' actions indicated their engagement across all four dimensions. Participants thought highly of using outdoor learning environments as potential teaching tools, and could identify some way they could integrate them into future teaching practices. No clear relationship existed between observable engagement actions and preservice teachers' future integration ideas; However, participants' overall past experiences with

informal learning environments (including the General Science fieldtrip) appeared to largely influence their perceptions and integration ideas. Participants who had no prior teaching experiences drew primarily on their experiences as a student, whereas participants with informal and formal teaching experiences drew upon their experiences as a teacher more than their experiences as a student. Observable engagement actions and interview responses also suggested some participants underwent personally meaningful learning experiences.

I. INTRODUCTION

It is widely accepted that engagement is as a critical component of successful academic outcomes. In school settings, increased engagement is linked to positive learning outcomes (Fredericks, Blumenfeld, & Paris, 2004; Finn & Zimmer, 2012) lower educational risk (e.g., decreased instances of dropping out) (Finn & Rock, 1997), and sustained interest (Finn, 1989). Three major factors are widely accepted as the key determinants of student engagement in science: gender, quality of teaching, and pre-adolescent experiences (Tytler & Osborne, 2012). Of those, quality of teaching is the most promising to study, as potential exists to improve on teacher training and behavior. Additionally, given teachers' behaviors and teaching styles are inherently linked to student engagement, a direct route to improve student engagement via improving teaching styles exists.

K-12 science education recommendations and goals published by the National Research Council emphasize the need for students to not only gain adequate knowledge of scientific concepts, but also develop an appreciation for science (National Research Council [NRC], 2012). The National Research Council's 2012 recommendations and goals build on previous decades of science education reform goals, which emphasize early childhood exposure to authentic learning experiences (NRC, 2007 & 2012). This continued shift from an academic achievement-focused teaching approach, to a more rounded approach stresses the belief that learning is not simply confined to a classroom setting; Rather, learning is an ongoing, cascading process that spans a person's lifetime. As teachers' actions and teaching styles are inherently linked to student engagement and, by proxy, academic success, this shift in science learning goals places a more focused

spotlight on teachers (Avraamidou, 2015). The new National Research Council recommendations and goals (NRC, 2012) necessitate teaching styles which are flexible, highly engaging, academically rigorous, and applicable in a variety of contexts (Avraamidou, 2015).

For new teachers, this can be a daunting prospect. However, the utilization of a variety of learning environments (e.g., formal and informal) during preservice teachers' schooling or professional development can quell fears they have about teaching in holistic manners, and can foster feelings of excitement and self-confidence about teaching science in new ways (Avraamidou, 2015; Fanning, 2016; Anderson, Lawson, & Mayer-Smith, 2006; Tal, 2001; Jung & Tonso, 2006). While the benefits of these experiences for preservice teachers are apparent, there is a need to research phenomena occurring during these learning experiences on a more fundamental level.

While educators, researchers, and policy-makers place much emphasis on the role of in-classroom experiences on science learning, the time a student spends learning outside of the classroom in various environments is equally important and influential (Falk & Dierking, 2010). On average, students spend approximately five percent of their lifetime in classrooms (Falk & Dierking, 2010), and this classroom time likely only accounts for a small portion of students' overall science learning. The remainder of their science learning likely occurs during experiences in a variety of informal (i.e., outside of the classroom) learning environments and institutions (e.g., museums, science centers, zoos, nature, television, radio, internet) (Falk & Dierking, 2010; Falk, Storsdiek, & Dierking, 2007). Informal learning experiences span a learner's lifetime, and impact intergenerational groups (Falk & Needham, 2013; Falk et al, 2016). While informal

learning environments and institutions are traditionally thought of as separate entities from formal learning environments, these two entities share the common goals of increasing engagement in, and knowledge of, science (Falk, Randol, & Dierking, 2011). For informal learning environments and institutions, these goals for increasing engagement and science learning extend beyond the confines of school-age children, as they also aim to engage adults.

A well-known positive relationship exists between increased engagement and greater science learning gains, specifically in informal learning environments (Boyce, Mishra, Halverson, & Thomas, 2014; Kamarainen, 2013). This relationship is mirrored in adult learning experiences (Falk & Gillespie, 2009; Falk & Needham, 2013), and suggests similar outcomes may occur for preservice teachers around the same age groups in the same environments. Preservice teachers show increased openness to changing their behaviors and incorporating informal teaching techniques and learning environments after participating in informal learning experiences (Tal, 2010; Avraamidou, 2015). To date, research exploring preservice teacher learning in informal learning environments primarily addresses the impacts of these learning activities on preservice teachers' opinions and attitudes (Avraamidou, 2015; Fanning, 2016; Anderson, Lawson, & Mayer-Smith, 2006; Tal, 2001; Jung & Tonso, 2006), and fails to address the internal, psychological mechanisms in place that are impacting preservice teachers' experiences. Thus, there is a need to explore how preservice teachers engage during informal learning activities, as it may help predict the likelihood of them utilizing informal learning environments and teaching techniques in their future career. Additionally, studying preservice teachers in these environments may also provide insight into to how informal

learning institutions can adapt their programs to best prepare preservice teachers and meet their unique needs.

The purpose of my study is to investigate how preservice teachers engage during informal, outdoor learning activities, and explore how their engagement may impact their perceptions about utilizing informal resources during their future teaching career.

Literature review

The National Research Council's recently published report (NRC, 2012) presents the primary goals for K-12 science education, which state science education efforts should not only result in students having sufficient knowledge of scientific concepts, but should also leave students with some appreciation of the beauty and wonder of science. These goals built upon several guiding principles. One of these principles addresses students' interests and experiences, and their critical link to students' sustained attraction to and appreciation of science. The National Research Council's report (NRC, 2012) states students' interests and experiences are critically linked to their learning, and may be linked to later education and career choices. As these interests and experiences are specific to each student, it is safe to assume that this goal envelopes the wide range of knowledge, skills, and attitudes students gain both in and out of school (Avraamidou, 2015). The National Science Education Standards state, "The classroom is a limited environment. The school science program must extend beyond the walls of the school to the resources of the community" (NRC, 1996). Based on the National Research Council's 2009 goals, there is a need for teachers to not only proficiently teach critical scientific concepts and responsively integrate students' interests and experiences, but to do so in a variety of settings and contexts.

The National Research Council recognizes the value of informal learning environments, as they provide opportunities for learning science that compliment and extend in-school experiences (NRC, 2009). Informal learning environments can be broadly defined as any learning environments and institutions present outside of a formal classroom setting. Informal learning environments range from science centers to museums, national parks, zoos, citizen science organizations, live public events, digital environments, and libraries (Falk & Troxel, 2016; Falk et al., 2016). These learning environments are utilized by individuals across all age ranges, all over the world (Falk & Dierking, 2010; Falk, Randol, & Dierking, 2011; Boyce, Mishra, Halverson, & Thomas, 2014; Tal, 2001, 2010, & 2004).

Within the past decade, research efforts in science education have placed great emphasis on science learning which takes place outside of the school classroom in various informal learning environments (Falk & Dierking, 2010; Avraamidou, 2015; Falk & Storksdiek, 2010; Farmer, Knapp, & Benton, 2007; Maynard & Waters, 2007; Alon & Tal, 2016; Kim & Dopico, 2016). Specifically, regarding science education, informal learning is linked to richer, more meaningful learning experiences (Well & Lekies, 2006; Maynard & Waters, 2007; Avraamidou, 2015; Falk & Gillespie, 2009), increased interest in science (Falk, Storksdiek, & Dierking, 2007; Sellmann & Bogner, 2013), short-term and long-term retention of science knowledge (Falk & Gillespie, 2009; Farmer, Knapp, & Benton, 2007; Sellmann & Bogner, 2013), positive attitudes towards science and environmental learning (Farmer, Knapp, & Benton, 2007; Avraamidou, 2015; Boyce, Mishra, Halverson, & Thomas, 2014; Falk & Gillespie, 2009; Falk & Dierking, 2010; Sellmann & Bogner, 2013), environmental and scientific literacy (Falk & Dierking,

2010), and student engagement (Boyce, Mishra, Halverson, & Thomas, 2014; Kamarainen, 2013). Informal learning environments also offer a greater freedom for student exploration, independence, and identity development, which leads to more meaningful connections of learned material to student interests and experiences. This in turn leads students to further seek out science; perpetuating their engagement and interest (Falk et al., 2016).

Meaningful learning is a long-standing goal of science education (National Research Council, 1996; Mayer, 2002), and is a well-documented outcome of informal learning experiences (Jonassen & Strobel, 2006; Tanaguchi, Freeman, & Richards, 2005; Jeffery-Clay, 1998). Meaningful learning occurs when students can build on their previous knowledge (Mayer, 2002; Jonassen & Strobel, 2006; Mintzes, Wandersee, & Novack, 1997), and/or transfer learned material to future actions (Kostiainen et al., 2018). Meaningful learning can arise from a variety of learning environment characteristics including, how material is taught (Cox-Peterson et al., 2003), topics (Kostiainen et al., 2018), or various personal interactions during learning experiences (Ryan & Patrick, 2001); However, at its root, meaningful learning suggests students find personal value or meaning in the learning experience (Mintzes, Wandersee, & Novack, 1997; Kostiainen et al., 2018; Taniguchi, Freeman, & Richards, 2005). While researchers have conceptualized meaningful learning in a variety of ways in the past, it is typically characterized by learning that is active, intentional, authentic, constructive, and relational (Kostiainen et al., 2018; Jonassen & Strobel, 2006). Active and intentional learning highlights students' choices to set and achieve goals based on personal motivations (Kostiainen et al., 2018; Day et al., 2006; Jonassen & Strobel, 2006). By actively

choosing to work towards goals, students' actions are more intentional and fulfilling (Jonassen & Strobel, 2006). Authenticity has many meanings across education research. In terms of authenticity related to meaningful learning experiences, it either refers to authentic applications of information (e.g., "real-world" applications of knowledge) (Jonassen & Strobel, 2006), or are personally relevant for students (Stein, Isaacs, & Andrews, 2004). The cognitive connections made when students ponder authentic problems or think about topics that are situated in their own personal beliefs and interests are likely more transferable because they have real contextual meaning (Kostiainen et al., 2018; Jonassen & Strobel, 2006). Constructive aspects of meaningful learning experiences allow students to rebuild their self-image and sense of self, or reconstructing opinions and/or beliefs based on integrating new information with past knowledge (Mintzes, Wandersee, & Novack, 1997; Kostiainen et al., 2018; Hakkarainen, Saarelainen, & Ruokamo, 2007; Clay, 1995). Relational components of meaningful learning are characterized by learning experiences which include opportunities to interact and collaborate with peers, instructors, and the learning process (Stein, Issacs, & Andrews, 2004; Jarvis & Pell, 2002). Social interactions are a well-documented part of successful informal learning endeavors (Jarvis & Pell, 2002; Eshach, 2007; Jonassen & Strobel, 2006; Kostiainen et al., 2018; Boyce, Mishra, Halverson, & Thomas, 2014; Cox-Peterson, Marsh, Kisiel, & Melber, 2003; Rennie & Mclafferty, 1995; Braund & Reiss, 2004), and are an ongoing goal for informal science program development (McCallie et al., 2009). This is because socially engaging allows learners to better articulate, build on, and solidify their previous knowledge (McCallie et al., 2009). Interactions during

informal learning experiences can involve learning interacting with other learners, or with one or more instructors (Boyce, Mishra, Halverson, & Thomas, 2014).

Formal educators recognize the value in utilizing informal learning institutions as part of their school curriculum, primarily through incorporation of fieldtrips (Tal, 2001 & 2004). However, teachers often have reservations about utilizing informal learning environments as fieldtrip destinations. Educators' hesitations stem from concerns regarding student safety (Ateskan & Lane, 2016; Maynard & Waters, 2007), academic achievement pressures, parental expectations (Maynard & Waters, 2007), unclear roles (Tal, 2001), financial pressures (Anderson 2006; Kisiel, 2013; McMeeking, Boyd, Weinberg, & Balgopal, 2016; Whitesell, 2016), lack of administrative support (Ateskan & Lane, 2016), and low feelings of self-efficacy for teaching material (Tal, 2001). These barriers present an opportunity to utilize alternative educational resources, such as the local natural environment. Outdoor learning environments offer authentic learning experiences coupled with the enjoyment of exploring one's local environment (Adams & Branco, 2017). These environments also offer the potential to combat nature deficit disorder, which is linked to numerous psychological and physiological ailments, as well as an increased disconnect from nature (Louv, 2005). While concerns about utilizing outdoor environments mirror overarching concerns about other informal learning environments, studies show that teachers who participated in informal learning activities during their preservice education showed increased levels of interest, excitement confidence, and increased content knowledge (Avraamidou, 2015; Anderson et al., 2006; Tal, 2001; Jung & Tonso, 2013). These outcomes are paralleled for preservice and in-service teachers' experiences in outdoor environments, where they expressed excitement

about (Avraamidou, 2015), openness to (Tal, 2001; Fanning, 2016), and comfort with teaching in (Avraamidou, 2015; Fanning, 2016) informal outdoor learning environment following participation in outdoor learning activities.

There is an apparent need to rethink teacher education to incorporate content- and context-rich training techniques that foster teacher identification with teaching styles in line with the 2012 National Research Council's science education goals (NRC, 2012; Avraamidou, 2014) (given the dynamic nature of preservice and new teachers' beliefs and teaching identities (Mckinnon and Lambert, 2014)). These changes to teacher training should occur sooner rather than later in the training process.

One of the most critical components for ensuring successful science learning is the need to effectively engage students (Sinatra, Heddy, & Lombardi, 2015). In school settings, increased engagement is linked to positive learning outcomes (Fredericks, Blumenfeld, & Paris, 2004; Finn & Zimmer, 2012) lower educational risk (Finn & Rock, 1997), and sustained interest in academics (Finn, 1989). Engagement encapsulates numerous constructs throughout educational research, but at its core is often defined as commitment or investment by a student during a learning process (Appleton, Christenson, & Furlong, 2008; Sinatra, Heddy, & Lombardi, 2015; Fredericks, Blumenfeld, & Paris, 2004; Marks, 2000; Aker, 2016). Newmann (1992) defines engagement as "the student's psychological investment in and effort directed toward learning, understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote" (p.12). In addition, Marks (2000) refers to engagement as "the attention… investment, and effort students expend in the work of school" (p. 155). Though the specific construct of engagement fluctuates throughout the literature, it is

widely accepted that engagement is characterized by multiple components, or dimensions, that develop and manifest simultaneously (Sinatra, Heddy, & Lombardi, 2015; Zepke, 2017; Reeve & Tseng, 2011; Fredericks, Blumenfeld, & Paris, 2004; Finn & Zimmer, 2012; Archambault & Dupéré, 2016; Appleton, Christenson, Kim, & Reschly, 2006). The most widely accepted model of engagement suggests the presence of three dimensions: behavioral, affective (or emotional), and cognitive engagement (Fredericks, Blumenfeld, & Paris, 2004; Archambault & Dupéré, 2016).

Behavioral engagement is typically conceptualized as a learners' on-task participation with their learning environment. Demonstrations of behavioral engagement include paying attention, participation in on-task activities, compliance with instruction and rules, and completion of required academic assignments (Appleton, Christenson, & Furlong, 2008; Archambault & Dupéré, 2016; Sinatra, Heddy, & Lombardi, 2015; Fredericks, Blumenfeld, & Paris, 2004; Fredericks et al., 2016). In school settings, early behavioral engagement is shown to impact academic success (i.e., grade point average) over a student's academic career (Chase, Hilliard, Geldhof, Warren, & Lerner, 2014; Reeve, 2013). Factors such as self-identification (Finn, 1989), individual motivations (Finn, 1989), school structure, teaching style, and peer and teacher emotional support (Wang & Eccles, 2013) influence behavioral engagement. Behavioral engagement is often interwoven with affective and cognitive engagement, as manifestations of behavioral engagement (e.g., classroom participation) can stem from internal, affective or cognitive processes (e.g., motivation, excitement, fear) (Archambault & Dupéré, 2016; Finn, 1989; Chase, Hilliard, Geldhof, Warren, & Lerner, 2014; Finn & Zimmer, 2012), or

can facilitate greater interest in learning by triggering affective or cognitive responses (Renninger & Bachrach, 2015).

Affective engagement includes a student's emotional response to, and feelings, attitudes, interests, and perceptions towards their learning materials and learning environment (Archambault & Dupéré, 2016; Sinatra, Heddy, & Lombardi, 2015; Fredericks, Blumenfeld, & Paris, 2004). The terms "affective" and "emotional" are used almost interchangeably throughout the literature. However, affective engagement includes expression of emotions as well as expressions of feelings, attitudes, interests, and perceptions, and thus is intermittently distinguished from emotional engagement, which only encompasses emotional responses. Affective engagement positively impacts levels of interest and excitement about science (Falk & Gillespie, 2009), conceptual learning (Tal, 2004), academic success (Chase, Hilliard, Geldhof, Warren, & Lerner, 2014), and ability to recall scientific information (Falk & Gillespie, 2009). This type of engagement typically manifests as a reaction to unexpected external stimuli present in an environment (Finn & Zimmer, 2012). Similar to behavioral engagement, factors shown to influence affective engagement include self-identification (Finn, 1989), individual motivations (Finn, 1989), school structure, teaching style, and peer and teacher emotional support (Wang & Eccles, 2013).

Cognitive engagement is a person's psychological investment and resulting expenditure of cognitive or mental effort directed towards understanding learning materials (Fredericks, Blumenfeld, & Paris, 2004; Newmann, 1992; Sinatra, Heddy, & Lombardi, 2015; Miller, 2015). Cognitive engagement includes self-regulation of learning and comprehension, sense-making and problem-solving, reflecting on learning,

and drawing connections to preconceptions or previous knowledge (Fredericks, Blumenfeld, & Paris, 2004; Sinatra, Heddy, & Lombardi, 2015). Cognitive engagement has frequently been divided into two levels of engagement that reflect the depth or complexity of mental process occurring (Greene, 2015). Deeper cognitive engagement is characterized by students putting forth more psychological effort to make connections to prior knowledge, and to intentionally create more complex knowledge (i.e., self-regulate learning) (Fredericks, Blumenfeld, & Paris, 2004; Greene, 2015), whereas shallow engagement involves rote processes which are more mechanical than thoughtful in nature (Greene, 2015). Deep and shallow cognitive engagement have been measured via student self-reports, and shown to predict high and low levels of academic success, respectively (Greene, 2015).

Recently, a fourth dimension of engagement, (i.e., agentic engagement) was proposed by Reeve & Tseng (2011). Agentic engagement is a learner's active and proactive participation in their learning environment (Sinatra, Heddy, & Lombardi, 2015), or their constructive contributions to the flow of instruction they are receiving (Reeve & Tseng, 2011). Agentic engagement represents a learner's attempt to exercise their agency, or independence and ability to make free choices, and take learning in a new direction. This type of engagement occurs when a learner does not simply react to materials or events in their learning environment, but rather they contribute to the flow of instruction to customize their learning experience to meet internal goals or motivations (Reeve & Tseng, 2011; Gilje & Erstad, 2017). Demonstrations of agentic engagement include offering input, expressing a preference, offering a suggestion or contribution, asking a question, or soliciting resources (Reeve & Tseng, 2011; Reeve, 2013).

Demonstrations of agentic engagement are rooted in a learners' intrinsic motivations to proactively construct a learning experiences that meets their personal goals (Reeve, 2013), and thus, do not manifest out of reactions to stimuli like behavioral, cognitive, and affective engagements. Overlap between cognitive engagement and agentic engagement is common, as both address mental processes; however, this overlap presents a fuller portrayal of a student's experience in that moment. The construct of agentic engagement developed by Reeve & Tseng (2011) is rooted in the Hit-Steer Observation System (Fiedler, 1975; Koenigs, Fiedler, & deCharms, 1977), which defines a "hit" as a student's "attempt to constructively influence the teacher," and a "steer" as the successful or unsuccessful change in the teacher's behavior. This dimension of engagement is still in its infancy. However, the four-dimensional model which incorporates agentic engagement is psychometrically validated, and has shown agentic engagement to be statistically and meaningfully different from the other three dimensions of engagement (Reeve, 2013). This type of engagement is shown to predict academic achievement (Reeve & Tseng, 2011; Reeve 2013), and is shown to be both influenced by, and influence the other three types of engagement (i.e., behavioral, affective, and cognitive) (Reeve, 2013).

Potential drawbacks associated with defining engagement as a multi-dimensional construct stem from significant potential for overlap between cognitive, behavioral, affective/ emotional, and agentic engagement (Sinatra, Heddy, & Lombardi, 2015; Fredericks et al., 2016; Fredericks, Blumenfeld, & Paris, 2004). However, as noted by Fredericks, Blumenfeld, & Paris (2004), the construct of engagement is more valuable if

multiple dimensions are included, as it presents a richer characterization of the inherent interdimensional interactions.

Given the well-known, lifelong nature of science learning (Falk & Dierking, 2015; Falk & Needham, 2007; Avraamidou, 2015; Falk et al., 2016), the well documented positive outcomes for students resulting from increased engagement through informal learning environment is likely be mirrored for preservice teachers. While research into adult engagement during informal learning experiences is limited (Falk & Gillespie, 2009; Avraamidou, 2015; Tal, 2010), these studies show adults, including preservice teachers (Avraamidou, 2015; Tal, 2010), engage with informal science learning environments in meaningful and transformative ways. Given engagement in science learning persists into adulthood, and the levels of engagement experienced by participants during these studies suggests deeper, more meaningful processes may have occurred, beyond what the studies captured.

Studies exploring preservice teacher experiences in informal learning environments as part of their preservice schooling consistently show the positive attitudes preservice teachers have about using these resources (Jung & Tonso, 2006; Avraamidou, 2015; Tal, 2010). However, there is a need to investigate how these experiences influence preservice teacher engagement, as increased engagement can be a predictor for future behavior. To date, limited research exists which explicitly addresses preservice teacher engagement through the four-dimensional framework of engagement (Reeve & Tseng, 2011). Furthermore, there is a need to explore preservice teacher engagement alongside their perceptions of using informal resources as part of their future career. This information may shed light on how various aspects of these informal resources, and

resulting engagement, may or may not impact preservice teachers' perceptions of utilizing informal learning environments in their future careers.

Conceptual framework

I used a combination of engagement frameworks and definitions to guide my research. For this study, I conceptualized engagement as conscious investment, effort, commitment, or expenditure of energy during a learning process (Appleton, Christenson, & Furlong, 2008; Sinatra, Heddy, & Lombardi, 2015; Fredericks, Blumenfeld, & Paris, 2004; Marks, 2000; Newmann, 1992). Within this general definition, I utilize a four-dimensional framework of engagement, which includes behavioral, affective, cognitive, and agentic demonstrations of engagement (Figure 1). This four-dimensional framework was first utilized by Reeve & Tseng (2011), when they introduced a new, fourth dimension of engagement into to the widely accepted three-dimensional model. This framework provides a richer characterization of a person's internal and external experiences, as their cognition, affection, behavior, and agency are dynamically interrelated and evolve together (Fredericks, Blumenfeld, & Paris, 2004; Archambault & Dupéré, 2016; Reeve & Tseng, 2011; Sinatra, Heddy, & Lombardi, 2015). Within this framework, I define each dimension of engagement individually: behavioral engagement includes one's active participation in on-task activities (Appleton, Christenson, & Furlong, 2008; Archambault & Dupéré, 2016; Sinatra, Heddy, & Lombardi 2015; Fredericks, Blumenfeld, & Paris, 2004); affective engagement includes actions reflecting a person's emotions, feelings, attitudes, interests, and perceptions (Archambault & Dupéré, 2016; Sinatra, Heddy, & Lombardi, 2015; Fredericks, Blumenfeld, & Paris,

2004); cognitive engagement includes a person's psychological investment and expenditure of cognitive or mental effort (Fredericks, Blumenfeld, & Paris, 2004;

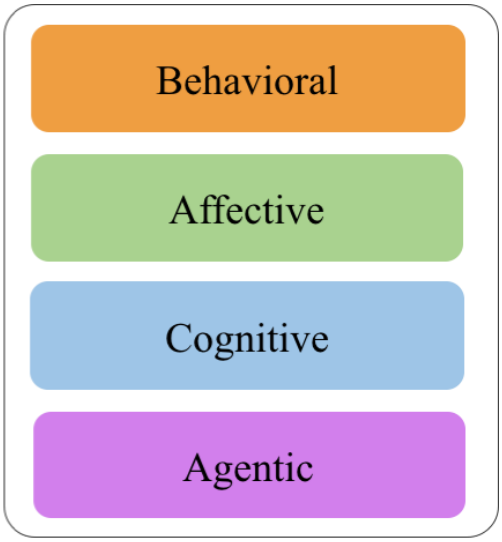

Figure 1. Four-dimensional framework of engagement (Reeve & Tseng, 2011)

Newmann, 1992; Sinatra, Heddy, & Lombardi, 2015; Miller, 2015); and agentic engagement includes a person's active and proactive participation in, or constructive contributions to the flow of instruction (Sinatra, Heddy, & Lombardi, 2015; Reeve & Tseng, 2011). Agentic engagement can also be thought of as learners taking their learning experience in a new direction which aligns with their personal motivations, goals, and interests. This four-dimensional framework builds upon the foundations of self-determination theory, which posits that actions, motivations, and development are driven by a universal and intrinsic need for competence, autonomy, and relatedness (Deci & Ryan, 2011).

Research questions

Research questions guiding this study were three-fold, and include:

1. How do preservice teachers demonstrate different dimensions of engagement (i.e., behavioral, affective, cognitive, and agentic) during informal outdoor science activities?

    a. Behavioral (i.e., active participation in on-task activities) engagement?

    b. Affective (i.e., actions reflecting a person's emotions, feelings, attitudes, interests, and perceptions) engagement?

    c. Cognitive (i.e., psychological investment and expenditure of cognitive or mental effort) engagement?

    d. Agentic (i.e., person's active and proactive participation in learning experience to make it more personal, exercising agency, and/or person takes learning in a new direction) engagement?

2. In what ways do preservice teachers perceive how they can use informal outdoor learning environments as future education tools?

3. How are dimensions of engagement related to preservice teachers' reported perceptions about integrating informal outdoor learning environments in their future educational practice?

II. METHODOLOGY

To answer my research questions, I completed a qualitative case study with five individual cases. Each case explored the experience a preservice teacher (i.e., participant) had while participating in a one-day fieldtrip to an informal outdoor learning environment (i.e., the Meadows Center for Water and the Environment). This case study is instrumental and collective (Stake, 1995), as it comprehensively explores the experiences and subsequent impacts of an informal learning environment shared by the participants.

Participants

I recruited participants from a large, southwestern university. Prior to recruitment, I obtained IRB approval (IRB Number 2017593; Appendix A), permission from the instructor of the General Science (GS 3320) course, and consent from each participant (Appendix B) in the Spring 2017 semester. The General Science course is a K-6-focused, general science instruction course, which focuses on the fundamentals of chemistry, earth and space science, and biological science.

At the time of the study, participants were enrolled full-time (e.g., greater than 12 credit hours), and were working towards their Bachelor's of Science degree in Interdisciplinary Studies. Participants were planning to obtain certifications for Early Childhood through Sixth-Grade, English as a second language (EC-6 ESL) Generalist, or Early Childhood through 12th-grade Special Education (EC-12 Special Education). Both degree paths require students to complete 125 credit hours, of which 54 hours are educator preparation courses, 42 hours are core curriculum, 1 hour of institutional requirement (i.e., introductory freshman seminar), and 2 years of a language other than English. EC-6 ESL Generalist students are also required to complete 19 hours of

interdisciplinary studies, 9 hours of support coursework. EC-12 Special Education students must also take 28 hours of interdisciplinary studies. Copies of degree plan requirements for EC-6 ESL Generalist and EC-12 Special Education students are included as Appendices C and D, respectively.

I recruited a total of eight participants as part of this study. To identify participants, I obtained basic demographic information from all laboratory sections of the course, and selected eight participants that reflected the overall course demographic. Participants were at least 18 years old, were enrolled in GS 3320, and were passing the course at the time. One of the eight participants served as a pilot study, and is not included in this final study. I did not include two other participants due to technical difficulties, weather-related issues, and potential demographic skewing. The final five participants reflected the general demographic make-up of the GS 3320 course. I met with each participant prior to data collection, briefed them on the study, and explained participation expectations. Each participant provided written approval for participation. Participants then took part in informal outdoor learning activities at the Meadows Center as part of their course-required fieldtrip.

Data Collection

Following IRB approval and participant recruitment, I collected video and eye-tracking, data from the five participants during their fieldtrip to the Meadows Center. Approximately one week after the fieldtrip, I conducted semi-structured interviews and collected each participant's homework and notes (Table 1).

All participants took part in a 90-minute fieldtrip at the Meadows Center, which is a science and nature center in the southern United States. Fieldtrips occurred the week of

April 11, 2017. During the fieldtrip, participants took part in four informal outdoor learning activities. Specifically, activities included a guided tour through a wetlands boardwalk, a glass-bottom boat tour, aquarium exploration, and a macroinvertebrate identification activity. Participants rotated through each activity listed above during their fieldtrip, and the activity order and assigned docent varied across participants. Prior to beginning the first activity, I equipped participants with eye-tracking glasses, and calibrated the glasses based on manufacturer protocol. I provided participants with a hat to wear during the fieldtrip, which served a hygiene purpose, and prevented excessive ambient lighting from impacting the eye-tracking glasses.

Table 1

Data matrix: Research questions by data sources

Research Questions	Data Sources			
	Video	Semi-structured interviews	Eye-tracking	Artifacts
1. How do preservice teachers demonstrate different dimensions of engagement (i.e., behavioral, affective, cognitive, and agentic) during informal outdoor science activities?				
a. Behavioral engagement?	✓		S	S
b. Affective engagement?	✓		S	
c. Cognitive engagement?	✓		S	S
d. Agentic engagement?	✓			S
2. In what ways do preservice teachers perceive how they can use informal outdoor learning activities in their future teaching experiences?		✓		S
3. How are dimensions of engagement related to preservice teachers' reported perceptions about integrating informal outdoor learning environments in their future educational practice?	✓	✓	S	S

S = Secondary data source

Video recordings. I collected video data documenting each participant's fieldtrip experiences and demonstrations of engagement via a front facing camera found on the eye-tracking glasses (i.e., Tobii eye-tracking glasses). Participants wore these front-facing glasses throughout the entire fieldtrip.

Semi-structured interviews. Approximately one week following the fieldtrip, I conducted an in-person, semi-structured interview (Patton, 2002) with each participant. Interviews were approximately 20-minutes long. I preselected interview questions (Appendix E), but question order and topics varied based on participant responses, and I probed participants based on unanticipated responses. Interview questions addressed the participants' opinions of the fieldtrip and informal outdoor learning environments, and opinions regarding potential utilization of informal outdoor learning environments as teaching tools.

Eye-tracking. In addition to video data, I collected eye-tracking data extracted from the eye-tracking glasses (i.e., Tobii eye-tracking glasses) worn by participants. I superimposed these eye-tracking data over the video data. Eye-tracking data collected from the glasses included focal points (e.g., fixations).

Artifacts. Following the fieldtrip, I obtained a copy of both the notes and homework from each participant. Each participant completed a required in-class assignment which required taking in response to prompts about each activity (See Appendix F). Following the fieldtrip, participants also completed reflective homework questions about each activity (See Appendix G), and submitted their homework to their instructional assistant during their next lab. The in-class and homework assignments

were consistent across all course sections. I did not collect information regarding the grade participants received on their notes or homework assignments.

Data Analysis

To answer my research questions, I analyzed data from two primary data sources, including videos and semi-structured interviews (See Table 1). I used eye-tracking and artifact data (i.e., notes and homework) data as secondary data sources which provided information that supplemented the video data. Data for each participant were aggregated to generate a profile of the participant that captured their general demographic information, engagement during the fieldtrip, as well as their perceptions of informal outdoor learning environments. I assigned each participant a pseudonym during the data coding process. When names of other students or the participants were mentioned during video or interview data, I anonymized these names, or applied pseudonyms as necessary.

Video recordings.

Prior to coding video data, I uploaded videos into NVivo coding software. I utilized a simultaneous coding approach (Saldaña, 2016) throughout the coding process, which allowed me to code for each of the four dimensions of engagement (i.e., behavioral, affective, cognitive, agentic) concurrently. I selected simultaneous coding because I anticipated multiple dimensions of engagement would occurred simultaneously throughout the fieldtrip.

When coding video data, I first used an inductive approach to descriptive coding (Saldaña, 2016), which allowed me to provide rich descriptions of how participants engaged with their learning environment (Saldaña, 2016). I identified these initial moments of engagement based on the general definition of engagement, which represents

a learner's investment, effort, commitment, or expenditure of energy during a learning process (Appleton, Christenson, & Furlong, 2008; Sinatra, Heddy, & Lombardi, 2015; Fredericks, Blumenfeld, & Paris, 2004; Marks, 2000; Newmann, 1992). These rich coding descriptions captured actions, verbalizations, and any other demonstrations of active engagement in the fieldtrip and the learning environment. For example, moments of speaking included each verbalization from a participant during the fieldtrip. For these moments of speaking, I transcribed what the participants said verbatim, recorded who they spoke to, as well as the topic or context of the verbalizations. I used a similar approach when coding other actions. Next, I assigned key terms based on these coding results to better categorize and condense data for the next coding cycle (e.g., "talking with another student" and "talking to oneself" as "speaking"). A code book presenting a description of each of the engagement actions identified during the descriptive coding is shown in Appendix H.

Then, I used a deductive approach to coding (Patton, 2012; Saldaña, 2016) to categorize participants' actions into their appropriate dimensions of engagement. For example, I categorized actions coded as "speaking" as behavioral engagement, as this action reflects participants' active participation in their learning experience.

Categorizing engagement actions.

For this study, behavioral engagement actions included participation in on-task activities which are specific to the scope of the class, fieldtrip, and assignments (Appleton, Christenson, & Furlong, 2008; Archambault & Dupéré, 2016; Sinatra, Heddy, & Lombardi 2015; Fredericks, Blumenfeld, & Paris, 2004). Associated actions denoting behavioral engagement included, but were not limited to, taking notes, asking questions,

answering questions, physical interaction with activity materials, paying attention, and discussing class-related activities.

Affective engagement actions included participants' emotional responses, and expression of feelings, attitudes, interests, and perceptions towards events, stimuli, and learning materials (Archambault & Dupéré, 2016; Sinatra, Heddy, & Lombardi, 2015; Fredericks, Blumenfeld, & Paris, 2004). Actions suggesting affective engagement included, but were not limited to, laughter, explicit sarcasm and/or joking around, emotional responses, storytelling, expressions of feelings and personal opinions about science education, and/or fieldtrip events.

Cognitive engagement is the cognitive effort participants put forth during a learning experience (Newmann, 1992; Sinatra, Heddy, & Lombardi 2015; Miller, 2015; Fredericks, Blumenfeld, & Paris, 2004;). I conceptualized cognitive engagement for this study as clear expressions of cognitive processes regarding the course and the fieldtrip. Cognitive engagement actions included, but are not limited to verbal statements suggesting connections to previously learned content and/or previous experiences, synthesis of answers or new ideas, or observable problem-solving.

Agentic engagement actions are a student's active and proactive participation in, and constructive contribution to their learning environment (Reeve & Tseng, 2011). Agentic engagement may also be further defined as a student taking learning in a new direction based on personal motivations (Gilje & Erstad, 2017). Indicators of agentic engagement included addressing new topics via questions, statements, and visual observations, as well as interacting with unintroduced activities.

Identifying engagement episodes.

When necessary, I also grouped engagement actions which occurred in sequence into engagement episodes. For example, participants often payed attention to the docent during instruction, then conversed with their peers and/or the docent about the topic of instruction. For these episodes, I linked the individual coded moments of engagement (e.g., paying attention, speaking) in sequential order (e.g., Participant watched the docent during instruction [Code: Paying attention], then turned to her peer and said, "I didn't hear what was said" [Code: Speaking]) until a new topic was addressed by the participant or docent, or if the participant reacted to stimuli related or unrelated to the topic at hand. By developing engagement episodes, I could identify what participants responded to, and how they reacted to certain stimuli and interactions.

Semi-structured interviews.

Prior to coding interview data, I uploaded and transcribe data in NVivo coding software. I used two rounds of coding to process interview data. First, I used an inductive approach to descriptively code data. For descriptive codes, I focused on identifying participants' perceptions about outdoor learning environments (e.g., "Outdoor learning is the way I feel that they [students] have learned the best"), as well as their future integration ideas (e.g., "I would take them to something like the Meadow Center"). I then assigned key terms based on these coding results to better categorize and condense data for the next coding cycle (e.g., "I would take them to something like the Meadow Center" = Meadows Center). I then use code mapping transitional techniques to categorize and condense coded interview data (e.g., "I know that taking them outside will help them

engage" and "I feel like it'd be easier to get them engaged on trips" = "better engagement"). For my second round of coding, I used pattern coding to identify major themes inherent within interview responses (e.g., "better learning experiences" and "engagement")

Eye-tracking.

Eye-tracking data can reflect real-time, internal processes not measureable via video data (Marshall, 2007) or third-person observations. To analyze these eye-tracking data, I utilized a manual coding approach (Holmqvist & Nyström, 2011; Munn, Stefano, & Pelz, 2008); this allowed me to capture data from dynamic stimuli where pre-set areas of interest could not be defined, or are moving throughout the length of data collection (Holmqvist & Nyström, 2011).

I focused analysis of eye-tracking data on identifying visual fixations, as these are primary indicators of mental processes. A fixation is defined as when the eye stays focused on one location, or on one subject or object, for at least 200 milliseconds (Slykhuis, Wiebe, & Annetta, 2005). Prior to coding eye-tracking data, I use a velocity-threshold automatic fixation-identification algorithm to identify the start and end of each fixation (e.g., moments 200 milliseconds or longer) (Holmqvist & Nyström, 2011; Munn, Stefano, & Pelz, 2008). Utilizing this algorithm streamlined manual coding of fixations by identifying the start and end points of individual fixations (Munn, Stefano, & Pelz, 2008). Following algorithmic fixation identification, I manually checked eye-tracking data frame by frame to verify all fixations were captured by the algorithm. Once I identified all fixations, I used an inductive approach to descriptively code fixations (e.g. participant looks at fish) (Saldaña, 2016) and actions associated with fixations (e.g.,

paying attention). I then used a deductive approach to coding to sort the fixation and any subsequent actions into the appropriate dimension of engagement (i.e., behavioral, affective, cognitive, agentic). By coding these fixations, I could name and track dynamic areas of interest, and participants' responses to external cues throughout the length of the eye-tracking video.

Artifacts.

I used participants' field notes and homework assignments from the fieldtrip as a secondary data source to triangulate findings from video, eye-tracking, and interview data. Approximately one week after the fieldtrip, I obtained copies of the participants' notes and homework, and used two rounds of coding to analyze them. For my first round of coding, I descriptively coded responses which reflected potential expression of affective (e.g., emotions, attitudes, beliefs) and cognitive (e.g., reflective thoughts) components. When I identified affective or cognitive components, I assigned key terms based on these coding results to better categorize and condense data for the next coding cycle. Then I use code-mapping transitional techniques to categorize and condense coded data ("I just found the boat trip to be so intriguing" = intriguing boat trip). For the second round of coding, I used pattern coding (Saldaña, 2016) to identify major themes present in the responses (e.g., "enjoyed boat trip"). Artifact analysis did not provide data applicable to explore agentic engagement, as agency reflects a participant's active, external, and constructive contribution to the flow of instruction (Reeve & Tseng, 2011).

I coded participants' homework assignment to answer research question 3, as the lab notebook assignment did not address topics related to research question 3. I only used data from the homework assignment to provide additional evidence of interview

responses and engagement actions. I coded homework responses using two rounds of coding. First, I descriptively coded answers which present information about participants' perceptions about using informal learning environments during their future teaching career. I then use code mapping transitional techniques to categorize and condense coded data (e.g., "At first I didn't want to touch the bucket because I was grossed" = grossed out). For my second round of coding, I used pattern coding to identify major themes in the data (e.g., "experienced change of opinion").

Following all coding, I went through the coded data and search for emergent themes within the data. Identified themes provided thicker, richer descriptions of the nature of relationships between engagement actions and participants' perceptions of how they can use informal learning environments in their future teaching careers.

Trustworthiness statement

I used multiple steps to meet the four criteria for trustworthiness presented by Lincoln and Guba (1985) (i.e., credibility, transferability, dependability, and confirmability). To enhance the credibility of my results, I used multiple data sources (i.e., video, eye-tracking, artifacts, and interviews) to triangulate my findings. I also used member checking by participants to verify interpretations of the video and eye-tracking data. I first presented participants with my interpretations of their engagement data, and asked if this aligned with their perceived experience on the fieldtrip. When differences arose, we discussed the data until we reached a consensus of 100% on the interpretation. Additionally, I asked each participant for clarification regarding moments where video and eye-tracking data did not clearly capture the presence of cognitive or affective engagement. I recoded data as necessary to incorporate these clarifications. To further

enhance the credibility of my findings, I had another colleague experienced with coding qualitative data like the methods used in this study provide interrater reliability for approximately 10% of my findings. I referenced my colleague when I was unsure about how to code video, eye-tracking, interview, and/or artifact data, and discussed the coding with them until we reached consensus of 100% of the final code. Using member checking and multiple coders will limit bias associated using a single person to analyze data (Patton, 2002).

Additionally, to increase the reliability and dependability of my findings, I conducted consistent peer debriefing during the data collection and coding process to verify that these assumptions remained present throughout the research process, and remained in line with my research questions. To further increase the dependability and confirmability of my findings, the methods I selected for this study were verified as the most appropriate approach by the members of my committee. Furthermore, the methods selected for this study best addressed the level, types, and expected demonstrations of engagement associated with the context of the study and participants.

Using descriptive coding to provide rich, thick descriptions of participants' experiences increases the transferability of my findings. Richer descriptions will allow other researchers to make connections to their own circumstances and investigations outside of the context of my study (i.e., connecting preservice teacher perceptions to in-service teacher beliefs and practices). Finally, I confirmed any similar findings from this research to those present in existing literature.

III. RESULTS

The findings from this case study are organized by individual cases. For each of my five cases, I present a profile of the participant detailing general demographic information, fieldtrip engagement and experience, and perceptions of outdoor learning environments. General demographic information includes age, ethnicity, gender, class standing, undergraduate degree program, anticipated certification program, and/or past teaching experience. Descriptions of participants' demographics represent conditions at the time of the study (i.e., as of April 2017). I describe participants' fieldtrip experiences through engagement actions within this study's four-dimensional framework of engagement (i.e., behavioral, affective, cognitive, agentic) (Appendix G). I also reference researcher observations, and each participant's perceptions of their fieldtrip experience when necessary. Perceptions of outdoor learning environments include participants' opinions of outdoor learning environments, willingness to use outdoor learning environments in their future classrooms, as well as potential integration ideas. I integrate and reference secondary data sources (i.e., notes, homework, eye-tracking data) to supplement findings from primary data sources (i.e., first-person video, interviews).

Case #1: Leighla

General demographics and teaching experience.

Leighla is a 19-year old, Caucasian, female in her junior year. She is pursuing a Bachelor's of Science degree in Interdisciplinary Studies, with a focus in early childhood education. Leighla's career goals include teaching first-graders (ages 5-7), and she intends on obtaining EC-6 ESL Generalist teaching certification. Leighla has no prior formal teaching experience; however, she has previous experience helping her mother, a

fifth-grade teacher, with her students at an annual outdoor camp trip. During these trips, Leighla assisted with a bug-picking, oversaw children swimming in a river, and interacted with animal ambassadors. Additionally, at the time of the study, Leighla had an internship where she created preschool-level developmental learning environments and experiences, and helped students learn to read. Leighla previously experienced the glass-bottom tour at the Meadows Center as part of a freshman University Seminar course.

Fieldtrip experience.

Leighla's engagement during her fieldtrip indicated her enjoyment, and highlighted how she differently viewed the roles of her peers and the docent. Leighla's stated she like the fieldtrip a lot, and described it as "really fun." Much of Leighla's enjoyment appeared to stem from her general interest in the outdoors, as well as social interactions with her peers. For example, Leighla's interactions with peers were largely characterized by actions such as laughter, joking, and conversation. By comparison, Leighla's interactions with the docent were more focused and informative, and included actions such as paying attention and writing notes. These interactions appeared to highlight her perception of the docent as a provider of information, rather than an outlet for social enjoyment.

Engagement.

Leighla engaged a total of 711 times. Leighla's behavioral comprised 71.2% of her total engagement, while affective engagement comprised approximately 22.5% of her total engagement. Cognitive engagement comprised 5.6% of her total engagement, and agentic engagement comprised 1.7% of her total engagement (See Figure 2). Total counts of Leighla's engagement actions are presented in Appendix I.

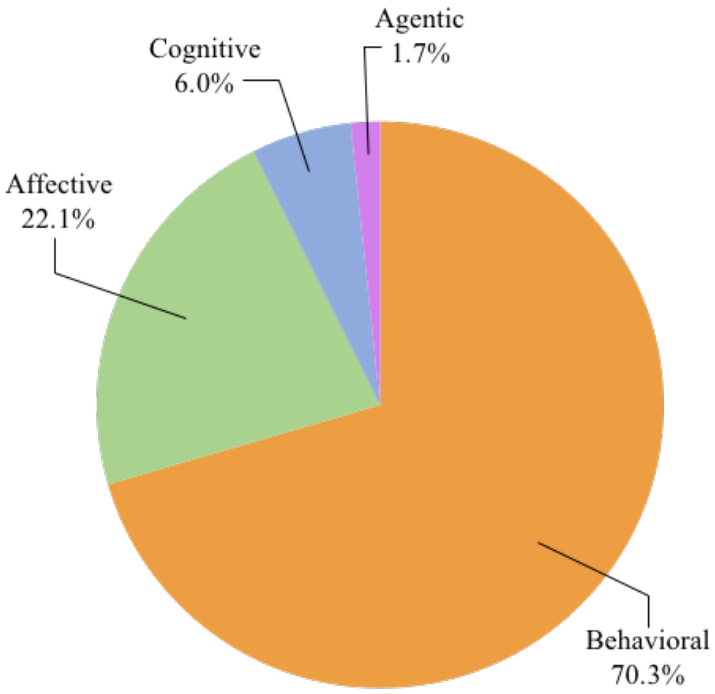

Figure 2. Combined behavioral, affective, cognitive, and agentic fieldtrip engagement for Leighla (n=720)

Behavioral.

Leighla behaviorally engaged via 14 actions: conversation, paying attention, writing notes, reading, responding to external cues, asking questions, making hand motions, answering questions, moving closer, physical interactions, shaking head, digital documentation, thinking noises, and following explicit directions (See Figure 3).

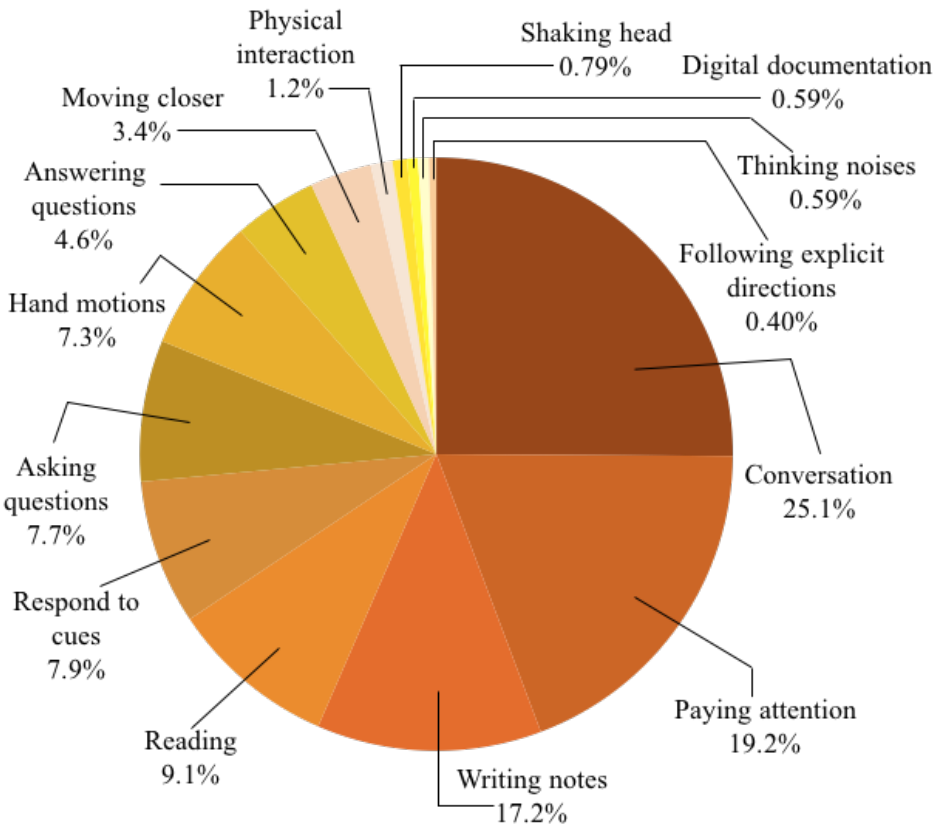

Figure 3. Breakdown of behavioral engagement actions for Leighla (n=506)

Leighla's behavioral engagement suggested her primary focus for the fieldtrip was completing the lab notebook assignment. Her specific actions during instruction, such as paying attention, writing notes, reading, and responding to external cues highlighted her focus on identifying the topics required to answer the lab notebook questions.

Leighla paid close attention to the docent throughout fieldtrip activity instruction, and regularly responded to the docent's cues to observe target foci. For example, during the wetlands walk, the docent taught the class about identifying maple trees by their leaves. During this event, the docent first prompted the students to look at two trees just off the trail. Leighla responded by turning her attention to the trees [Code: response to external cues], and watched the docent as she left the trail to get leaves for the students to

touch. Once the docent returned to the trail, she encouraged the students to feel the leaves' texture, and continued to instruct the group about how they can use touch to identify trees. During this time, Leighla studied the docent and the leaves closely [Code: Paying attention], felt the leaves, and recorded the information in her lab notebook to answer a question requiring one fact from the wetlands walk [Code: Writing notes].

Interestingly, after recording the information about maples leaves in her lab notebook, Leighla returned to change her answer after learning about a different plant species. At this time, Leighla reread the question prompt [Code: reading], and changed her answer to align with an invasive species she recorded to answer the first part of the wetlands walk prompts. This process of retroactively changing answers after rereading the lab notebook prompts and/or answers was common for Leighla throughout each activity. Overall, Leighla's attention, as well as her review and reflective changes to her notes, indicated her attentiveness to the subject matter needed to answer the lab notebook questions.

Furthermore, Leighla's behavioral engagement actions during transitional periods (e.g., when no instruction occurred) support these findings. During these periods, Leighla spent much of her time communicating (e.g., conversation, joking, asking questions, answering questions) with other students about topics primarily unrelated to the fieldtrip and/or the lab notebook assignment. Leighla's communication was consistent throughout transitional periods between all activities during the fieldtrip. Leighla's shift from off-task communication to on-task focus indicated she valued the identification of information needed to complete the lab notebook assignment.

Affective.

Leighla affectively engaged a total of 153 times via five actions: laughing, emotionally responding, stating personal opinions, joking, and storytelling (See Figure 4).

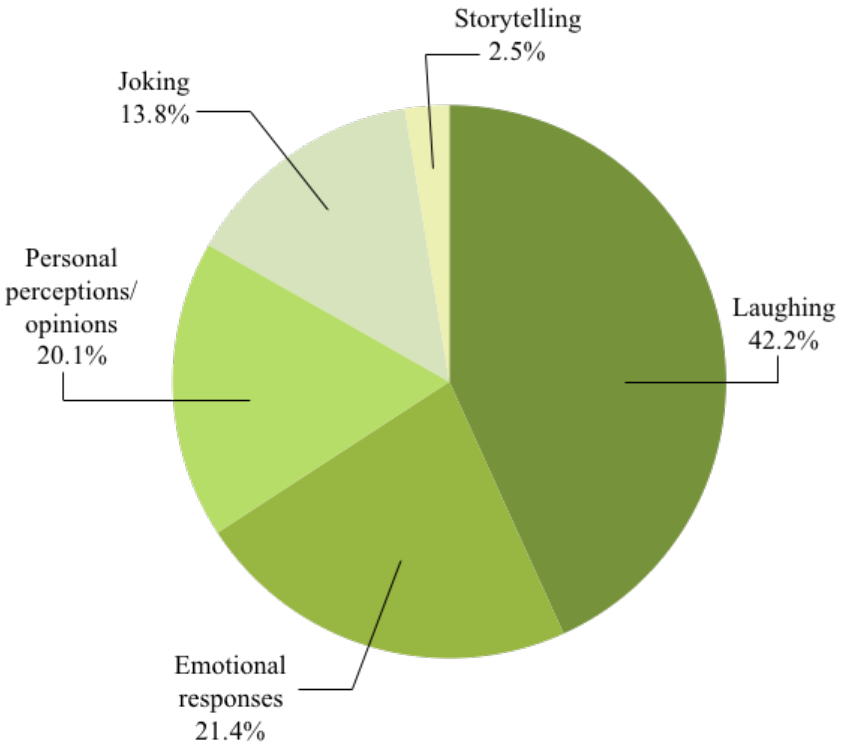

Figure 4. Breakdown of affective engagement actions for Leighla (n=159)

Overall, Leighla's affective engagement highlighted her enjoyment of the fieldtrip, and indicated her use of transitional periods to communicate with her peers. Leighla's laughter, positive emotional responses (e.g., "wow!"), and positive personal opinions (e.g., that's amazing!") highlighted her enjoyment of the fieldtrip. In her interview, Leighla referenced similar feeling about her fieldtrip experience, stating she "liked it a lot" and thought it was "really fun." Leighla's expressed positive emotional responses and opinions regularly throughout the fieldtrip in response to target foci

provided by the docent. Leighla's affective responses to the educational topics further highlighted her attention to the docent and the learning material.

Leighla's socially-geared affective engagement (e.g., joking and laughter) also followed a similar pattern to her behavioral engagement (e.g., conversation), as much of her affective actions occurred during transitional periods. During these periods, Leighla largely talked, joked, and laughed with her peers about topics unrelated to the fieldtrip activities. For example, as the class waited to board the glass-bottom boat, Leighla and her friend, Khalia, joked about something Khalia needed to tell Leighla after the fieldtrip. After Khalia stated she needed to tell Leighla something, Leighla mimicked Khalia's statement to another student, but did so with a deep voice [Code: Joking]. This led Khalia to laugh and exclaim "why are you giving me a man's voice?!" As a result, both Khalia, Leighla and the other student laughed, and continued to joke about the conversation. In her interview, Leighla referenced her social interactions with Khalia and described herself as "talkative" whenever Khalia was around her. Thus, Khalia's presence likely prompted many of Leighla's socially-geared, affective engagement. For the most part, Leighla's affective engagement actions throughout the remainder of the fieldtrip followed a similar pattern, and primarily occurred during transitional periods.

Interestingly, Leighla rarely affectively responded to the docent's ample jokes and conversation. This shift in engagement from Leighla's social interactions with her peers to those with the docent further highlights how she sees the docent as a provider of information, rather than an outlet for social enjoyment.

Cognitive.

Leighla cognitively engaged a total of 41 times via two actions: referencing previous knowledge/ experiences (n=36) and synthesis (n=5) (See Figure 5).

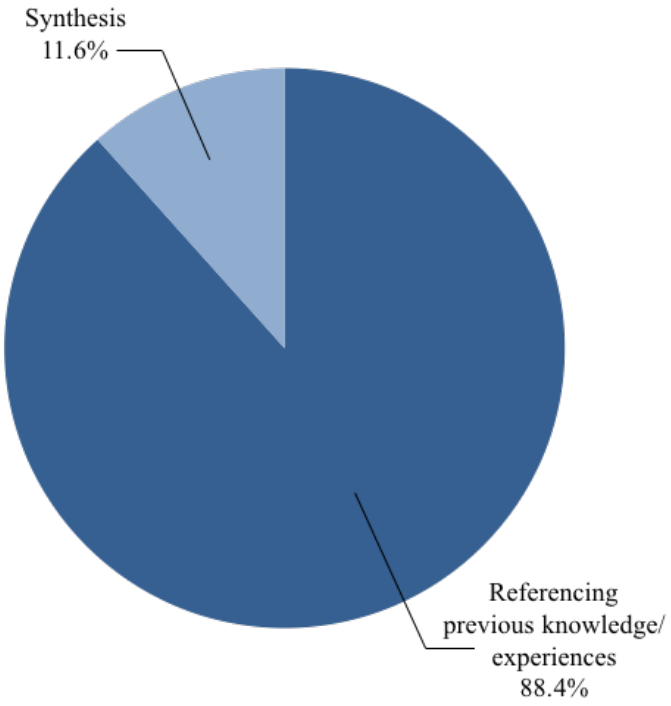

Figure 5. Breakdown of cognitive engagement actions for Leighla (n=41)

Leighla's cognitive engagement throughout the fieldtrip primarily involved referencing previous knowledge and experiences related to the General Science course, but unrelated to the fieldtrip activities. Most notably, Leighla and a group of fellow students spent ample time discussing another assignment required for the General Science course which was due the following week. During this event, Leighla described the content required for the assignment, its due date, and its purpose to the other students near her. While this is related to the General Science course, it was unrelated to the fieldtrip or the subsequent in-class or homework assignment. Consistent with Leighla's other social interactions, Leighla's communication with her peers about topics unrelated

to the fieldtrip largely occurred during the transitional periods of the fieldtrip. Leighla expressed little cognitive engagement during times of instruction, as she appeared to pay attention and to the docent and/or the target foci presented by the docent.

Agentic.

Leighla agentically engaged a total of 12 times via three different actions: asking questions and talking about unintroduced topics, and visually observing unintroduced objects and/or focal points (See Figure 6).

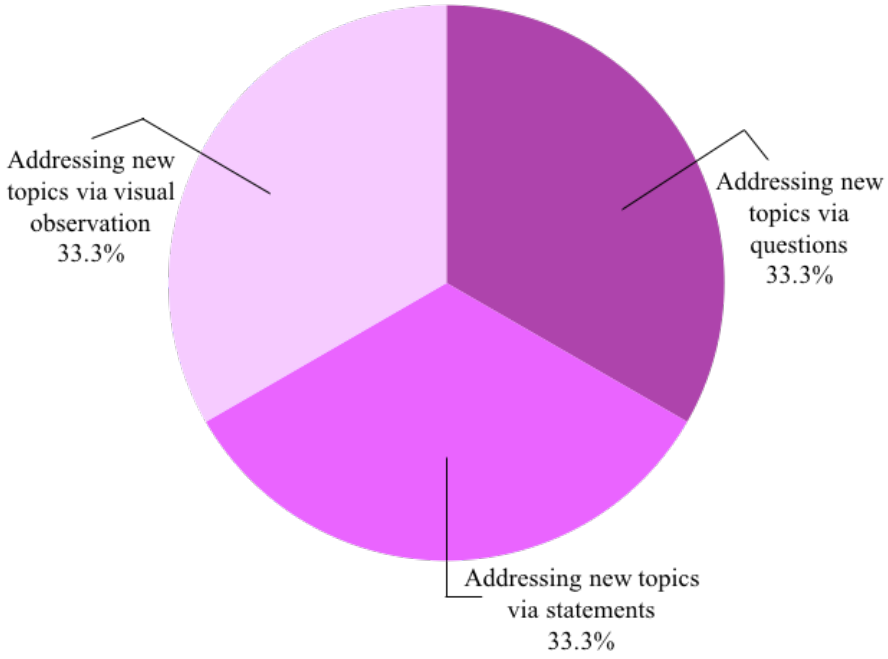

Figure 6. Breakdown of agentic engagement actions for Leighla (n=12)

Leighla's agentic engagement was infrequent and the target objects/ topics of her engagement lacked an apparent pattern; however, consistent with her engagement within the other dimensions (i.e., behavioral, affective, cognitive), much of Leighla's agentic engagement occurred during transitional periods of non-instruction. Leighla's choice to use transitional periods to explore other subjects of interest, rather than using the docent's instruction time highlights the value she places on listening to the docent. One example

where Leighla explore a topic of interest included the educational showcase at the beginning of the wetlands walk. The docent announced the class could explore the area and look at things if they wanted to. Leighla and Khalia both approach the animal skulls display and observe the contents closely [Code: Addressing new topics via visual observation]. While observing the skulls, Khalia and Leighla name each species and talk about the size of the skulls [Code: Addressing new topics via statements], and Leighla asked, "are these real?" [Code: Addressing new topics via questions]. After observing the showcase for a bit longer, the class followed the docent's instructions and left the showcase for the wetlands boardwalk. As the class left the showcase, Leighla said, "I want to stay and look this stuff!" Leighla's choice to follows the docent's instructions and leave a topic she found personally interesting further indicated Leighla's perception of the docent as a figure of authority and a provider of information. Overall, Leighla's engagement highlighted her respect of the boundaries of the educational components versus the social components of the fieldtrip.

Perceptions.

Outdoor learning environments as teaching tools.

Leighla thought positively of using informal, outdoor learning environments as potential teaching tools, stating she will "definitely use them" in the future. During her interview, Leighla explained she always thought favorably of using outdoor learning environments to teach, and the fieldtrip only enhanced her desire to do so. Leighla's beliefs about the benefits of using outdoor learning environments mainly arose from her desire to provide students with experiences encouraging cognitive growth. For instance, Leighla described two primary beliefs about teaching students in outdoor learning

environments: (a) outdoor learning environments offer experiences which allow students to express their personal agency; and (b) outdoor learning environments offer more engaging learning experiences which result in greater learning gains.

First, Leighla described how outdoor learning environments provide experiences allowing students to exercise their personal agency. When describing agency, Leighla stated teaching in the outdoors would give students "what they want," and would allot them the freedom to be adventurous and learn about themselves. In her interview, Leighla recounted witnessing elementary students exercising their agency during an outdoor math lesson. During this lesson, the instructor took the students outside, gave the students the option to select a color of chalk to write with, and then had the students do addition outside. Leighla noted the students who picked their own chalk color had "more fun" and appeared learned the math better. Leighla did not elaborate on how she knew those students learned better; however, at the very least she recognized the presence of some benefits of allowing students to have control over components of their learning experiences.

Second, Leighla believed outdoor learning environments provided better, more engaging learning experiences than standard classroom teaching. When asked to elaborate on what she considered a "better" learning experience, Leighla indicated she greatly values those activities which increase engagement. Leighla defined engagement as "focusing and paying attention," and "having fun." Interestingly, Leighla's primary engagement actions during her fieldtrip followed a similar pattern to her definition of engagement. When asked to provide an example of an engaging activity, Leighla again referenced the chalk activity. When asked why she considered the chalk activity

engaging, Leighla stated described how the outdoor location for the chalk activity helped the students focus. She also stated that allowing the students to choose the chalk color made it more fun. This description aligned very closely with Leighla's definition of engagement. Leighla believed the engaging nature of the activity led the students she observed to learn better. These perceived benefits are in stark contrast to Leighla's reported feelings about teaching student in standard classroom setting. Leighla believed teaching students in a standard classroom can be "boring," and "stuffy," and does not encourage students to engage with the subject matter. Overall, Leighla's perceptions highlighted the cognitive (e.g., learning gains) and emotional (e.g., exploration, exercising agency) benefits associated with using outdoor learning environments as teaching tools.

Outdoor learning environment integration ideas.

In her interview, Leighla stated there are "lots of situations" and "so much you can do" to use outdoor learning environments. Leighla's outdoor learning environment integration ideas are relatively simple, and reference activities which do not require transporting students or special equipment. Leighla also appeared to favor integration ideas which replaced standard classroom teaching, rather than supplementing it.

First, Leighla described how she could use rain barrels to teach about weather in Texas. She also indicated that a similar idea could be used in places where it snows. The proximity of activities to the school appeared to play an important role in Leighla's integration ideas. This is because Leighla reported she knows of "some school's principals who don't like the classes going outside because it's not safe or because somebody could be on the campus." Leighla then described how schools could overcome

these concern by installing infrastructure (e.g. fences) around outdoor education areas to keep students safe. She enthusiastically stated that concerns can be "worked around to be able to take students outside." Here, Leighla recognized the realistic concerns which could impact her future use of outdoor learning environments; however, she also appeared to have potential solutions in mind to overcome those concerns. Beyond the rain barrel activity, Leighla again referenced the chalk activity as a potential activity she could use in her future classroom, and described it as "the coolest idea." These integration ideas are simple, do not require ample specialized equipment, and can theoretically be set up in locations close to the school. Given the concerns about taking students outside Leighla outlined earlier in her interview, her identification of these feasible activities makes sense.

Finally, Leighla cited "forest schools" as means to use outdoor learning environments. She described these schools as "outdoor schools," and indicated she previously learned about these schools in one of her education classes. When describing these schools, Leighla stated they provide students the chance to "be adventurous and climb things," and push themselves out of "their comfort zone." Leighla's description suggested forest schools likely regularly use the outdoors as a classroom.

Leighla's integration ideas highlight her belief in using feasible activities, tools, and locations. The activities Leighla identified are theoretically executable on school grounds as they require minimal space. Additionally, Leighla identified modifications to the activities which could account for concerns administrators could have about student safety. Furthermore, Leighla's identification of forest schools represents the epitome of outdoor learning environment integration, because these schools regularly using local

nature as the physical classroom. These schools would not need to identity locations appropriate for outdoor education, as their pedagogy is based on outdoor education.

Conclusions

Leighla's engagement throughout the fieldtrip highlighted the split between her behavior with the docent and with her peers. Based on her engagement, Leighla likely saw the docent as a facilitator to obtain the information necessary to complete her required lab assignment, and saw her peers as an outlet for social enjoyment. These dual behaviors highlight Leighla's compartmentalization of her experiences into academics and social components. In general, Leighla positively viewed outdoor learning environments as teaching tools, and considered them a better alternative to standard classroom teaching. Leighla's integration ideas for outdoor learning environments highlighted her belief in using realistic and feasible outdoor activities in her future classroom. Overall, Leighla's engagement, perceptions, and integration ideas highlight her pragmatic beliefs about using outdoor learning environments as teaching tools in her future classroom.

Case #2: Olivia

General demographics and teaching experience.

Olivia is a 20-year old, Caucasian, female in her senior year. Olivia is a mother with a young son, and is engaged to be married. She is pursuing a Bachelor's of Science degree in Interdisciplinary Studies. Olivia's career goals include teaching preschool, and she intends on obtaining her EC-6 ESL Generalist teaching certification. Prior to her General Science fieldtrip, Olivia attended the glass-bottom tour at the Meadows Center as part of a freshman University Seminar course. At the time of the fieldtrip, Olivia taught at

a private, nature-based preschool and held the title of "Lead Teacher." Olivia did not have her teaching certification at this time, but lead all classroom activities and developed lesson plans. During her interview, Olivia reported her preschool students attended a fieldtrip at the Meadows Center approximately two months before Olivia attended the fieldtrip. She indicated she and her students completed the same activities (i.e., bug-picking, glass-bottom boat tour, aquarium, and wetlands walk) during their respective e fieldtrips. Olivia did not personally attend the fieldtrip with her preschool students, but discussed the follow-up activities she conducted in her classroom during her interview. When Olivia's preschool students indicated their interest in learning more about the plant and animals associated with the San Marcos River, Olivia responded creating classroom activities which allowed them to further explore the topics they found personally interesting. These activities included researching and asking questions about the San Marcos River, herons, river birds, and insects, as well as the students pretending to be Texas blind salamanders.

Fieldtrip experience.

Olivia reported her role as a teacher influenced her engagement during the fieldtrip. Olivia indicated she spent most of her fieldtrip thinking about what information she could bring back to incorporate into her classroom curricula. Olivia's choice to do so stemmed from the fact her preschool students previously expressed their interest in learning about the plant and animal species of the San Marcos River. Subsequently, during her fieldtrip, Olivia focused on the plant and animals of the river, as well as activity components she found interesting and emotionally stimulating. These actions resulted in Olivia expressing minimal social engagement, and choosing to pay attention

to objects in lieu of paying attention to her docent. Olivia's fieldtrip experience differs greatly from Leighla's experience, as Leighla largely spent her fieldtrip both paying attention to the docent, as well as socially engaging with her peers.

Engagement.

Overall, Olivia engaged 557 times during the fieldtrip (See Figure 7). Olivia's behavioral engagement comprised 70.9% of her total engagement, while affective engagement comprised 24.1%. Cognitive engagement comprised 2.7% of her total engagement, and agentic engagement comprised 2.3%. Total counts of Olivia's engagement actions are presented in Appendix I.

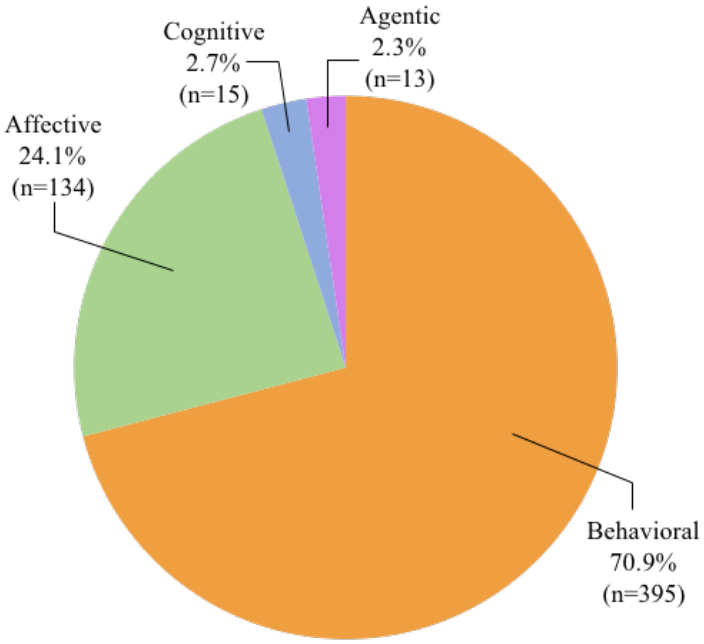

Figure 7. Combined behavioral, affective, cognitive, and agentic fieldtrip engagement for Olivia (n=557)

Behavioral.

Olivia behaviorally engaged a total of 395 times via 15 different actions: paying attention, conversation, responding to external cues, making thinking noises, asking questions, reading, moving closer, writing notes, answering questions, making hand

motions, physically interacting, shaking head, yawning, following explicit directions, and humming (See Figure 8).

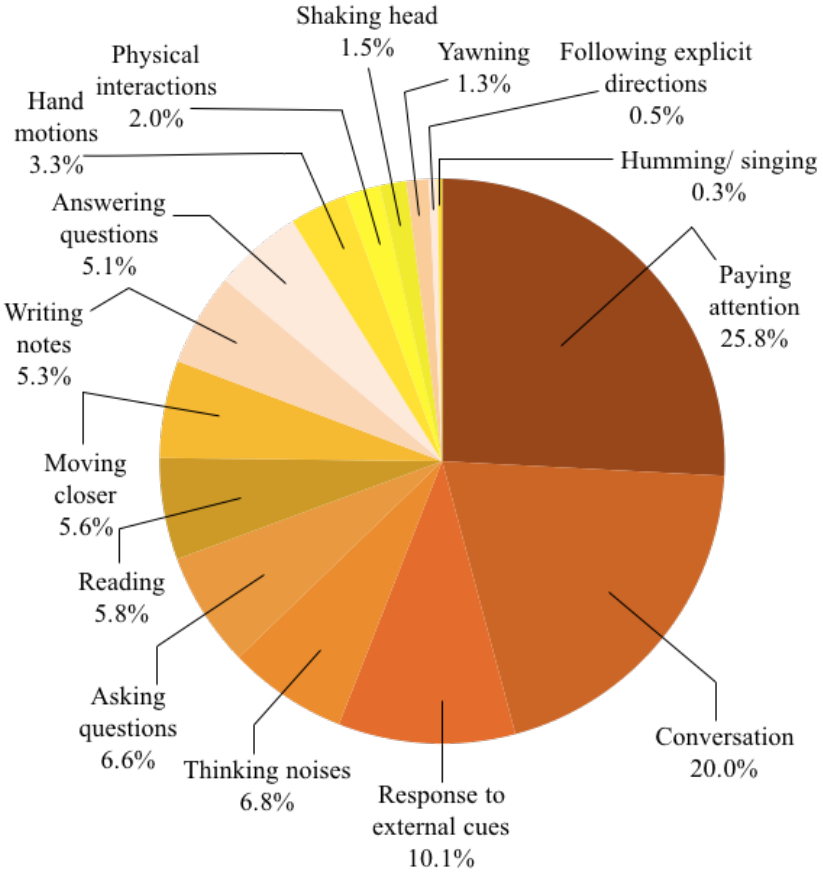

Figure 8. Breakdown of behavioral engagement actions for Olivia (n=395)

Much of Olivia's behavioral engagement manifested through non-social actions. For example, Olivia focused much of her attention on plants and animals (i.e., target focal points) presented by the docent (n=95), subsequently providing less attention to the docent himself while he was teaching (n=7). These moments largely occurred during the aquarium and glass-bottom boat activities. During the aquarium activity, the docent typically gathered the students around a target subject (e.g., tank with salamanders) and provided basic scientific information about the target subject. In these moments, Olivia briefly watched the docent while he provided introductory information, then focused on

the target focal point for the remainder of the time. One example of this phenomena occurred when Olivia's docent, docent, instructed the students about the Texas blind salamander. First, Roger gathered the students around the tanks and introduced the salamander. At this time, Olivia watched the docent [Code: Paying attention – Sage on stage]. After Roger provided the introductory information and began providing more a more detailed description, Olivia shifted her attention to the salamander's tank [Code: Paying attention – Target focal point] and did not return to the docent. Olivia observed the salamander up close for an extended period of time [Code: Paying attention, Moving closer]. Olivia behaved similarly during the glass-bottom boat tour and bug-picking activities, fixating her attention almost entirely on the organisms described by the docent, and not on the docent himself.

Olivia's second most prominent behavioral engagement action included conversation; however, most of Olivia's moments of conversation involved her talking under her breath to herself, or whispering to organisms she observed. Olivia's social interactions with her peers and the docent occurred infrequently throughout the fieldtrip, and primarily occurred during the bug-picking activity and on the wetlands walk. Olivia described the bug-picking activity as "the only part of the tour where you can talk to your friends openly and work with them." Thus, Olivia's increased social interactions during the bug-picking activity aligned with her beliefs about the social nature of the activity. Olivia's increased social interactions during the wetlands walk resulted from an unexpected and exciting event where the class witnessed a turtle laying her eggs along a walking trail. The novelty of this event prompted many interactions between the Olivia, the docent, and the other students in the class.

Affective.

Olivia affectively engaged a total of 134 times via four actions: emotionally responding, laughing, expressing personal opinions and perceptions, and joking (See Figure 9).

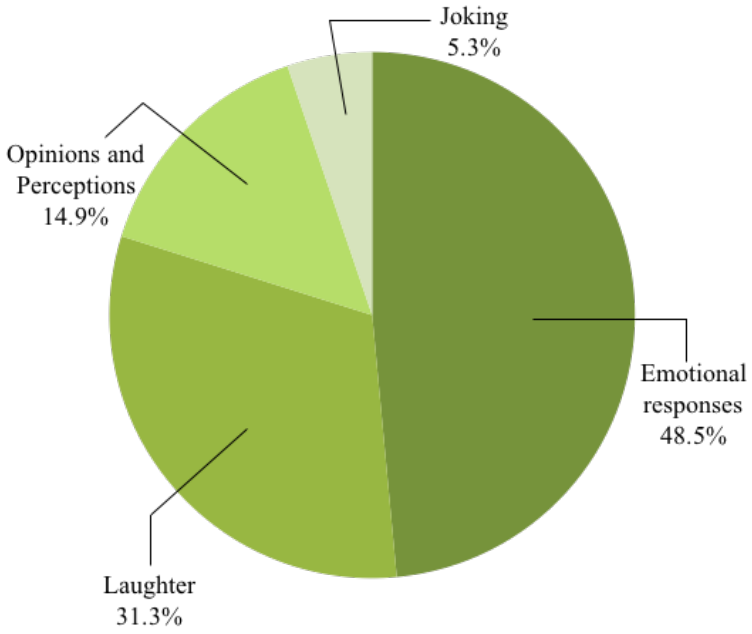

Figure 9. Breakdown of affective engagement actions for Olivia (n=134)

The emotional responses and personal opinions which Olivia expressed primarily focused on the animals she observed during her fieldtrip. Olivia regularly expressed excitement (e.g., "whoa!") in response to the variety of interesting animals she encountered (e.g., salamanders, fish, turtles), and whispered things such as "I love you," "amazing," and "so cool" to the animals themselves.

One event Olivia reported as particularly meaningful occurred at the end of the fieldtrip as the class exited the wetlands walk and proceeded towards the van to Meadows Center's exit. On the walk to the exit, the group witnessed a turtle laying eggs along the side of the walking trail. Olivia's emotional responses, opinions, joking and laughter

highlighted the depth of her emotional involvement in this moment. She also appeared to personify the turtles experience, drawing parallels to her own personal experiences as a mother. When Olivia first observed the turtle, she gasped and exclaimed "oh hey!" [Code: Emotional response]. Olivia then quickly moved in close to get a better look. After watching the turtle closely, Olivia whispered words of encouragement to the turtle (e.g., "deep breathes, you got this") [Code: Opinions and Perceptions]. After the group observed the turtle for a while longer, the docent and other students began discussing and joking about the event. The docent's jokes lead Olivia to laugh. As the group walks away from the turtle, Olivia eventually said "That was amazing" [Code: Perceptions and opinions].

The novelty of the turtle experience resonated with Olivia, as she referenced and described her personal feelings in both her homework and interview. In her homework, she wrote how the event was "such a rare experience," and was something she "would not have been able to see" had the class not done the wetlands walk activity. Olivia expressed similar thoughts about the experience in her interview, describing the event as "something not everyone gets to see," and "a cute little personal moment." The affective engagement Olivia experienced during the turtle event encompassed a range of actions and interactions, and led Olivia to break from her predominantly non-social behavior. Furthermore, Olivia's use of descriptors such as "rare," "cute," and "personal" highlight the impact this event had on her.

Cognitive.

Olivia cognitively engaged a total of 15 times via two actions: synthesis and referencing previous knowledge and experiences (See Figure 10).

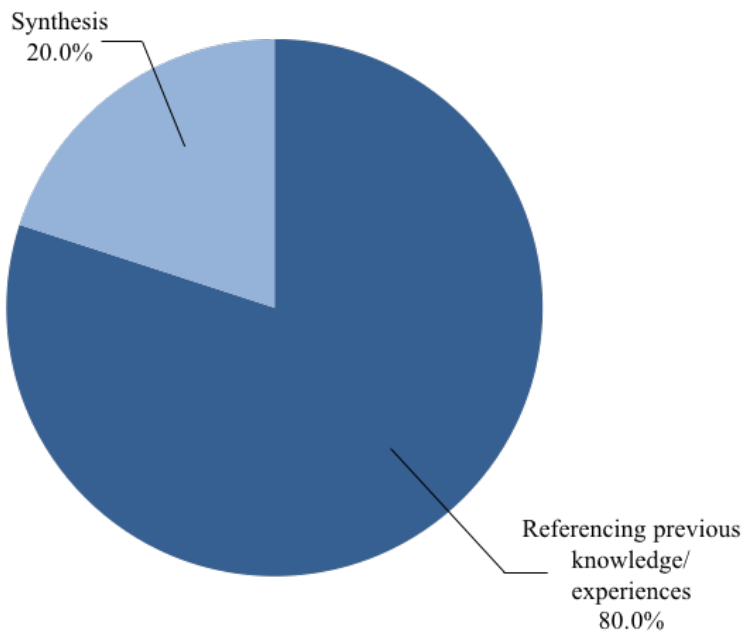

Figure 10. Breakdown of cognitive engagement actions for Olivia (n=15)

Referencing previous knowledge and experiences through recognition of organisms and their subsequent characteristics comprised most of Olivia's cognitive engagement throughout the fieldtrip. Most moments of recognition occurred during the bug-picking activity, and were characterized by short-term recollections of information Olivia learned during the fieldtrip. For example, when identifying the aquatic mite during the bug-picking activity, Olivia referenced both the Meadows Center's identification sheet, as well as information the docent provided earlier in the day about looking for a small, red bug in the water. After the docent describes the insects as "small, red bugs that swim around," Olivia recognized the bug in the water, pointed to both the bug and the identification sheet, and exclaimed "I think it's this one" [Code: Referencing previous knowledge/ experiences]. Olivia's observable cognitive engagement throughout the other activities is infrequent, but followed a similar pattern of short-term information recollection when it did occur.

In her interview, Olivia reported her own substantial cognitive processes regarding the application of her fieldtrip experiences in her preschool classroom at the time. Olivia stated, in her interview "since I'm a teacher, I was thinking what would be good for my kids. I was going, "What kind of lesson plan could I make?"" The first-person video data did not capture these internal moments, as Olivia did not verbally express these thought processes. Furthermore, Olivia's limited verbal communication (i.e., conversation, asking questions, answering questions) throughout her fieldtrip likely attributed to not capturing her internal processes, as she overall spoke fewer times.

Agentic.

Olivia agentically engaged a total of 12 times via three actions: visually observing unintroduced objects and/or focal points, and asking questions and talking about unintroduced topics and/or objects (See Figure 11).

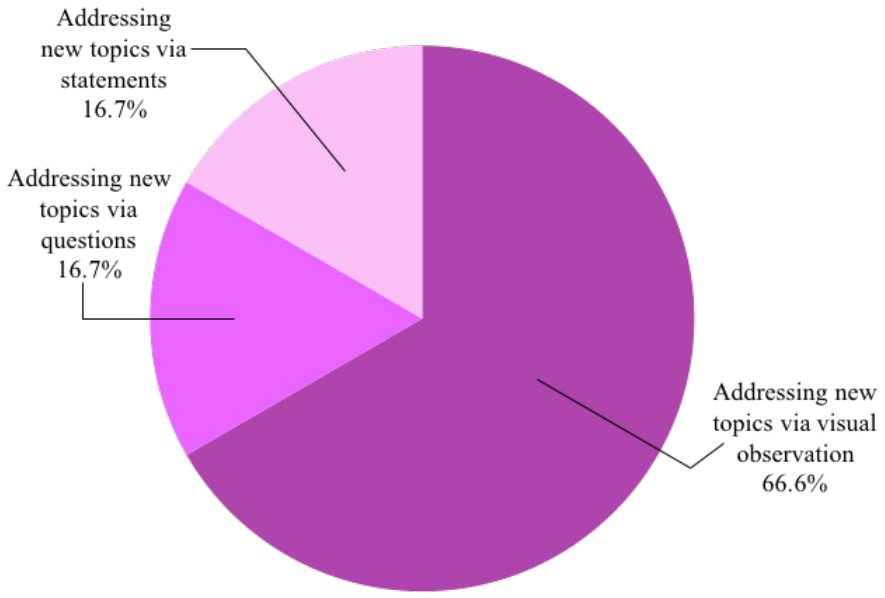

Figure 11. Breakdown of agentic engagement actions for Olivia (n=12)

Olivia agentic engagement occurred predominantly occurred during the aquarium and glass-bottom boat activities, and showcased her interest in the animals observed

during the fieldtrip. For example, Olivia forewent paying attention to the docent at the beginning of the aquarium tour, and chose to focus on fish species in a large tank in a different area of the aquarium [Code: Addressing new topics via visual observation]. Because Olivia remained at the tank to observe the fish, she missed the beginning of the docent's instruction about the other species in the room. Olivia behaved similarly during the glass-bottom boat tour, when she diverted her attention from observing the docent's target subjects (e.g., springs, underwater trees, etc.) to observe fish and turtle species she found interesting. Olivia's agentic engagement further highlighted her interest in observing the animals at the Meadows Center.

Perceptions.

Outdoor learning environments as teaching tools.

Olivia positively viewed outdoor learning environments as potential teaching tools, and stated in her interview, "I will definitely do this with my kids way more than just being inside and talking about stuff." Olivia had two primary beliefs about using outdoor learning environments as teaching tools: (a) outdoor learning environments provide students with beneficial, hands-on learning experiences; and (b) outdoor learning environments provide students with learning experiences that encourage them to exercise their personal agency.

Hands-on learning was central to Olivia's perceptions about outdoor learning environments. Olivia identified and described parallels between the benefits of teaching students via hands-on activities and teaching students in the outdoors. During her interview, Olivia referenced her personal experiences from her own preschool class when describing the benefits of hands-on learning. She noted her students showed greater

interest and excitement, and learned better when provided with tangible, manipulate representations of the topics they covered in class. She described the benefits of hands-on learning as the information "goes straight from your fingers to your brain." Olivia then provided a hypothetical situation connecting the benefits of hands-on learning with the bug-picking activity she completed during her fieldtrip, stating:

> If they [preschoolers] did the bug-picking activity and they got to be in that, I'd ask "What did you learn?" and they would be like "there was this one bug and it was really cool," because they got to touch it, and do things, and scoop it up.

Here, Olivia described how her students would better recall details of their experiences because they physically interacted with real aquatic macroinvertebrates.

Next, Olivia discussed how outdoor learning environments provide students with the freedom to exercise their personal agency. Olivia described agency as students choosing to either tune out or pay attention to instruction. For Olivia, "tuning out" involved students choosing to disregard instruction and focus on a topic they found personally interesting. Building on her fieldtrip experience, Olivia described how the glass-bottom boat tour represents an opportunity for students to exercise their agency:

> You can be doing other things, like looking down, so I think that would be really good for the kids, too, because they're probably not going to be listening to the docent, they'll just be looking… Just looking is fine too, because you can observe what you want to see.

Here, Olivia described how students could "tune out" the docent, and visually paying attention to a topic or subject of preexisting interest. Olivia built on this, stating that when students have the opportunity to see things they are already interested in, "they want to

lean, instead of just tuning you out." This suggested that Olivia recognized the value of student interest, and respecting student exploration of their interests, in the execution of a learning experience.

Outdoor learning environment integration ideas.

Olivia's current role as a teacher was critical in the development of her outdoor learning environment integration ideas. Many of Olivia's integration ideas built off her recent experiences as a preschool teacher, and highlighted her pedagogical beliefs about teaching.

Olivia recognized the value of using the Meadows Center as a tool to incorporate outdoor learning environments into her curricula; however, Olivia reflected much on how she would update the Meadows Center's activities for her preschool students. For example, Olivia recognized the value of the bug-picking activity because it offers the students the change to participate in inquiry-based learning; however, she reported she would have her preschool students just identify the aquatic macroinvertebrates during the bug picking activity, because "they [students] wouldn't really understand" the advanced concepts related to the polluted water. Additionally, Olivia reported her students likely would only care about looking at the bugs, and would not care about understanding the connection to polluted water. Here Olivia adapts the activity to make it not only age appropriate, but appropriate based on what she perceived her students would find meaningful and interesting.

Olivia provided and in-classroom extension of the bug-picking activity which incorporated art. In her interview, Olivia described herself as "really big on art," and referenced a number of art integration ideas for her current and future curriculum. For

example, Olivia stated her students could "make clay figures of the bugs they saw" after completing the bug-picking activity. Olivia drew connections between the clay idea and the benefits of hands-on learning, and stated:

> I love when they [preschool students] do hands-on art projects. I feel like that's when they learn the most… If I ask them "what did you make in art?" they can tell you exactly what they did, what colors they used, and everything else.

Olivia's description here mirrors her sentiments about hands-on learning during the actual bug-picking activity, and highlights her belief in using hands-on learning to teach her students. Olivia's description of other art integration ideas (e.g., drawing organisms and discussing them back in the classroom) followed a similar pattern, and highlighted Olivia's interest in extending the concepts from the activity back into the classroom.

Later in her interview, Olivia elaborated on how she extended the concepts covered during the Meadows Center's fieldtrip into her classroom. Olivia provided an example of what happened after her preschool class attended a fieldtrip to the Meadows Center approximately two months before her General Science fieldtrip. She detailed how her preschool students learned about the plants and animals at the Meadows Center, and returned to the classroom wanting to learn more about the organisms and habitats they saw along the river. Respecting her students interests and agency, Olivia developed activities which allowed the class to further explore these topics in the classroom. For example, Olivia described how her class "did a little experiment" to replicate being Texas blind salamanders. During this activity, her class "covered their eyes and went under a table" and pretended to be the blind salamanders. Olivia cited several other similar

examples she used in her class to extend on the topics covered during her students' Meadow Center fieldtrip.

Overall, Olivia's descriptions provide a glimpse of her beliefs about teaching (e.g., use of hands-on learning, integration of art, extensions on fieldtrips), and indicate what her teaching practices likely look like. Through Olivia's description, one can imagine what her current and future curriculum will likely include (e.g., fieldtrips, art projects, activities based on students' interests).

Conclusions

Olivia's engagement during the fieldtrip indicated her desire to identify activities and topics she could use in her current and future classrooms. While Olivia's was largely internal and personal in nature (i.e., paying attention, conversing with self, expressing emotions, etc.), she described how she spent the fieldtrip thinking about potential ways she could use what she experienced in her classroom. This suggests Olivia's observable engagement might not reflect her internal thought process throughout the fieldtrip.

Olivia's role as a teacher largely drove her perceptions and integration ideas. This is evidenced through her reference to past teaching experiences and curriculum, as well as her focus on updating fieldtrip and classroom activities to be appropriate for her class. Olivia likely referenced components of her past experiences when synthesizing integration ideas, because she observed the success of these activities, and sees them as practical and sustainable.

Furthermore, Olivia's focus on the Meadows Center as a good location for fieldtrips also reflected the relevancy of the fieldtrip topics to her. Given her preschool students' great interest in the topics covered at the Meadows Center, much of Olivia's

engagement during the fieldtrip revolved around identifying and learning about topics she could integrate into her classroom that her students found personally interesting. Olivia's perceptions integration ideas centered on how to use these materials in her classroom. As such, learning about these materials and identifying appropriate integration ideas held great relevancy for Olivia.

Case #3: Aurora

General demographics and teaching experience.

Aurora is a 20-year old, Hispanic, female in her junior year. She is pursuing a Bachelor's of Science degree in Interdisciplinary Studies. Aurora's career goals include teaching second through fifth grade (ages 7 to 11), and she intends on obtaining her EC-6 ESL Generalist teaching certification. At the time of the study, Aurora had no prior experience teaching, and had not previously experienced the Meadows Center or the glass bottom boat tour. Aurora reported she attended fieldtrips during her elementary and secondary education, citing these trips as "fun" and "nothing like the Meadows Center."

Fieldtrip experience.

Similar to Leighla, Aurora's engagement through the fieldtrip suggested her primary interests in the fieldtrip included socializing and completing the lab assignment. Aurora reported she did not have prior interest in the fieldtrip's subjects. Still, she gained an appreciation for aquatic environments after taking part in the glass-bottom boat tour. While she appreciated the boat component of the fieldtrip, Aurora reported the topics about aquatic environments presented by the docent went "over her head," and kept her from knowing "what to do with that information." Overall, Aurora was primarily engaged socially and through paying attention throughout the fieldtrip.

Engagement.

Overall, Aurora engaged 661 times (See Figure 12). Aurora's behavioral engagement comprised 79.3% of her total engagement, while her affective engagement comprised 18.3% of her total engagement. Aurora's cognitive engagement comprised 1.1% of her total engagement, and her agentic engagement comprised 1.4% of her total engagement. Total counts of Aurora's engagement actions are presented in Appendix I.

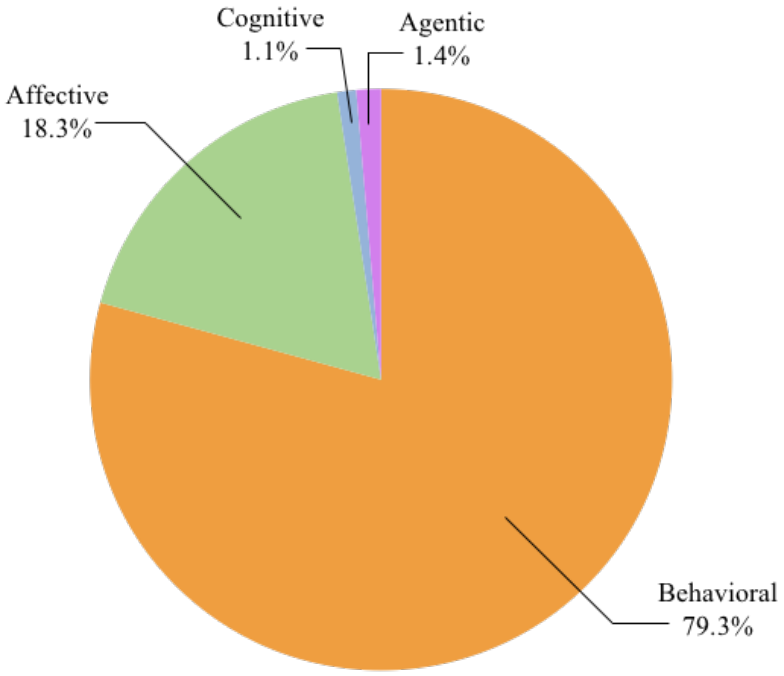

Figure 12. Combined behavioral, affective, cognitive, and agentic fieldtrip engagement for Aurora (n=661)

Behavioral

Aurora behaviorally engaged a total of 523 times via 16 different actions: paying attention, responding to external cues, conversation, asking questions, reading, writing notes, answering questions, making hand motions, physically interacting, digital documentation, moving closer, following explicit directions, making thinking noises, sharing notes, and shaking head (See Figure 13).

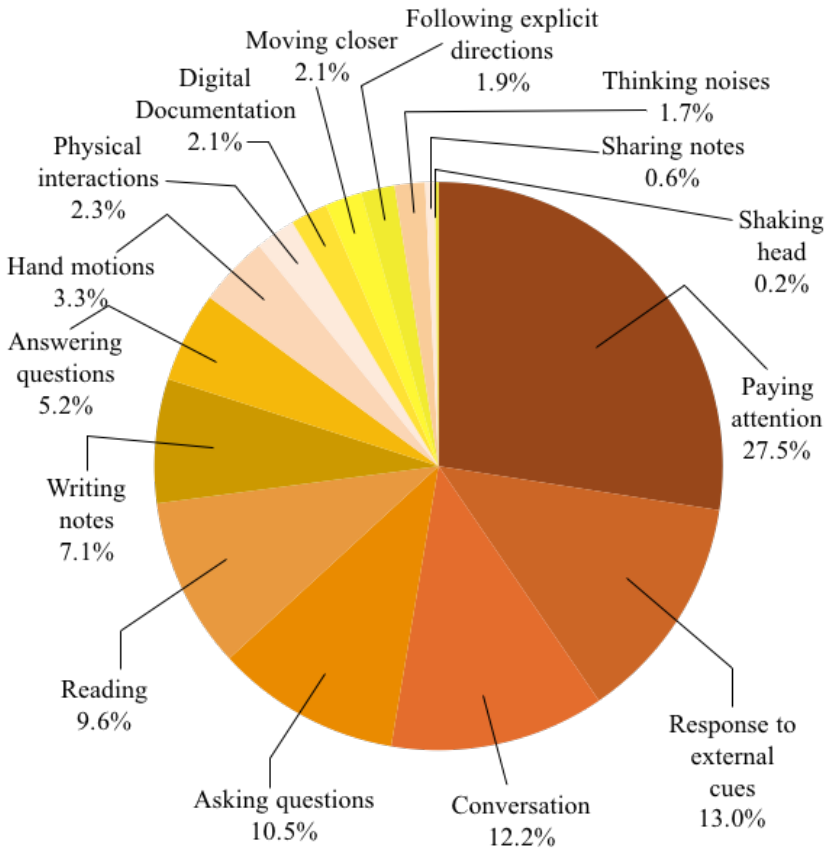

Figure 13. Breakdown of behavioral engagement actions for Aurora (n=523)

Like Leighla, Aurora's key behavioral engagement actions (e.g., paying attention, responding to external cues, conversation, asking questions) centered on collecting information necessary to complete the lab assignment. For example, at the beginning of the wetlands walk, Aurora's docent, Janet, instructed the group in a gazeebo with educational displays. The docent prompted the students to direct their attention to some animal skulls located along the right wall, and Aurora's gaze travelled to this area [Code: Response to external cues]. The docent then instructed the class about what the skulls and teeth mean, and Aurora focused on the skulls [Code: Paying attention]. Eventually, Aurora appeared to move closer to get a better look [Code: Moving closer], and continued to focus closely on the skulls. Aurora explicitly addressed this episode in her

interview, and described how she attempted to observe a subject the docent presented. She stated, “I was just trying to get a better view. I wasn’t really far away, but the skulls were pretty small, so I guess when she was pointing stuff out I was trying to see what she was talking about.” Aurora’s behavioral actions suggesting her attention to the docent were consistent throughout the other fieldtrip activities.

While Aurora paid attention during instruction, she often broke her attention to communicate with other students. During these times, Aurora typically asked the other students for verification of the instructional content as it related to answering the lab notebook questions (e.g., “what invasive species did she say?”) [Code: Asking questions]. After receiving answers and recording the information [Code: Writing notes], Aurora then turned her attention back to the docent and/or target focal point [Code: Paying attention]. These actions suggest Aurora sees both the docent and her peers as facilitators to obtain the information for the lab notebook questions.

Another large component of Aurora’s engagement included her social interactions with her peers. Similar to Leighla, many of Aurora’s social interactions occurred between herself and two of her friends, Grace and Kia. Aurora’s interactions with Grace and Kia largely occurred during transitional periods, and involved the girls joking around and discussing various topics both related and unrelated to the fieldtrip and General Science course. Outside the transitional moments, Aurora also socially engaged during bug-picking activity, where Aurora led her bug-picking group through the activity. During this time, Aurora verbally described the activity instructions to the group [Code: Conversation], helped them develop a hypothesis about the quality of their water, and

caught and identified bugs. Aurora's social interactions regularly gave way to affective and cognitive engagement actions.

Affective

Aurora affectively engaged a total of 121 times via five different actions: laughter, stating personal opinions and perceptions, emotional responses, and joking (See Figure 14).

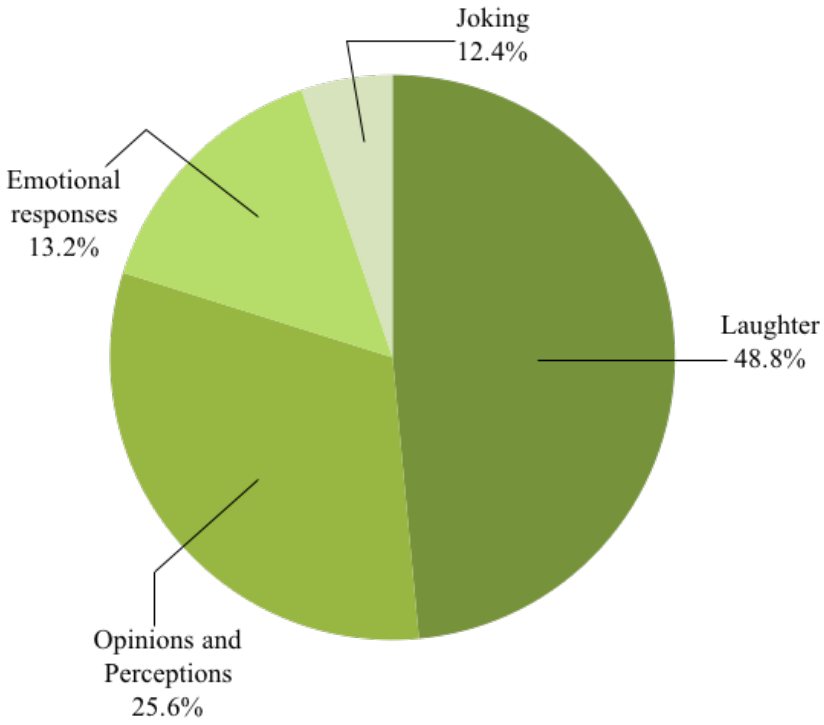

Figure 14. Breakdown of affective engagement actions for Aurora (n=121)

Aurora's observable affective engagement suggested she enjoyed the social nature of the fieldtrip. Demonstrating her affective engagement via socially-geared actions (e.g., joking, and expressing positive opinions), Aurora spent much of her affective engagement interacting with her friends, Kia and Grace. During moments of instruction, Aurora largely paid attention to the docent; however, after the docent completed her instruction (e.g., transitional period) Aurora typically joked and laughed with Grace and

Kia about topics both related and unrelated to the fieldtrip. Aurora's social interactions comprised a large portion of her affective engagement; however, she did not reference these interactions in her interview or homework. Perhaps this is because Aurora did not view her social interactions as relevant to completing the fieldtrip activities or lab notebook assignment.

The social nature of the bug-picking activity appeared to help facilitate Aurora's participation. For example, during the bug-picking activity, Aurora took the lead in her group by facilitating discussion, and physically interact with the macroinvertebrates in the water bin. Aurora first read the introductory question to the group in a silly voice [Code: Joking], which led herself, Kia, and her other group members to laugh [Code: Laughing]. Next, Aurora was the first member of her group to physically interact with the bucket of water, and captured the bug. Upon capturing the bug and observing it in the cup, Aurora and the other group members exclaimed "whoa! wha!" [Code: Emotional response]. Aurora and her group members then continued to laugh, joke, and express emotional responses as they captured and identified additional bugs. This episode highlighted the overlap between Aurora's socially-geared engagement which incorporates both behavioral (e.g., conversation, physical interaction) and affective (e.g., joking, laughing) engagement actions. Aurora's observable enthusiastic engagement, however, contrasted with her reported feelings about the activity. For example, during her interview, Aurora stated she had no prior interest and "didn't know what to make" of the bug-picking activity. Given Aurora's reported apprehension and limited interest in the bug-picking activity, it appeared the presence and participation of her peers helped facilitate Aurora's participation.

Cognitive

Aurora cognitively engaged a total of 7 times via two actions: synthesis and referencing previous knowledge/ experiences (See Figure 15).

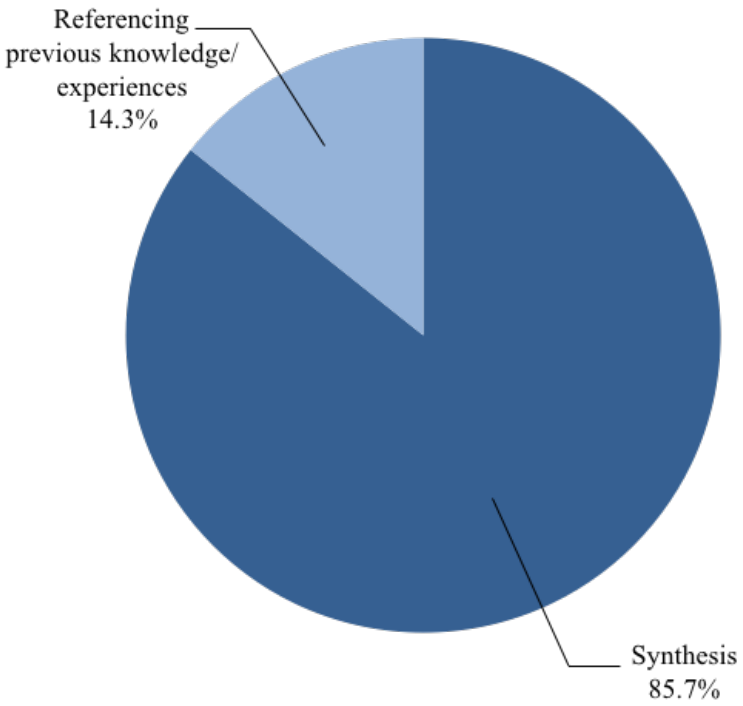

Figure 15. Breakdown of cognitive engagement actions for Aurora (n=7)

Aurora's cognitive engagement throughout the fieldtrip largely manifested during the bug-picking activity. To complete the Meadows Center's activity, Aurora led her group in synthesizing a hypothesis and conclusions about the quality of the water in their bin. To do this, Aurora took the lead in identifying and categorizing aquatic macroinvertebrates in her water bin, and characterizing other features of the group's water to develop a hypothesis about the quality of the water. During the activity, Aurora first responded to the Meadows Centers' introductory questions about the water they had in their bins, which asked "based on the appearance of your water do you think it is polluted or non-polluted?" To answer this question, she asked her group "So is it just

kind of polluted or straight up polluted?" This response indicated Aurora independently characterized the water as polluted [Code: Synthesis], and suggested she needed additional input from her group members to characterize the level of pollution. The group decided together that the water was polluted. Following this, Aurora read the next question aloud, which asked the group to provide the rationale behind their hypothesis. Aurora again responded first, and stated she thinks the water is polluted because it is brown and is room temperature [Code: Synthesis]. Here, Aurora verbalized her thought process for characterizing the water based on observable characteristics (e.g., appearance, temperature), and synthesized this information to answer the activity questions.

In her homework, Aurora later reflected on her own cognitive processes, and identified the bug-picking activity as the best example of inquiry-based learning for her future students. She described the process as a "hands-on experiment" where her group could "develop a hypothesis" and "formulate a conclusion." Thus, her observable experience on the fieldtrip aligned with her beliefs about the nature of the bug-picking activity.

Agentic

Aurora agentically engaged a total of nine times via three actions: asking questions, talking about, and visually observing unintroduced topics and/or objects (See Figure 16.)

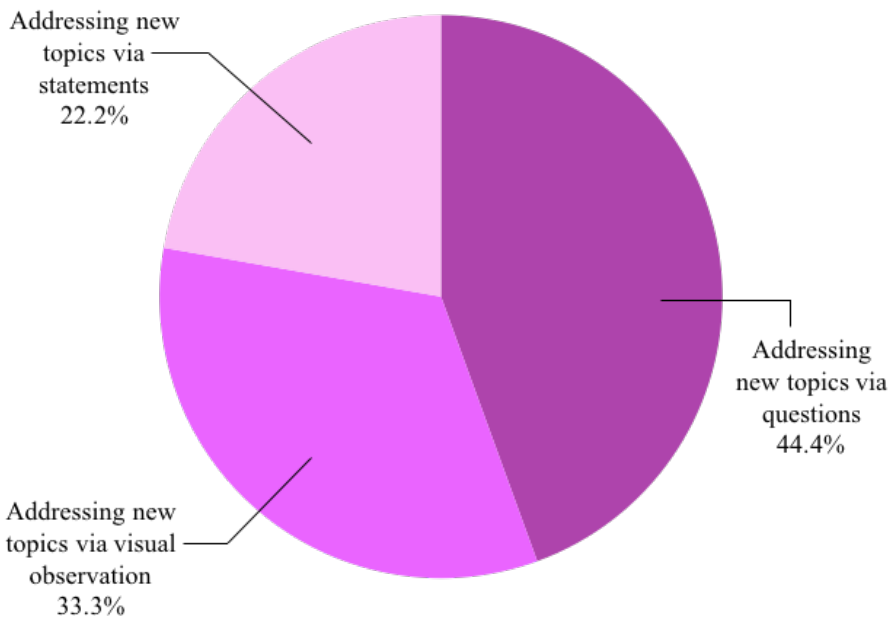

Figure 16. Breakdown of agentic engagement actions for Aurora (n=9)

Aurora's agentic engagement primarily occurred during the glass-bottom boat tour, as well as when the class travelled from the wetland walk to the aquarium. Like her cognitive engagement, Aurora's agentic engagement was infrequent and overlapped with her ongoing social interactions. Much of Aurora's agentic engagement centered on asking questions which addressed the logistics of the Meadows Center's daily operations. Aurora asked these questions to the docent as her class walked past groups of school children on fieldtrips. Aurora prompted the docent, and asked "Do you guys usually schedule the schools on a certain day?" [Code: Addressing new topics via questions]. She then proceeded to additional follow-up questions addressing the same topic.

During the glass-bottom boat tour, Aurora agentically engaged by visual observing and making statements about objects outside of to the docent's instruction. Aurora's observations and statements indicated her interest in the aesthetic quality of the lake. In these moments, Aurora chose to break from observing the target focal points, and observe the top of the water. She would also exclaim her opinion that the water looked

very pretty and blue. While Aurora makes these statements aloud, she did not appear to be communicating with other students. In her interview, Aurora stated everything on the boat "just looked visually interesting," because she had never "seen any of the stuff that was underneath the water." Thus, Aurora's observable interest in the aesthetic quality of the water aligned with her reflective thoughts about what she enjoyed about the glass-bottom boat tour.

Perceptions.

Outdoor learning environments as teaching tools.

Aurora perceived outdoor learning environments as supplementary classroom tools which offer better learning experiences because they increase student engagement, and provide students with transformative experiences.

Aurora defined engagement as both student focus, and active participation in learning material. Aurora first suggested the more authentic, fun, and hands-on nature of activities conducted in outdoor learning environments can increase student engagement. For example, she stated experiences in outdoor learning environments encourage students to go beyond "just sitting in a chair absorbing" subject matter, and pushes them to figure out "what's happening around them" by "using their hands that their brain." Here, Aurora recognized the cognitive benefits of increasing student engagement. She further discussed how taking students outside "connects what the students are seeing to what they are learning," and helps them better grasp the material. In contrast to cognitive growth, Aurora also believed outdoor learning experiences should also be fun, because fun activities help students "make memories and enjoy themselves." Citing her own

pedagogical beliefs, Aurora stated she wants to make her classes about more than just learning, and wants her future students to remember more than the time they had in class.

Aurora also reported the increased engagement associated with teaching in outdoor learning environments provides students with meaningful and transformative experiences otherwise unavailable via standard classroom teaching. For example, she described how taking students who are not fond of the outdoors into outdoor learning environments can help them "see it [the outdoors] in a different way," or even make them care about the environment more. This perspective aligned with Aurora's self-report of her glass-bottom boat experience. While Aurora reported she had no prior interest in "aquatic life and everything that happens under the water," she stated her visual, underwater observations during the glass-bottom boat tour provided her with "a different perspective." She stated this experience eventually changed her opinion of the subject, and she ultimately thought the activity was "actually pretty cool."

Overall, Aurora's beliefs about outdoor learning environments indicated her awareness of the complexities of student learning. Additionally, her descriptions highlighted her beliefs about providing students with educational experiences that are both academically meaningful, and personally transformative.

Outdoor learning environment integration ideas.

When describing the factors influencing her choice of outdoor learning environments, Aurora reported the specific location and way in which she would use outdoor learning environments would depend on the subject she planned to teach. Like Olivia, Aurora recognized the value of using the Meadows Center, and specifically the bug-picking activity, as a potential future fieldtrip destination to teach about aquatic

organisms and ecosystems. Aurora reported her hesitancy with facilitating the Meadows Centers' activities and indicated she would not "know what to do" were the docent not present. However, Aurora also reported her confidence in herself to "do research" and see what she "could possibly do" when the time came to lead an outdoor activity. Thus, Aurora appeared to have more confidence in developing and executing her own activities, rather than leading activities developed by the Meadows Center by herself.

While Aurora reported she did not personally enjoy the bug-picking activity because: (a) she "didn't know what to do with the information," and (b) she did not want to get dirty; she recognized her future students would enjoy and benefit from the activity. Aurora believed this in part because she observed students from another school enjoying the activity at the Meadows Center. Aurora's reported confusion about what to do with the information from the bug-picking activity also alighted with her reported hesitation about facilitating the activity for her future students. Thus, Aurora's integration ideas reflect her concerns and beliefs about her teaching abilities.

Conclusions

Aurora's observable engagement throughout the fieldtrip indicated she saw the docent and her peers as a means to socially interact, and obtain the information necessary to complete the lab assignment. Many of Aurora's behavioral, affective, and cognitive engagement actions appeared to overlap throughout the fieldtrip, and highlighted the complexity of her experience.

The perceptions and integration ideas Aurora reported suggested she recognized the complexity of student learning. Furthermore, Aurora reported her desire to use activities that are not only academically appropriate, but also provide students with

meaningful experiences they will remember for a long time. Aurora's reported concerns about facilitating outdoor learning experiences indicated her awareness of her perceived shortcoming, but also highlighted her confidence to overcome these concerns when the time comes to take her students outside. Overall, Aurora's engagement, perceptions, and integration ideas emphasize Aurora's complexity, as well as her awareness of the complexities of teaching in outdoor learning environments.

Case #4: Bernard

General demographics and teaching experience.

Bernard is a 20-year old, Caucasian, male in his junior year. He is pursuing a Bachelor's of Science degree in Interdisciplinary Studies. Bernard's career goals include teaching high school special education, and he intends on obtaining his EC-12 Special Education teaching certification. At the time of the study, Bernard had no prior formal teaching experience, but reported his experience as a peer tutor. Bernard stated his tutoring position allowed him to attend fieldtrips with the student he tutored. He also reported helping students with the materials from the fieldtrips they attended once they were back in the classroom. Bernard also discussed his experience on mission trips with his church, but did not elaborate on the activities he completed on the mission trips. Bernard also indicated his experience at the Meadows Center, where he previously attended a glass-bottom boat tour and a tour of the wetlands walk as part of his freshman University Seminar course. Finally, Bernard described himself as "very ADD," and emphasized he learns the best by multi-tasking and having constant external stimuli.

Fieldtrip experience.

Like Leighla, Bernard's engagement throughout the fieldtrip suggested he viewed the docent and his peers as filling two separate roles. He viewed the docent as a facilitator of information, and viewed his peers as an outlet for social interaction. Bernard's engagement with the docent largely manifested as paying attention and asking questions which extended the content of the activity to cover topics he found personally interesting. When engaging with his peers, Bernard primarily discussed and joked around about topics both related and unrelated to the fieldtrip. Bernard reported his overall goals for the fieldtrip included completing the lab assignment then enjoying the fieldtrip; however, as Bernard focused most of his time on interacting with the activities and his peers, he subsequently spent less time focusing on completing his lab assignment. Overall, Bernard primarily engaged by paying attention, asking questions, and socializing.

Engagement.

Overall, Bernard engaged 799 times (See Figure 17). Bernard's behavioral engagement comprised 63.5% of his total engagement, while his affective engagement comprised 28.2% of his total engagement. Bernard's cognitive engagement comprised 3.5% of his total engagement, and his agentic engagement comprised 4.9% of his total engagement. Total counts of Bernard's engagement actions are presented in Appendix I.

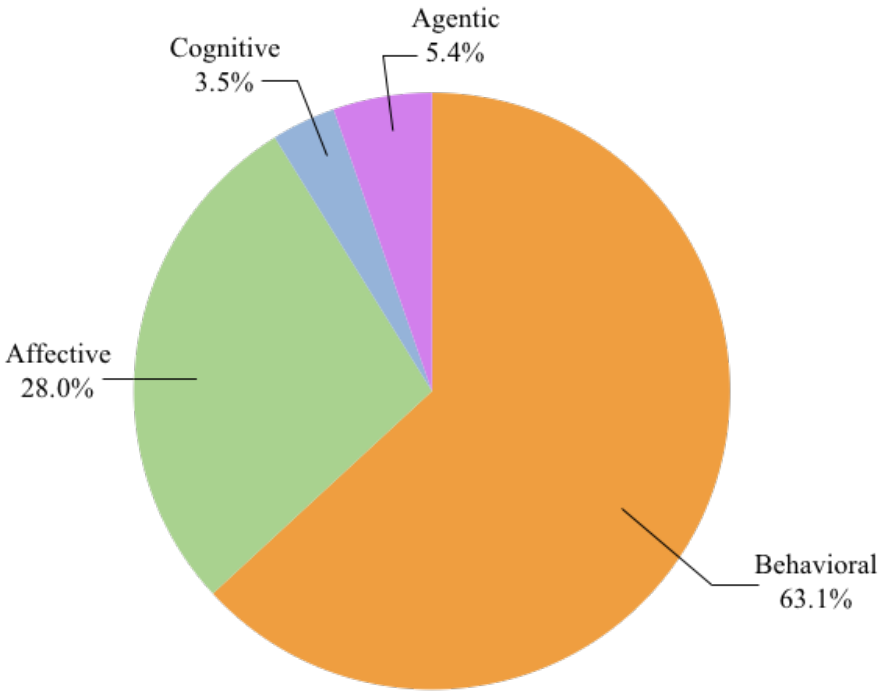

Figure 17. Combined behavioral, affective, cognitive, and agentic fieldtrip engagement for Bernard (n=803)

Behavioral.

Bernard behaviorally engaged a total of 507 times via 16 actions: conversation, asking questions, paying attention, responding to external cues, answering questions, reading, writing notes, moving closer, hand motions, singer or humming to self, physical interaction, thinking noises, mimicking, following explicit directions, shaking head, and sharing notes (see Figure 18).

Bernard demonstrated much of his behavioral engagement through social interactions with peers and the docent (e.g., conversation, asking questions, answering questions), and directing his focus towards the fieldtrip's material (e.g., paying attention, response to external cues, asking questions).

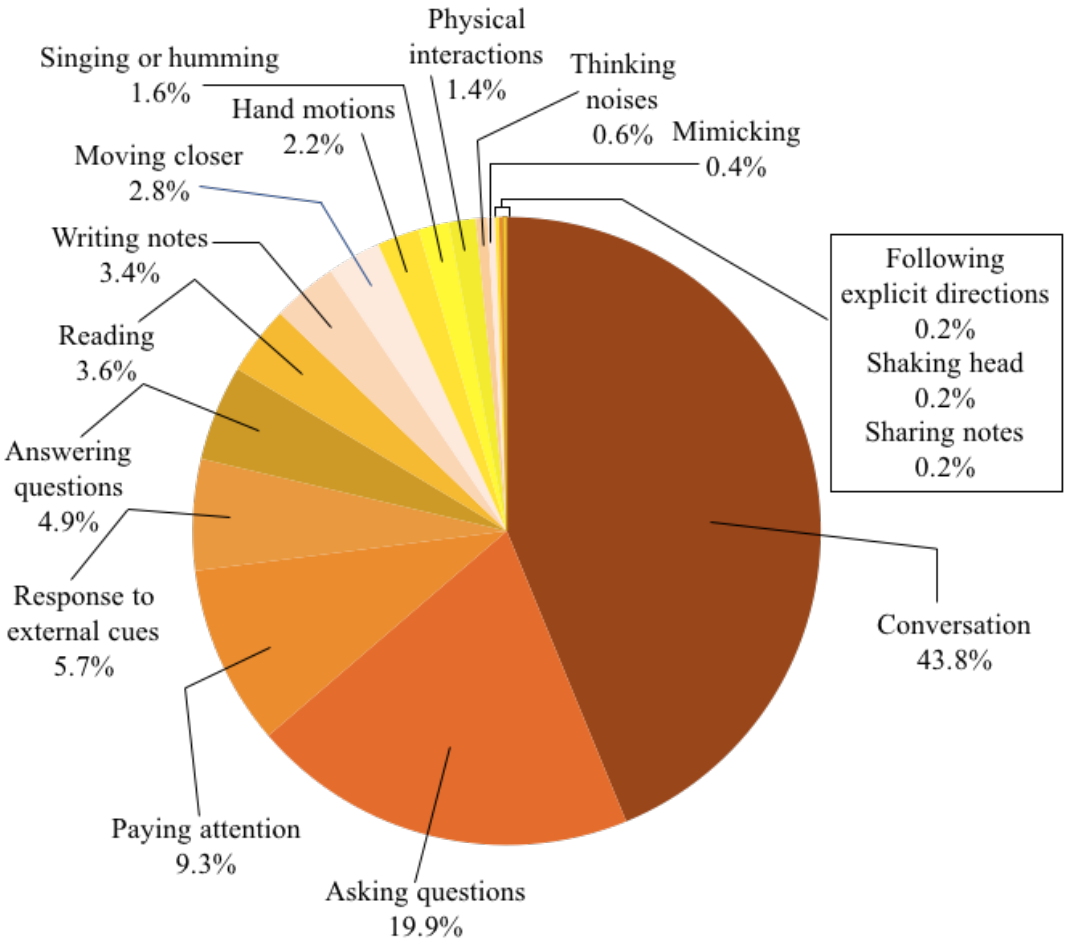

Figure 18. Breakdown of behavioral engagement actions for Bernard (n=507)

While Bernard's social interactions occurred throughout all the fieldtrip activities, most moments of conversation with his fellow peers and the docent occurred during transitional periods. Conversation topics primarily addressed fieldtrip activity topics (e.g., plants and animals), but occasionally incorporated topics outside the scope of the fieldtrip and General Science Course. The nature of Bernard's social interactions with many other students in his class involved ample joking during conversation. For example, during the glass-bottom boat tour, Bernard pointed to an area of the glass-bottom and exclaimed to his peers, "hey! There's a shark! Gotcha! There's no shark!" [Code: Conversation]. Bernard's social interactions with his peers followed a similar pattern throughout the

remainder of the fieldtrip. Unlike Leighla and Aurora, Bernard's social interactions included multiple students from the class, as opposed to just a few friends. When discussing how interactions with his peers influenced his fieldtrip experience, Bernard stated "I always think it's fun to go out with people that you're with every day, like just friends you've made in the class, and kind of experience them a little bit outside the class and have fun…" Thus, Bernard's engagement with his peers highlighted how he perceived his peers as an outlet for social interaction and enjoyment.

Bernard's interactions with the docent largely involved paying attention, and asking questions regarding the activity materials. Bernard typically paid attention to the docent and the target focal point the docent presented during instruction; however, he also regularly asked questions during the docent's instruction. For example, during the wetlands walk, the docent gathered the students around a plaque which presented invasive species found in the lake, and instructed the class about a specific species known as a nutria. During this time, Bernard shifted his gaze between the docent and the plaque [Code: Paying attention], and eventually asked the docent "do you remove the nutria when you see them?" [Code: Asking questions]. This question, like many others, were indirectly related to the required lab assignment, and indicated Bernard's desire to extend the subject material beyond what was necessary to complete the lab assignment.

Another example of this phenomena occurred during the wetlands walk when the class encountered one of the Meadows Center's scientists marking turtles from the lake. The docent first directed the students' attention to the scientist, and allowed the scientist to instruct the class about the turtles. When observing the scientist, Bernard paid close attention to the turtles, and asked a myriad of questions (e.g., "How do you age them?").

While the docent did not lead instruction during this event, Bernard's behavior suggested he viewed the scientist in a similar way to the docent (i.e., facilitator of information).

In his interview, Bernard indicated his goals for the fieldtrip included completing the lab notebook assignment and then enjoying himself. While Bernard's social interactions aligned with his reported goal of enjoying himself, very little of his engagement reflected his reported goal of completing the lab assignment. However, Bernard's behavioral engagement did indicate his interest in the fieldtrip materials, and his desire to expand on his learning experiences past the boundaries of what he needed to complete his homework assignment.

Affective.

Bernard affectively engaged a total of 225 times via five actions: joking, expressing personal opinions, emotionally responding, laughing, and storytelling (see Figure 19).

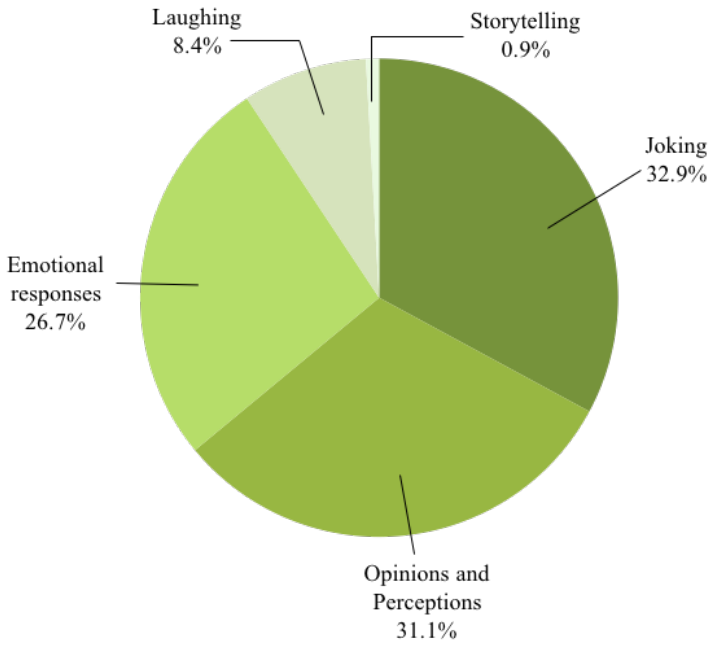

Figure 19. Breakdown of affective engagement actions for Bernard (n=225)

Consistent with Bernard's behavioral engagement, much of Bernard's affective engagement suggested his interest in learning about animals, and reflected his social behavior. The majority of Bernard's affective engagement included joking around with his peers throughout the fieldtrip about the organisms they observed. Bernard also frequently expressed opinions (e.g., "that was cool looking") and emotions (e.g., "oh wow") about objects and topics throughout the fieldtrip.

For example, the nutria event during the wetland walk prompted Bernard to express a variety of affective engagement actions. Upon first observing the nutria, Bernard expressed his excitement by exclaiming "Oh my god! That's the rodent thing" to another student [Code: Emotional response, Opinions and perceptions]. He then described the nutria as looking "really cool," [Code: Opinions and Perceptions] and joked with other students that they should "sound the alarm!" [Code: Joking]. When another student identified the nutria as a beaver, Bernard questioned her identification, and stated "that's the rodent! It's not a beaver!" [Code: Opinions and perceptions]. Bernard's joking, discussion, and expressions of emotions and opinions to other students highlights the overlap between his social, behavioral engagement and his affective engagement.

Bernard referenced this event in his interview as one of his favorite parts about the fieldtrip, describing it as "pretty cool." Bernard stated the nutria was his favorite because being in the same environment as the animal, and seeing it in action allowed him to "understand it [the nutria] a little better," and helped him see the environment "in a different way." During his interview, Bernard stated he had a pre-existing interest in seeing the nutria, as he previously learned about it when he attended a tour of the

wetlands walk in the past. He stated he spent the whole time looking for a nutria, but until that day had never found one.

The social nature of Bernard's affective engagement further highlighted his ongoing social interactions with his peers. Bernard's affective engagement episodes included many overlapping engagement actions which highlighted the complexity his experience.

Cognitive.

Bernard cognitively engaged a total of 27 times via two actions including referencing previous knowledge and experiences, and synthesizing (see Figure 20).

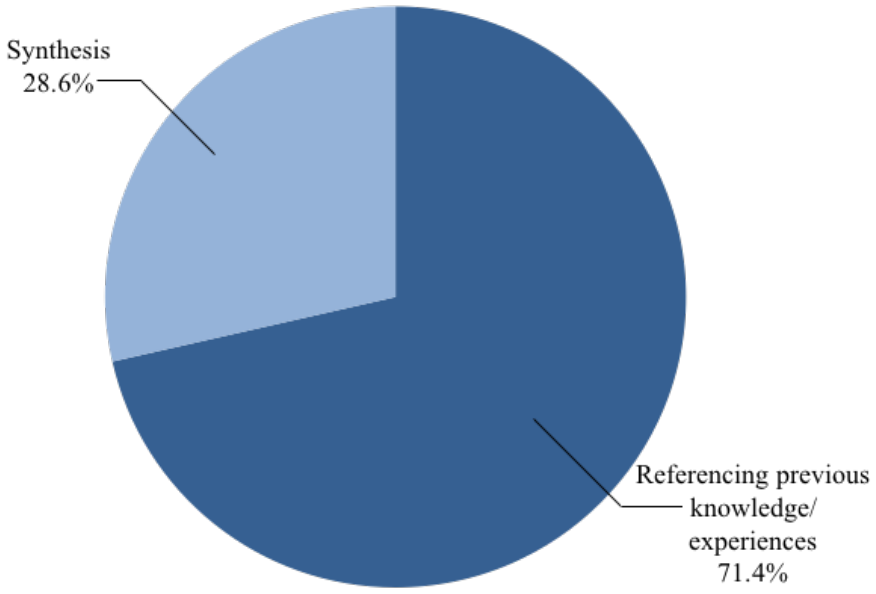

Figure 20. Breakdown of cognitive engagement actions for Bernard (n=28)

Most of Bernard's cognitive engagement occurred during the glass-bottom boat tour and the wetlands walk activities, and highlighted his pre-existing interest in the plants and animals found in the lake. Additionally, his engagement largely involved asking questions which referenced past experiences relating to the fieldtrip's subject

material. For example, during the glass-bottom boat tour, Bernard connected the concept of rarity between a mammal species he previously learned and a species described by the docent. After the docent spoke about the rarity of seeing native eels in the river, and Bernard asked, “Isn’t there like some sort of little animal that sometimes comes around here? I don’t remember which, what it was. It was like... like a mammal… They said they’re really rare…” Eventually, the docent identified the species Bernard referenced as a beaver, which prompted Bernard to say, “that’s what it was, a beaver.” In this moment, Bernard appeared to connect the concept of rarity between the native eels and the other rare species he previously learned about (i.e., beaver) Much like Bernard’s other questions during the fieldtrip, this moment highlights his interest in extending the learning experience to explore a topic in-depth. In this case, rarity and beaver were the topics he appeared to want to learn more about.

Following this pattern, Bernard brought up additional topics such as natural selection, and the conditions of the San Marcos River. During his interview, Bernard reported how his own personal experience with “recognizing and seeing the things” he learned about in the past during the fieldtrip made “the information real.” Bernard’s cognitive engagement highlighted his ability to link complex, abstract concepts (e.g., rarity) between different topics (e.g., different species). His engagement also indicated how the docent and the nature of the fieldtrip activities can encourage students to connect the learning material to other information.

Agentic.

Bernard agentically engaged a total of 39 times via four actions: asking questions, talking about, and visually observing unintroduced topics and/or objects, and interacting with an unintroduced activity (see Figure 21).

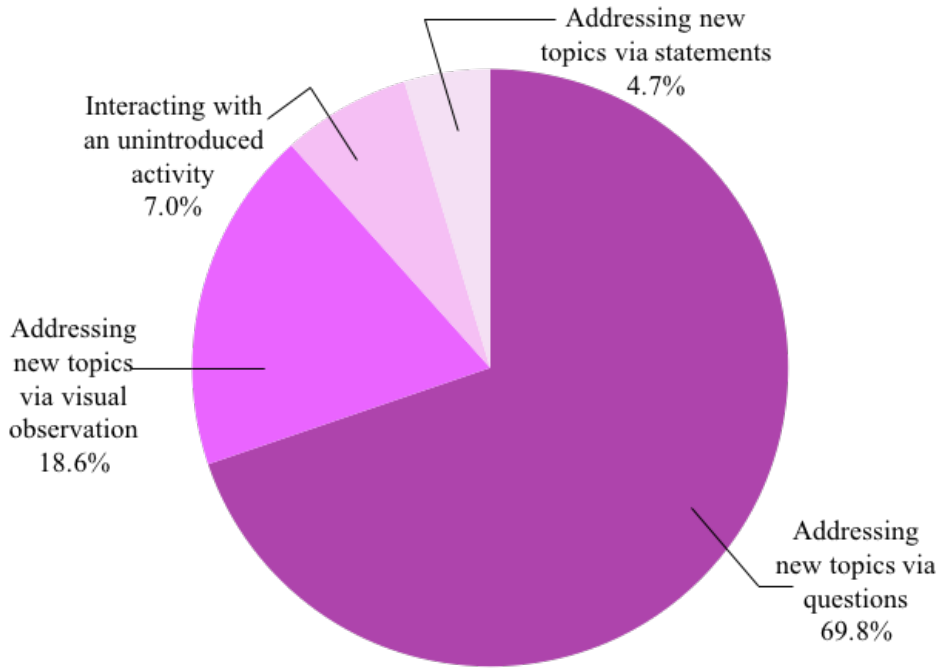

Figure 21. Breakdown of agentic engagement actions for Bernard (n=43)

Bernard's agentic engagement illustrated his desire to extend the learning experience and expand on the topics presented by the docent. Much of Bernard's agentic engagement occurred during the glass-bottom boat tour and the wetlands walk activities. His actions primarily included probing the docent and the Meadows Center's turtle scientist about the hydrogeology of the lake (e.g., "What do you mean by protected spring? Where would we find that?"), and the animals he observed (e.g., "So for turtles, size does matter for males?").

Most of Bernard's agentic engagement during the wetlands walk occurred when the class encountered the turtle scientist. As previously stated, Bernard affectively and

behaviorally engaged during this event via joking, talking, and asking questions. While Bernard's questions referenced organisms which the docent and scientist previously introduced, the probing nature of Bernard's questions went beyond the initial scope of instruction. For example, Bernard asked questions about the scientist's personal experiences with the turtles (e.g., How many times have you gotten bitten [by a turtle]?"), how to figure out how old the turtles are (e.g., "How are you aging them?"), and about mating behavior (e.g., "So for turtles, size does matter for males?"). By asking such pointed questions, Bernard demonstrated what appeared to be his interest in learning as much about the turtles beyond the scope of what the docent and scientist likely intended on teaching.

Bernard asked questions of a similar nature on the glass-bottom boat when the docent instructed the class about the springs and aquifer. As the docent talked about the springs, Bernard asked a variety of questions including requests for clarification about what a spring was and where to find it (e.g., "What is a protected spring?" and "where do we find that?"), as well as information about the fluctuating height of the water in the lake (e.g., "why does the water level not go up constantly?").

Overall, Bernard's affective engagement aligned with his other engagement actions across the behavioral affective, and cognitive dimensions, and emphasized his interest in expanding his learning experience to address topics of personal interest. Additionally, his probing questions and social interactions with the docent and the turtle scientist indicated he valued them as facilitators and providers of information.

Perceptions.

Outdoor learning environments as teaching tools.

Bernard thought positively of using outdoor learning environments as teaching tools in his future career. He stated using outdoor learning environments would "be really important," as these environments provide students many beneficial experiences. In his interview, Bernard elaborated on how outdoor learning environments provide students more engaging learning experiences with fewer constraints and rules. Bernard did not explicitly draw on his experience during the General Science fieldtrip as the basis for his opinions about the benefits of teaching in outdoor learning environments; however, he directly referenced his past experiences as a student and a peer tutor.

For example, Bernard described witnessing his past tutees engaging so deeply with animals during a fieldtrip that they "didn't even know they were learning." Bernard acknowledged active student participation and intense focus as the primary components of engagement. Bernard proceeded to explain how the active engagement students experienced prompted them to pay very close attention and ask many questions. Bernard appeared to experience a similar phenomenon when he interacted with the turtle scientist, and during the glass-bottom boat tour when he learned about the hydrogeology of the lake. Bernard elaborated on his fieldtrip experience, stating:

> I definitely felt more attentive to the material, to what was going on, to the questions, to the people around me. It was a lot more fun and engaging than when we were sitting in the classroom together.

Bernard's engagement actions during these moments (e.g., paying attention, asking probing questions) suggested his active participation and focus. Further reflecting on his

fieldtrip experience, Bernard also reported he felt the Meadows Center fieldtrip "pushed him" to participate. Although the active learning experiences Bernard described are like those he had at the Meadows Center, Bernard does not directly describe his experience at the Meadows Center as "active learning." Later, Bernard noted he felt his future students would experience phenomena like those from his own fieldtrip because he believed he and his future students "learn the same way." Moreover, Bernard cited these feelings as reasons he would want to take his students in to outdoor learning environments.

Next, Bernard described how outdoor learning environments provide students with learning experiences with fewer rules and constraints. Bernard again referenced observations of his past tutees, and reported "the participation and the interest is just so much higher when working with them [students], when they're not confined to the rules of the classroom." Bernard then stated outdoor learning environments in general help students "learn the best." He also described how the limited constraints in outdoor learning environments help special education students to learn better, because students have the opportunity to engage with hands-on activities. Bernard highlighted the value hands-on learning experiences, because he believed they are the way his students "learn the best."

While Bernard believed having less constraints benefited students, he recognized having too few constraints can be detrimental to student learning. Citing past observations, Bernard described student distraction as a downfall of teaching in outdoor learning environments. Bernard then referenced his own experiences in outdoor learning environments, and described how he can close his eyes "and just not pay attention as much because it's so relaxing outside." He also recognized some students "need to be in a

desk to focus," and might struggle or be uncomfortable learning in the outdoors. Thus, Bernard believed there is an appropriate time and place for the use of outdoor learning environments, and instructors much account for students' behaviors, strengths, and weaknesses when identifying and using outdoor learning environments.

Outdoor learning environment integration ideas.

Like Olivia and Aurora, Bernard recognized the value of using the Meadows Center, and similar learning environments, to teach science. Bernard stated he would enjoy taking students to zoos and other places where they could explore "different little ecosystems." However, Bernard's descriptions focused on the complexities of developing effective learning experiences through selecting experiences which are appropriate, supplement classroom teaching, and are facilitated in an effective manner.

After describing the general benefits of using outdoor learning environments, Bernard highlighted the need to select locations that are appropriate for the educational subject matter at the time. Bernard then discussed his dual perspective about using indoor and outdoor learning environments to teach different subjects. In his interview elaborated on his perception:

> You're not going to learn everything outside, and I don't think you're going to learn everything inside. I think there's some things that you learn from experience, and some things you literally just have to sit down and hear and it starts to make sense.

For example, Bernard considered more conceptual topics (e.g., ecosystems, population) better topics for standard classroom teaching, because he believed they are hard to see during fieldtrips. Topics which Bernard considered appropriate to teach in outdoor

learning environments included tangible things (e.g., animals) or historical events (e.g., battle of Gettysburg). This suggests Bernard believed topics taught in outdoor learning environments could supplement materials taught in standard classroom teaching, and vice versa.

Bernard also discussed the appropriate nature of outdoor learning experiences in terms of student perceptions of the class in general. Bernard described how instructors must be cautious when using outdoor learning environments regularly, as using them too much conveys the idea that a class "is not really a class," or has too much of a "laid back feel." For example, Bernard stated, "I wouldn't do well in a history class where I felt like I could close my eyes and just like not pay attention as much just because it is so relaxing outside." Thus, Bernard recognized there is a time and a place to appropriately integrate outdoor learning environments into his future curriculum.

Bernard also expressed his desire to have a facilitator (e.g., docent) during future outdoor learning experiences. During his interview, Bernard stated, "I think that [having a facilitator] is really important just for the boundaries when you're dealing with special education." While Bernard stated that handling special education students on fieldtrips is "difficult" and "a big responsibility," he countered that outdoor learning experiences are still beneficial for student learning "if the instructor facilitates them the correct way." For example, Bernard described how a class could be moved outside if it was facilitated, because it would help the students "be geared into" the material. Thus, Bernard sees facilitators as critical to directing and promoting student's engagement towards the learning material.

Conclusions

Bernard's engagement during the fieldtrip suggested he viewed his peers and the docent as filling two separate and important roles. For example, Bernard's ample conversation, joking and laughter with is peers highlighted how he viewed them as an outlet for social interactions and fun. Bernard's interaction with the docent and the turtle scientist (e.g., asking probing questions, paying attention) emphasized how he viewed and valued them as facilitators and providers of information which he found personally meaningful.

Furthermore, Bernard's behavior with the docent and scientist during the fieldtrip aligned with his description of the value of facilitators in carrying out successful outdoor learning experiences. Bernard's perceptions of outdoor learning environments, as well as his integration ideas highlight his awareness of the complexities and links between the structures of learning experiences and subsequent student learning outcomes.

Case #5: Tara

General demographics and teaching experience.

Tara a 23-year old, African American, female in her senior year. Tara previously changed her major from Art Education, and is in her 5th year as an undergraduate. She is pursuing a Bachelor's of Science degree in Interdisciplinary Studies. Tara's career goals include teaching elementary students (ages 5 to 10 years), and she intends on obtaining her EC-6 ESL Generalist teaching certification. At the time of the study, Tara had no prior formal or informal teaching experience. Tara reported she previously attended the Meadows Center's glass-bottom boat tour during her Freshman University Seminar course. Additionally, Tara described how her mother is from the area, and previously

attended events the Meadows Center. Tara stated her mother prompter her to explore and learn about certain topics while on her General Science fieldtrip

Fieldtrip experience.

Tara's engagement, as well as her thoughts about the fieldtrip indicated her awareness of her surroundings, and suggested she experienced personally meaningful learning that helped her see the environment in a new way. Tara's engagement episodes often contained complex series of actions indicative of multiple dimensions of engagement. Overall, Tara described the fieldtrip as "amazing," "surreal," and made her feel like she was "on a high." She specifically indicated the glass-bottom boat tour and the bug-picking activity challenged her to think of things in new ways, and pushed her to be aware of her surroundings. Overall, Tara primarily engaged via behavioral and affective engagement actions which highlighted complex, multi-dimensional engagement experiences.

Engagement.

Overall, Tara engaged 799 times (See Figure 22). Tara's behavioral engagement comprised 64.8% of his total engagement, while her affective engagement comprised 28.9% of her total engagement. Tara's cognitive engagement comprised 5.1% of her total engagement, and her agentic engagement comprised 1.2% of her total engagement. Total counts of Tara's engagement actions are presented in Appendix I.

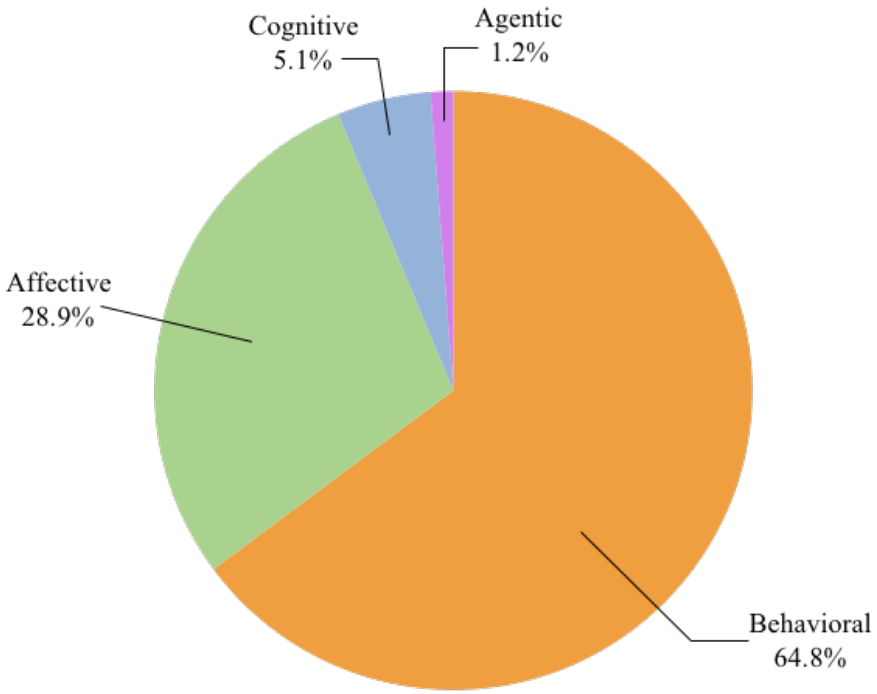

Figure 22. Combined behavioral, affective, cognitive, and agentic fieldtrip engagement for Tara (n=651)

Behavioral.

Tara behaviorally engaged a total of 422 times via 14 different actions: conversation, responding to external cues, asking questions, paying attention, reading, moving closer, answering questions, writing notes, making hand motions, physically interacting, following explicit directions, making thinking noises, digitally documenting, and shaking her head (See Figure 23).

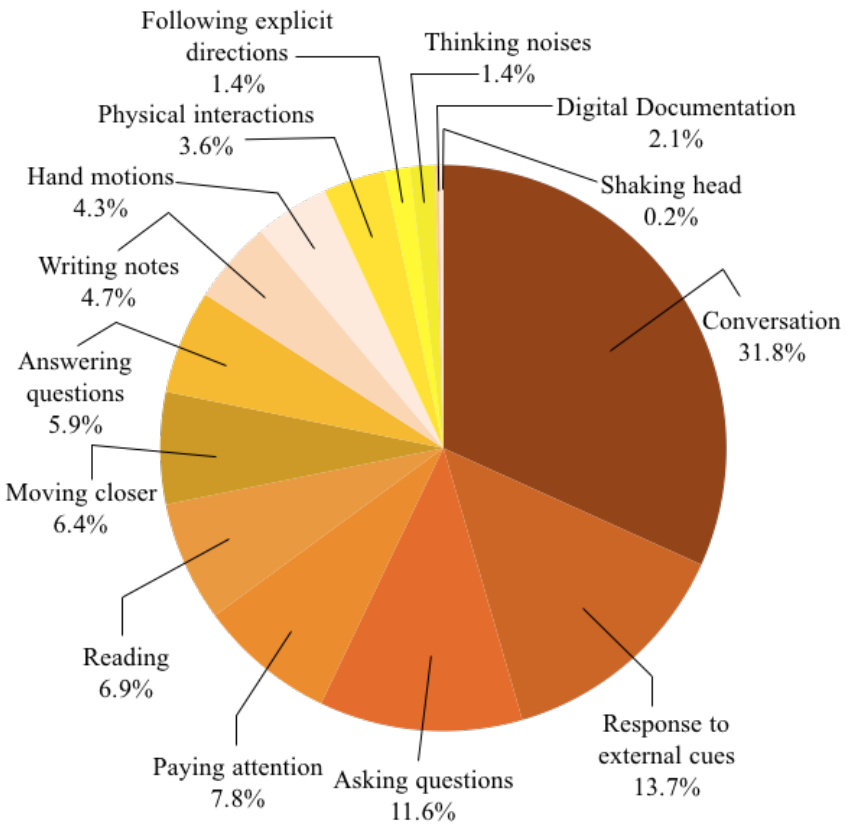

Figure 23. Breakdown of behavioral engagement actions for Tara (n=422)

Tara's behavioral engagement actions (e.g., conversation, response to external cues, asking questions, paying attention, reading, and moving closer) indicated the link between her environmental awareness and her behavioral shifts and increased participation in the fieldtrip activities.

Tara's responses to external cues and subsequent behavioral shifts occurred largely occurred during bug-picking activity, and manifested as complex engagement episodes. For example, Tara appeared hesitant to physically engage with activity materials at the start of the activity, and just looked at the vegetation in the bucket of water [Code: Paying attention]. Eventually her other group member grabbed the aquatic microscope, and used it to look for the macroinvertebrates. Tara watched her group

member trying to figure out how to use the microscope, and eventually attempted to use it herself by scooping up some water [Code: Physical interaction] and connecting the top of the microscope to the bottom. Eventually, Tara and her group member ask the docent for help, and the docent comes over and began looking through their water bin with her hands. While the docent looked, Tara observed a macroinvertebrate, points to it on the vegetation [Code: Hand motions - Pointing], and exclaims "Oh! I saw it on the… little thing…" [Code: Conversation]. The docent then identified the macroinvertebrate, which Tara looks at closely [Code: Paying attention].

At this moment, the group next to Tara finds a crayfish, and one of their members exclaims "Oh! It's a crayfish!" This prompts Tara to turn her head to the other group [Code: Response to external cues], and laugh. The docent then announced she found something Tara's water bin, and Tara turns her attention back to the docent [Code: response to external cues] and looks at the bug the docent identified [Code: Paying attention]. This detailed sequence of event highlights Tara's shifting attention and resulting behavioral engagement. First, Tara's broke her focus with her own group when she heard the other group's excitement over finding the crayfish. Tara returned her attention to her own water bin only after the docent announced she found a bug in Tara's group's bin.

Following this series of events, Tara's attention and engagement again shifted between that of her own group and the crayfish group next to her. Tara proceeded to travel in between her own group and the crayfish group when both groups continued to find more macroinvertebrates. These series of events highlighted Tara's awareness of her other classmates, and indicated her desire to explore exciting events as they occurred.

Tara exhibited similar behavior throughout the other three fieldtrip activities. When reflecting on her fieldtrip experience in her interview, Tara stated she felt there was "a lot to look at," and that she constantly shifted her observation from one object to another. She also reported she felt like she was "just everywhere" all at once. Thus, Tara's shifting attention and complex engagement episodes aligned with her reported thoughts about the complex, simultaneous nature of the fieldtrip events activity.

Affective.

Tara affectively engaged a total of 188 times via five actions: emotionally responding, expressing personal opinions, laughing, joking, and storytelling (see Figure 24).

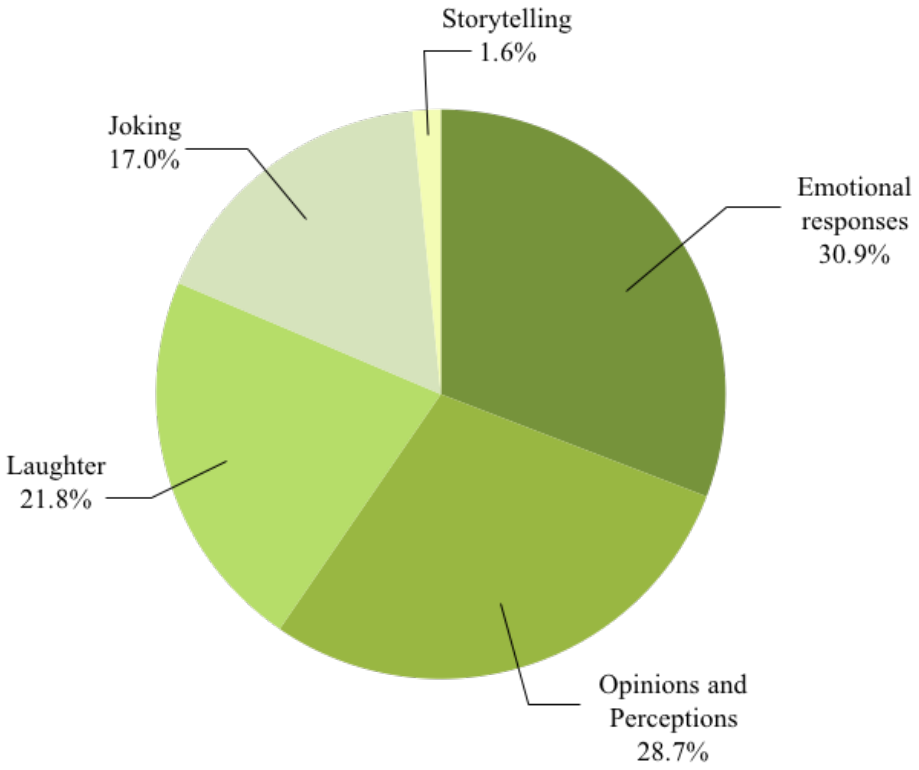

Figure 24. Breakdown of affective engagement actions for Tara (n=188)

Tara's observable affective engagement mapped her emotional experiences throughout the fieldtrip, and suggested her emotional responses and opinions and perceptions mediated much of her behavioral engagement.

Tara's emotional responses and stating opinions and perceptions typically occurred after the docent presented a target object for the students to observe (e.g., aquarium specimen), and continued throughout her interaction with the target focal point or activity. For example, Tara expressed a myriad of affective engagement actions when the docent introduced the San Marcos salamander. Upon introduction and first seeing the salamander tanks, Tara gasps with excitement [Code: Emotional responses] and paid close attention to the docent and the tank as instruction occurred. Eventually, the docent stated that the San Marcos salamanders have translucent skin and the students can see their hearts beating through the skin. This prompted Tara to exclaim "What?! Move out the way I want to see!" [Code: Conversation, Personal perceptions and opinions - desire]. She then moved in very close to the salamanders, observed it for a few moments, and exclaimed "oh dang, that's intense!" [Code: Emotional responses, Personal perceptions and opinions]. This event highlights the interplay between Tara's behavioral and affective engagement. Specifically, Tara's attention to the docent resulted in her hearing about their skin being translucent. This led to Tara excited exclamation, and eventual movement towards the tank. Once at the tank, Tara's attention to the translucent skin leads her expressing emotions and opinions.

Tara's similar behavior with the bug-picking activity also appeared to impact her opinions about the activity itself. As previously stated, Tara appeared hesitant to physically engage with the bug-picking activity, until her peers and the docent began

finding macroinvertebrates in the water. For example, Tara's affective verbalizes during the beginning of the activity suggested her hesitation in the activity (e.g., (e.g., "she did say we were bug picking…. Yeeesh…") [Code: Emotional responses]. Once engaging with the activity and responding to her peers finding interesting macroinvertebrates, Tara's affective expressions indicated her excitement (e.g., "I want to see the crayfish!") [Code: Opinions and perception]. Tara's description of the bug-picking activity in her notes and homework highlighted a similar phenomenon. For example, Tara indicated she "wasn't too excited" and "was really grossed out" at the beginning of the activity, but eventually she "wanted to see other water stations to see what organisms they had." Thus, it appeared Tara's much of Tara's affective engagement gave way to behavioral actions, and vice versa. Furthermore, Tara's affective engagement highlighted what could be an affectively meaningful experience with the bug-picking activity.

Cognitive.

Tara cognitively engaged a total of 36 times via 5 actions: referencing previous knowledge/ experiences, synthesis, verbalizing her thought process, generating hypothetical thoughts, and problem-solving (See Figure 25).

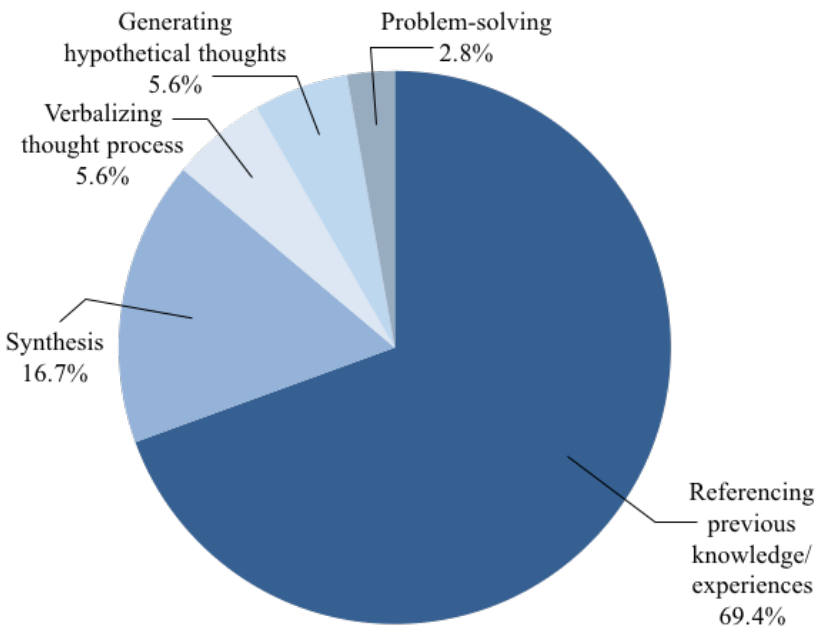

Figure 25. Breakdown of cognitive engagement actions for Tara (n=36)

Tara's cognitive engagement indicated she connected much of the fieldtrip's learning material back to her past experiences, and suggested the activity gave her a new perspective on organisms around her.

Tara's largely recalled events and information from the fieldtrip, but also referenced information from her General Science class. For example, while on the glass-bottom boat tour, another student in her class asked if anyone would think of any facts that she could use for her lab notebook assignment. Tara answered "it's [the lake] 10 to 30 feet deep." Tara learned this fact near the beginning of the fieldtrip, and recalled it a few minutes before her fieldtrip ended. An example of Tara's long-term recollection occurred during the wetlands walk, when the docent instructed the class about the invasive species, water hyacinth. While the docent is describing the plant, Tara looked to her instructional assistant, Samantha, and asked "is this the plant we had in class?" Here, we see Tara recognizing the plant, remembering she observed the plant in a previous lesson, and verbalizing her connection. Tara's short- and long-term recollections and

subsequent verbalizations followed a similar pattern, and occurred periodically throughout the remainder of the fieldtrip.

Tara is also the first participant to verbalize the succession of her thought process during the field. During the glass-bottom boat tour, the docent talked about how the power outage the previous day lead the Meadows Center's staff to have to stay late and keep the endangered species tanks at a constant temperature to keep the organisms alive. While the docent described this event, Tara says twice that she "never thought about that before." While these thought-processes only occur twice, they provide evidence of Tara undergoing a small, potentially meaningful learning experience that helper her think in new ways.

An additional instance where Tara admitted to undergoing a change in perspective included the bug-picking activity. While Tara's behavioral and affective engagement suggested she underwent a meaningful learning, her cognitive engagement manifested as abbreviating notes to answer the lab notebook prompts [Code: Synthesis] and identifying macroinvertebrates based on the Meadows Center's identification sheet [Code: Referencing previous knowledge/ experiences - Recognition]. However, in her interview, Tara reflected on this activity and stated she gained a new perspective, and stated, "they [macroinvertebrates] were like, so small… I didn't even think about things being that small and like, being around you." This quote highlights how the bug-picking activity pushed Tara to think in new ways, and become more aware of the organisms that were potentially around her in her environment. Given Tara did not verbalize these reflective thought processes during her video, the first-person video is likely incapable of capturing all facets and instances of meaningful learning experiences. Overall, Tara's cognitive

engagement emphasized how the nature of the fieldtrip prompted her recollection of past knowledge and experiences, and provided a potential snapshot of components of personally meaningful learning experiences.

Agentic.

Tara agentically engaged eight times via a total of four actions: asking questions, talking about, and visually observing unintroduced topics and/or objects, and interacting with an unintroduced activity (See Figure 26).

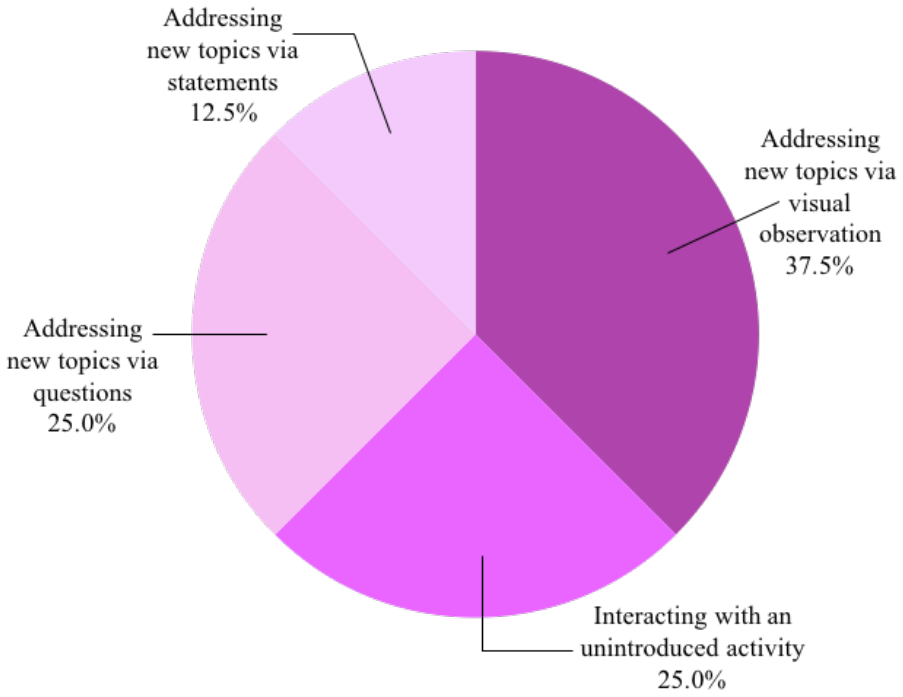

Figure 26. Breakdown of agentic engagement actions for Tara (n=8)

Tara's moments of affective engagement were infrequent and appeared to predominantly occur during the glass-bottom boat tour and in the aquarium. The subject of her engagement actions primarily centered on animals which the docent did not notice or introduce. For example, on the glass-bottom boat tour, the docent was typically instructed the class about a topic unrelated to animals (e.g., springs, artifacts), and Tara would observe the target focal point introduced by the docent until a fish or other

organism came into her field of view. Tara's gaze would then shift to the animal [Code: Addressing new topics via visual observation] and she would often verbalize an excited exclamation (e.g., "Oh! Pretty fish!") [Code: Addressing new topics via statements] or questions (e.g., "What kind of bird is that?") [Code: Addressing new topics via questions]. Tara would often observe the organism until it exited her field of view.

Perceptions.

Outdoor learning environments as teaching tools.

Tara thought positively of using outdoor learning environments in her future classroom, stating she "loves" the idea. Tara favored the use outdoor learning environments because she believed they offered three primary benefits to students, including: (a) helping students make meaningful memories; (b) helping students learn and recall materials better; and (c) providing students with environmental awareness.

First, Tara described how using outdoor learning environments provides students with meaningful memories. When asked about the basis for this belief, Tara referenced her own past experiences as a student. Specifically, she cited a gardening project she did in kindergarten. During this activity, Tara and her classmates brought seeds in to grow plants at the back of her class, and the students "all had jobs" they had to complete daily (e.g., taking pictures, drawing, watering plants). Tara emphasized that because the activity has stuck with her until now, that she believed it would also "stick with kids." Tara stated the reason she thinks the activity stuck with her was that the activity was fun, encouraged exploration, and allowed the students to take a break from academic learning.

Next, Tara stated that outdoor learning environments help students better learn and recall learning material. Tara stated that teaching students in outdoor learning

environments allows them to visually and physically interact with learning material, which results in students "remembering things more." Tara considered herself a "visual learning," and believed many kids are also similar learners that would benefit much the same way she did from outdoor learning experiences. She elaborated on this, stating if kids can "see something, they'll know it, they'll recognize it, if you show them again, they'll go, "Hey, I know what that is."" For example, Tara described how she could take her students outside to look at and learn about clouds, and the students could later tell their parents "Hey, mom that's a so and such cloud!" These examples not only highlight students' cognitive growth in learning the material, but also highlights cognitive growth through recognition and making connections between topics, objects, and/or concepts.

Finally, Tara believed outdoor learning environments provide experiences that cultivate students' environmental awareness. In terms of awareness, Tara highlighted how students are "so zoned in these days on the computers or whatever, or even in a book, they don't see what's going on around them." She further elaborated, stating students nowadays are just in a classroom, and when they can go outside "they're like, "Whoa, like who knew it was raining" or "whoa, I didn't know the sun was out yet."" These examples suggest Tara's appreciation of taking mental breaks and allowing students to remove themselves from an academic environment, as she sees them as beneficial for students' cognitive growth.

Overall, Tara's perceptions of outdoor learning environments suggested she recognized the benefits outdoor learning environments offer for student's cognitive growth both within and outside of academic situations.

Outdoor learning environment integration ideas.

Tara's integration ideas largely paralleled her perceptions about outdoor learning environments. Specifically, she described activities that allowed students to make lasting, meaningful memories, and cultivate their environmental awareness. Tara also addressed how she could use travelling exhibits to explore academic topics.

Connecting her integration ideas to her perceptions, Tara first referenced the kindergarten garden activity as a fun way to teach the plant cycle to her future students. She stated the activity would be fun, because the students could all explore the cycle through different plants. She focused on this activity, because she wants personally wants to "leave a mark" on her students, and help them make positive memories of their class experiences. Tara stated if she incorporated this activity into her future classroom, she would have students carry out daily maintenance and upkeep activities to keep the plants alive. Her reasons for this are two-fold, in that she wants the students to explore and she also believes it would lessen the workload on her. Tara later referenced a previous conversation she had with her instructional assistance, Emma, and described how easy it can be to "forget to do attendance," and that maintaining a garden would "be a task" for her. Thus, while Tara sees gardening with her class as a potential chore, she understands the benefits, as sees it as a stimulating way to teach the plant cycle.

Tara stated that she would use outdoor learning environments to cultivate environmental awareness for her students. To do this, Tara stated she would take her future students outside, have them do some stretching, or just "take a walk." In terms of a specific activity, Tara said she would have her students playing I spy, or just simply asking them what they see. She described how students can then focus on different

things, and some might say “I see a bug” or “I see a plane.” Tara saw these activities as beneficial, because they allow the students to “put their pencils down and take a break.”

Finally, Tara described how she could use travelling showcases, such as Bodies Revealed, to teach about topics such as bones or the human body. She did not elaborate further on this example, but noted she would both push for administrative support to send her students to these showcases, and select showcases that are applicable to the topics she would be teaching.

Overall, Tara’s integration ideas stress her belief that using outdoor learning environments should provide meaningful experiences alongside academic experiences. Her examples also highlight how the selection of outdoor learning environment should be applicable to the topics she intends on covering in class, and may require administrative support for integration.

Conclusions

Tara’s engagement throughout the fieldtrip emphasized how she experienced much of her fieldtrip through a very emotional lens. Her engagement episodes also showcased the complex, multi-dimensionality of her experience. For example, much of Tara’s affective engagement facilitated her behavioral or cognitive engagement, and vice versa. The complex interactions between these engagement actions appeared to indicate Tara’s awareness of her surroundings, and her meaningful experiences that changed her perspective and her way of thinking.

Interestingly, awareness and meaningful, transformative experiences were major topics Tara described in her perceptions and integration ideas for outdoor learning environments. Thus, Tara could have subconsciously drawn upon her own experiences

during her General Science fieldtrip when discussing the benefits of outdoor learning environments. Overall, Tara's engagement, perceptions, and integration ideas highlight her belief that successful education requires more than just academic learning, and should incorporate opportunities for students to grow as people and learners.

Comparison of engagement and integration ideas

To answer research question 3, I compared each participant's previously described engagement experiences to their integration ideas to identify potential relationships. The data suggested participants' past experiences influenced their fieldtrip experience, as well as their integration ideas. During the fieldtrip, participants cognitively engaged by connecting the fieldtrip material to their previous knowledge and experiences. During the interview, participants referenced their past experiences as students and educators when developing their integration ideas.

Each participant referenced past experiences and knowledge in some capacity during their fieldtrip; however, four of the five participants' (Leighla, Olivia, Bernard, and Tara) cognitive engagement highlighted significant references to past knowledge and experiences. Leighla referenced her past experiences in her general science course as well as her internship; Olivia referenced personal experiences and short-term information from parts of the fieldtrip; Bernard referenced information he previously learned on a past Meadows Center fieldtrip; and Tara referenced her personal experiences and information from her General Science class. Aurora only referenced her past experiences and knowledge once during the fieldtrip, and most of her cognitive engagement manifested as synthesizing answers in her notes and during the bug-picking activity.

Past experiences appeared to indirectly or directly influence the participants' integration ideas as well, as short-term (e.g., Meadows Center fieldtrip) and/or long-term memories (e.g., kindergarten) appeared to be the basis for their integration ideas. Leighla drew upon learning material from her class (e.g., forest schools), as well as an activity she witnessed as a bystander (i.e., doing math with chalk). Aurora drew upon her experiences at the Meadows Center; citing the inquiry she experienced during the bug-picking activity and her observations of students on the fieldtrip as reasons for wanting to us it in the future. Olivia cited many experiences she had teaching and working with her students, as well as her fieldtrip experience at the Meadows Center. Bernard referenced his past experiences as a tutor and going on past fieldtrips. Tara referenced experiences from her kindergarten classroom.

Docent descriptions

Leighla's docent, Ashley, was high-energy, excited, funny, and engaging. She frequently asked the group questions, and provided interesting facts both within and outside the scope of her instructional materials. Ashley regularly presented the students with physical specimen (e.g., plants, insects, turtle shells), and encouraged them to touch and interact them. This appeared to engage the students to explore and physically interact with the fieldtrip activities. Ashley spent more time than any other docent teaching the General Science students about teaching in outdoor learning environments.

Olivia's docent, Roger, admitted his lack of familiarity with leading the General Science class at the beginning of the fieldtrip. While he confidently led the students through the fieldtrip and showed sufficient knowledge of the Meadows Center topics, he fails to physically engage the students as often as other docents. Roger occasionally asked

the students basic questions about the activities (e.g., “How many of you have done the boat tour before?”), but rarely asked them higher-level thinking questions (e.g., “So if we call these low-pressure springs, what might we call these springs over here?”). Roger spent very little time teaching the General Science students about teaching in outdoor learning environments, and rarely talks about personal, interesting, and anecdotal information about the fieldtrip activities and the Meadows Center.

Aurora’s docent, Janet, indicated her role as both a high school teacher and a Meadows Center docent prior to beginning the tour. Janet relied heavily on scripted material, and occasionally provided personal stories and information, jokes, as well as logistical information about the Meadows Center. Janet also regularly taught via a “sage-on-the-sage” instructional style; gathering students around in a circle and instructing in a very didactic manner. Janet’s attempts to engage the students with the fieldtrip materials typically manifested through the asking of routine questions (e.g., “who knows what a wetland is?”), and prompts to look closely as subjects in showcases (e.g., “Come! Look! See!”). Students in Aurora’s class largely appeared apprehensive or unwilling to engage for the most part, leading to many unanswered questions prompted by the docent.

Bernard’s docent, Hannah, spent much of her instruction time providing Bernard’s class with applicable teaching tips to use in outdoor learning environments. Typically, before beginning each activity, Hannah provided the students with introductory information about the activity, as well as a tip to help the General Science students teach in outdoor learning environments in the future (e.g., “Instead of touching the glass, I usually tell the kids to wave at the fish”). Hannah showed sufficient knowledge of the fieldtrip information, and encouraged the students to physically engage

with target objects whenever possible. While Hannah provided scientific information about the fieldtrip's topics, she also presented much anecdotal information not provided by the other docents (e.g., information about edible and medicinal plants).

Tara's docent, Nia, was the most personal of all the participant's docent. In addition to teaching the General Science class about how to teach and what to teach, she spent a fair portion of her time providing her own anecdotal stories and information. Tara connected with Nia on a personal level, as Nia took seven years to get her undergraduate degree, and Tara was in her fifth year of her undergraduate degree. Nia expressed a lot of excitement about the organisms observed during the fieldtrip, including plants like water hyacinth and animals, like turtles. Interestingly, Tara's Instructional assistant, Emma, was also present on the fieldtrip, and interjected information tying information back to the General Science class curriculum at various points of Nia's instruction.

IV. DISCUSSION

Past experiences

Preservice and early career teachers often build on past experiences from their preservice education (McDaniel, 1991) and their time as primary and secondary students (Calderhead & Robson, 1991). Past experiences vary widely across preservice and early career teachers, and influence how they define a "good teacher" (Ng, Nicolas, & Williams, 2010; Calderhead & Robson, 1991; Witcher & Onwuegbuzie, 1999). Past experiences can also influence preservice teachers' opinions about the relevancy of topics or practices, and how they view their own or other's practices (Calderhead & Robson, 2010). These, and many other beliefs, attitudes, and lived experiences shape a preservice teacher's dynamic identity (Day, Kingston, Stobart, & Sammons, 2009). Preservice teachers bring their beliefs to their practice during student teaching or in their early career (Eick & Reed, 2002). Given preservice teachers typically have little or no experience teaching, they typically lack a concrete identity as a teacher (Eick & Reed, 2002). This often results in referencing past experiences as a student, and projecting their past learning experience onto their future students' learning (Geddis & Roberts, 1998). Findings for this study align with these phenomena. For example, neither Aurora nor Tara had past teaching experience at the time of the study, and exclusively referenced their past experiences when discussing integration ideas for outdoor learning environments. Specifically, Aurora referenced past fieldtrips and the Meadows Center trip, and Tara largely referenced her experiences during kindergarten. In contrast, Olivia, who was a teacher at the time of the study, had more student-centered integration ideas which focused on what she witnessed as successful for her students. She exclusively

referenced experiences related to her teaching. Bernard and Leighla, who have some informal teaching experience, referenced a mixture of their personal experiences and those experiences with their informal teaching.

Identity development.

The mixture of experiences referenced by the participants in this study aligns with the two overarching components of teachers' identities: personal experiences and professional experiences (Bukor, 2015; Day et al., 2009). As Bukor (2015) described, personal experiences include components such as childhood, family, schooling and/or professional education; whereas professional experiences include the participant's teaching practices. Thoughts and feelings about the personal and professional components of these experiences unavoidably overlap (Day et al., 2009; Geddis & Roberts, 1998), and can lead to preservice teacher confusion about when to view learning from the context of a student or a future teacher (Geddis & Roberts, 1998). Interestingly, Aurora, who had no prior teaching experience, appeared to view the bug-picking activity from both a personal and professional viewpoint. She also expressed some confusion about how to use the information both personally and professionally. For example, she described how she personally did not enjoy the activity, struggled to grasp when she would use the concepts personally and professionally, but still recognized the value of the activity for kids because it was fun and encourages inquiry. The participants were asked about which activity provided the best example of inquiry-based learning (See Appendix X), and Aurora responded she thought the bug-picking activity was the best example inquiry-based learning. Thus, the homework assignment could have facilitated some metacognitive reflection about the qualities of the activity, but did not appear to prompt

deep personal reflection about the activity. Thus, Aurora appeared independently undergo some metacognitive reflection about her own experience and separate it from those of her potential future students. This level of personal reflection is uncommon for preservice teachers with little to no teaching experience (Geddis & Roberts, 1998; Ruohotie-Lyhty & Moate, 2016). Aurora did not indicate what triggered her personal reflection, but it appeared her observations of the elementary school students on the fieldtrip greatly influenced her opinion about the benefits of the activity. Having such a clear view of students benefitting from the activity could have prompted Aurora to reflect on her own personal feelings of ambivalence.

In terms of projecting personal experiences on students, all participants, excluding Olivia, projected some component of themselves (e.g., preferred learning styles) or their learning experiences (i.e., fun during an activity) on their future students. For example, Tara described how she was a "visual learner," and believed "kids are the same way as well." Leighla also described how she knew from her own experience that learning outside was better alternative to learning inside. Olivia likely did not project her learning experiences on her students because she had experience working with students, leading to her develop a more concrete role as a teacher built on witnessing students learning. Thus, she likely did not have to draw from her own personal experiences to described what she thought benefited her students' learning.

Thus, the findings from this study mostly align with existing literature about how preservice teachers think about teaching and generate ideas about teaching practices. However, the deep reflection expressed by Aurora highlights how preservice teachers can

still reflect on their experiences, identify beneficial activities for their students, and do so while remaining rigid in their personal beliefs.

Meaningful learning experiences

Existing research suggests preservice teachers' relatively stable personal identities are based on lived experiences and can change in response to meaningful learning experiences (Day et al., 2009). In this study, it appeared participants' observable engagement during the fieldtrip could highlight components of these learning experiences. However, engagement only emphasized some components of meaningful learning. Upon analyzing student interviews, I was able to provide supportive evidence for meaningful learning experiences identified via engagement actions.

As previously stated, meaningful learning experiences result in students forging new cognitive links between prior knowledge and new knowledge (Kostiainen et al., 2018; Jonassen & Strobel, 2006; Mintzes, Wandersee, & Novack, 1997). While meaningful learning can derive from many sources (e.g., topics, teaching approaches), the root of meaningful learning lies primarily in students personally valuing, or finding meaning in the learning experience (Mintzes, Wandersee, & Novack, 1997; Kostiainen et al., 2018; Taniguchi, Freeman, & Richards, 2005). Typically, meaningful learning is characterized by learning that is active, intentional, authentic, constructive, and relational (Kostiainen et al., 2018; Jonassen & Strobel, 2006).

Components of meaningful learning.

Active and intentional learning requires learners to exercise their individual agency to achieve consciously set goals (Kostiainen et al., 2018). All of the participants in this study exercised their agency in some capacity; however, it was through the interview

process that I was able to understand participants' individual goals and motivations. For example, Olivia indicated she spent the fieldtrip paying attention to things she thought she could use in her preschool classroom. Her actions manifested as her intently paying attention to focal points not presented by the docent. However, it took Olivia retrospectively describing her thought-process to correctly interpret the data, as her behavior during the fieldtrip did not indicate much cognitive engagement at all. Thus, Olivia's actions indicated she found personal meaning by exercising her agency, but findings had to be validated with retrospective descriptions.

Authenticity is defined many ways across education research. As it relates to this study, authenticity refers to experiences that are relevant to learners' interests, goals, and motivations (Kostiainen et al., 2018; Jonassen & Strobel, 2006; Shaffer & Resnick, 1999). Based on participant actions and interview responses, it appeared the fieldtrip experience was "authentic" for some participants based on their interests and goals. Engagement actions such as asking probing questions (e.g., agentic) (Gilje & Erstad, 2017), and referencing past experiences/ knowledge (e.g., cognitive) (Kostiainen et al., 2018), suggest the participants were motivated enough by their interests to consciously explore them when presented with the opportunity (Gilje & Erstad, 2017; Blumenfeld, Kempler, & Krajcik, 2006). Thus, authenticity, active, and intentional components are linked, as active and intentional actions (e.g., asking probing questions) highlight the authentic connections students make between their existing interests and the learning experience (e.g., referencing past knowledge/ experiences). Interview responses from participants validated these interpretations. For example, Bernard discussed his preexisting interest in spending time in the outdoors, and one of his goals of enjoying

himself on the fieldtrip. Bernard found the experience meaningful because he could both explore nature and associated topics, and have a good time. Thus, Bernard exercised his agency to further explore topics he found personally meaningful and interesting (e.g., turtles), and spent much of his time enjoying himself by joking, laughing, and conversing with his peers. However, it was only through follow-up questions that I learned of Bernard's interests and conscious goals. Thus, engagement can provide some information about student's potential interests, but probing students about their intentions, interests, and motivations tells a more holistic story when assessing engagement actions.

Constructive components of meaningful learning experiences result in students potentially rebuilding self-image and sense of self, or reconstructing opinions and/or beliefs based on integrating new information with past knowledge (Mintzes, Wandersee, & Novack, 1997; Kostiainen et al., 2018; Hakkarainen, Saarelainen, & Ruokamo, 2007; Clay, 1995). Research also suggests meaningful constructive learning results in reconstructing outward facades when facing novel or unexpected situations (Taniguchi, Freeman, & Richards, 2005). In terms of recognizing constructive components of meaningful learning, some researchers suggest asking questions represents students thinking about learning topics, and attempting to link them with past knowledge (Chin & Osborne, 2008). During the fieldtrip, all participants specifically referenced their past experiences and knowledge in relation to events during the fieldtrip via conversation (e.g., "That's definitely the rodent thing") or via questions (e.g., "Isn't that the plant we had in class?"), but rarely verbalized their potential constructive changes. On one occasion, Tara specifically stated how information from the boat tour lead her to think about caring for aquarium animals in a new way (e.g., "I never thought about it like that

before"), which reflected how new knowledge altered her preconceptions. While observable engagement actions rarely captured cognitive changes, Leighla, Bernard, Tara, and Aurora all referenced how the new information from the fieldtrip changed their perspective about the world around them, which suggests they underwent constructive components of meaningful learning (Mintzes, Wandersee, & Novack, 1997; Kostiainen et al., 2018). Thus, engagement actions which are clearly characterized by referencing past experiences and knowledge (e.g., asking pointed questions) or stating new thought patterns could aid in identifying constructive components of meaningful learning; however, in cases when cognitively changes are not verifiable from observable engagement actions, metacognitive reflections should be referenced for verification.

Relational components of meaningful learning are characterized by learning experiences which include opportunities to interact and collaborate with peers, instructors, and the learning process (Stein, Issacs, & Andrews, 2004; Jarvis & Pell, 2002). Interactions observed in this study were consistent with these previously identified interactions, as all the participants interacted with their peers and the docent during the fieldtrip. Additionally, one participant (i.e., Tara) interacted with her instructional assistant. However, the nature of this interaction suggested Tara viewed the instructional assistant as filling a similar role as the docent, as Tara asked her clarification questions about some of the fieldtrip material.

Interactions.

Peer-to-peer interactions in this study largely included humor-related communications and discussion about material related and unrelated to the fieldtrip. Peer interactions can greatly influence outcomes of learning experiences, including influencing student

engagement (Ryan & Patrick, 2001). Findings from this study support previous research which suggests humorous interactions between peers during learning experiences is fosters collaboration and positive feelings about the learning experience (Volet, Summers, & Thurman, 2009). All the participants expressed their enjoyment of the fieldtrip, and some participants' (i.e., Leighla, Aurora, and Bernard) actions (e.g., joking, laughing) also indicated they viewed their peers as an outlet for enjoyment. Aurora specifically seemed to not only value her peers for enjoyment, but her engagement actions suggested having peers working on the same activity helped her push through her ambivalence about the activity and actively participate.

Didactic interactions are common between learners and docents in informal learning environments (Cox-Peterson et al., 2003; Mony & Heimlich, 2008), and can influence a variety of outcomes for students (Rennie & Mclafferty, 1995; Braund & Reiss, 2004; Jarvis & Pell, 2002). Some docents in this study exhibited didactic teaching styles like those noted in Cox-Peterson et al. (2003). That is, docents provided information, prompted the students with rote questions, occasionally received answers from the students, and often failed to reflect on the meaning or importance of these questions (Cox-Peterson et al., 2003). In these instances, student participation in discussion with the docent was minimal. However, Leighla, Bernard, and Tara's docents appeared to go beyond just didactic interactions, and engaged students in discussion about anecdotal and/or personally meaningful topics (e.g., topics about personal experiences outside of the context of the General Science course). Interestingly, Bernard's engagement actions indicated he placed much value in the docent as a facilitator of his learning experience. Bernard asked many probing questions and discussed topics with the docent during

instruction, which highlights Bernard's focus, interest in the topics, and past experiences. The docent consistently responded to Bernard's questions via answers and discussion points, which indicated the docent's willingness to facilitate Bernard's exploration. The docent's behavior is consistent with what Cox-Peterson, et al. (2003) and Stein, Issacs, & Andrews (2004) consider "desirable" docent behavior, because it gives students space to learn, encourages exploration, discussion, and asking questions. Tara's docent also behaved in a similar manner by regularly discussing personal topics and experiences with the students. This could explain why Tara's engagement actions suggested her comfort to explore topics that were personally meaningful to her. In conclusion, it appeared social interactions played a large role in the experiences each participant had, both docents and peers appeared to help facilitate meaningful learning.

To conclude, participants' observable engagement actions highlighted components of meaningful learning, and suggested participants underwent meaningful learning in some capacity. However, participants' reflective interview responses provided validation or clarification for some engagement actions, adding depth and evidence to support my interpretations.

Multidimensionality of engagement

As previously stated, engagement is typically defined as a complex, multidimensional process (Ben-Eliyahu, Moore, Dorph, & Schunn, 2018; Wang & Eccles, 2013; Fredericks, Blumenfeld, & Paris, 2004; Sinatra, Heddy, & Lombardi, 2015; Zepke, 2017; Reeve & Tseng, 2011; Archambault & Dupéré, 2016). This study focused on a four-dimensional framework of engagement (i.e., behavioral, affective, cognitive, and agentic), which allowed me to characterize rich, interconnected engagement episodes

reflective of potential internal and external experiences (Fredericks, Blumenfeld, & Paris, 2004; Archambault & Dupéré, 2016; Reeve & Tseng, 2011; Sinatra, Heddy, & Lombardi, 2015). Participants' engagement episodes highlighted how inter- and intradimensional engagement actions can occur simultaneously (e.g., conversation characterized by joking) or sequentially (e.g., response to external cues [behavioral] leading to probing questions [agentic]). This is consistent with findings from previous studies (Ben-Eliyahu et al., 2018), which explored the relationships between engagement dimensions during various in-school and out-of-school learning experiences. This study found engagement actions regularly build on and give way to other engagement actions and elaborated on how internal engagement is expressed through external means. The multidimensionality of engagement episodes underscores the complexity of learning experiences and showcases how researchers can observe participants experiences through different lenses. Thus, findings from this study alight with findings from previous research about how engagement is a complex, multidimensional construct which reflects simultaneous, cyclical, and sequential relationships between dimensions of engagement.

V. CONCLUSIONS

In conclusion, participants from this study readily engaged across all four dimensions of engagement during their fieldtrips. Furthermore, inter- and intra-dimensional engagement actions often occurred simultaneously or in sequence, creating complex engagement episodes. Participants positively viewed outdoor learning environments as potential teaching tools, and presented a variety of integration ideas.

Relationships between participant engagement during the fieldtrip and integration ideas highlight the influence past experiences can have on preservice teachers' learning experiences, as well as their views of outdoor learning environments. During the fieldtrip, most participants cognitively engaged through connecting the Meadows Center fieldtrip topics and activities back to previous personal and professional experiences and knowledge. All participants built on experiences during and/or prior to the fieldtrip when referencing integration ideas. Thus, participants' past experiences involving and not involving outdoor learning experiences did appear to influence their fieldtrip engagement and integration ideas in some capacity.

Additionally, participants' engagement actions appeared to highlight potential components of personally meaningful learning. Previous studies suggest meaningful learning experiences which connect to learners past experiences lead to positive outcomes, and allow learners to make lasting memories. These lasting memories can later impact learners' actions, and are thus critical for preservice teachers to develop successful future teaching practices. However, moments of video data where components of meaningful learning were unclear required triangulation by analyzing participants' answers to follow-up interview questions. Participants' answers provided additional

depth about their internal motivations, beliefs, and experiences. Thus, I suggest future research endeavors use video data alongside follow-up interviews to characterize meaningful learning during outdoor learning experiences. Furthermore, I suggest probing participants about their past experiences, interests, and motivations (i.e., factors of personal identity) before and after observing them on fieldtrips, as the information can provide additional data to identify internal factors which may impact participants' beliefs and behaviors.

VI. FUTURE DIRECTIONS AND IMPLICATIONS

Future directions

Recent research addresses the multidimensionality of engagement, and highlights the interplay between different dimensions of engagement, and how that interplay influences outcomes of formal and informal learning experiences (Ben-Eliyahu et al., 2018). Thus, I believe future research could further explore overlapping engagement actions across different dimensions, and compare those data to learning outcomes, students' attitude changes, and numerous other outcomes in the context of outdoor learning environments.

Olivia's retrospective description of her goals and motivations for the fieldtrip (i.e., lesson plan development ideas) compared to her observable cognitive suggested first-person video data might not have captured all her internal processes. Cognitive and affective engagement captured and analyzed during this study included those engagement actions which were clearly observable and verbalized; however, based on Olivia's interview responses, I believe participants' cognitive and affective engagement was likely greater than what I captured in this study. Quantitative data from the eye-tracking glasses can help identify internal cognitive and affective processes (Marshall, 2007). Specifically, pupillary constrictions (Munn, Stefano, & Pelz, 2008; Marshall, 2007; Kinner et al., 2017) and fixation data (Slykhuis, Wiebe, & Annetta, 2005) can indicate the presence and intensity of affective or cognitive processes. These data will allow us to better understand and quantify the influence characteristics of activities in outdoor learning environments influence have on student engagement. These data could also be compared to outcomes of outdoor learning experiences to explore relationships between outcomes and the presence/ intensity of cognitive and/or affective engagement.

While docent behavior likely impacted participants' experiences at some level during this study, I did not explicitly characterize or investigate how docents influenced participants' experiences. Discussion of docent interactions stemmed from observable interactions from the viewpoint of the student and my third-person observations, and may not address every component of the docents' behaviors, or their interactions with the students. Future studies should continue to investigate the relationships between preservice teachers' experiences during fieldtrips, professional development activities, and other informal learning experiences.

Lastly, exploring integration ideas begs the question of if and/or how the study participants will use their experiences from the Meadows Center in their future classrooms. As research suggests early career teachers largely use their past experiences as a student in their teaching practices (McDaniel, 199; Calderhead & Robson, 1991), it would be interesting to explore what components (if any) these preservice teachers use from their General Science fieldtrip, or other outdoor learning experiences, in their future classrooms. I hope to explore the impact of these outdoor learning experiences in a more longitudinal study in the future, as understanding what components remain with the teachers into their future classrooms is crucial to developing programs with lasting impacts. Furthermore, future research should also explore how different types of informal, preservice teacher education programs and activities influence future practices.

Implications for outdoor learning program design

Based on findings from this study, it appeared the social and collaborative components of the fieldtrip played a large role in some participants' engagement and participation. Thus, outdoor learning program should incorporate opportunities for

students to behaviorally, affectively, and cognitively engage via collaboratively work together to explore topics in outdoor learning environments. Collaborative work involving cognitively-driven discussion allows students the chance to lead and explore activities (Stein, Issacs, & Andrews, 2004; Jarvis & Pell, 2002) with minimal control from the docent. Engaging students through mentally-stimulating, collaborative, and personally-meaningful activities and projects allows them the opportunity for mean-making within the scope of their own identity and lived experiences (Geddis & Roberts, 1998). Furthermore, encouraging affectively-geared social interactions (e.g., joking around, laughter) can increase students' ability to process and understand educational topics, and fosters further collaboration (Volet, Summers, & Thurman, 2009).

Furthermore, docents should help guide students when they are unsure of activities (Cox-Peterson et al., 2003), but not dictate or control their actions. This approach should theoretically encourage students to exercise their personal agency (i.e., agentic engagement). Attempting to control students' actions through strictly didactic and personally-unauthentic learning experiences strips students of their chance to exercise their agency and meaningfully learn about topics they find personally interesting (Cox-Peterson et al., 2003; Day et al., 2009; Geddis & Roberts, 1998). Additionally, docents could facilitate meaningful learning by allowing students to share and link past experiences that align with the target educational topics. This offers students the opportunity to cognitively engage by making connections to prior experiences (Geddis & Roberts, 1998).

Preservice teacher education programs should also foster metacognitive reflections after educational or professional development programs happen, as this allows

teachers to cognitively engage and grow through integrating what they learned about teaching into their prior knowledge (Geddis & Roberts, 1998; Baird, Fensham, Gunstone, & White, 1991). Additionally, given some of the participants addressed concerns about using outdoor learning environments in the future, preservice teacher education programs should also focus on providing preservice teachers with practical information about overcoming barriers to taking students outside. This would ensure preservice teachers are prepared to handle obstacles from students, administrators, or even personal beliefs.

APPENDIX SECTION

APPENDIX A: IRB APPROVAL

TEXAS STATE UNIVERSITY
SAN MARCOS
The rising STAR of Texas

In future correspondence please refer to 2017593

March 30, 2017

Sara Salisbury
Texas State University
601 University Dr.
San Marcos, TX 78666

Dear Ms. Salisbury:

Your application 2017593 titled, "Preservice Teachers' Engagement during, and Perceptions of, Science Learning Activities in an Informal, Outdoor Learning Environment," was reviewed by the Texas State University IRB and approved. It has been determined there are: (1) research procedures consistent with a sound research design and they do not expose the subjects to unnecessary risk. (2) benefits to subjects are considered along with the importance of the topic and that outcomes are reasonable; (3) selection of subjects is equitable; and (4) the purposes of the research and the research setting is amenable to subjects' welfare and producing desired outcomes; that indications of coercion or prejudice are absent, and that participation is clearly voluntary.

1. In addition, the IRB found that you need to orient participants as follows: (1) signed informed consent is required; (2) Provision is made for collecting, using and storing data in a manner that protects the safety and privacy of the subjects and the confidentiality of the data; (3) Appropriate safeguards are included to protect the rights and welfare of the subjects.

This project is therefore approved at the Expedited Review Level until February 28, 2018

2. Please note that the institution is not responsible for any actions regarding this protocol before approval. If you expand the project at a later date to use other instruments, please re-apply. Copies of your request for human subjects review, your application, and this approval, are maintained in the Office of Research Integrity and Compliance. Please report any changes to this approved protocol to this office. A Continuing Review protocol will be sent to you in the future to determine the status of the project.

Sincerely,

Monica Gonzales

Monica Gonzales
IRB Regulatory Manager
Office of Research Integrity and Compliance
Texas State University

CC: Dr. Kristy Daniel

OFFICE OF THE ASSOCIATE VICE PRESIDENT FOR RESEARCH
601 University Drive | JCK #489 | San Marcos, Texas 78666-4616
Phone: 512.245.2314 | *fax:* 512.245.3847 | WWW.TXSTATE.EDU

APPENDIX B: CONSENT FORM

Study Title: Preservice Teacher Engagement and Perceptions of Science Learning in Informal, Outdoor Learning Environments

Principal Investigator: Sara Salisbury **Co-Investigator/Faculty Advisor: Dr. Kristy Daniel**

This consent form will give you the information you will need to understand why this research study is being done and why you are being invited to participate. It will also describe what you will need to do to participate as well as any known risks, inconveniences or discomforts that you may have while participating. We encourage you to ask questions at any time. If you decide to participate, you will be asked to sign this form and it will be a record of your agreement to participate. You will be given a copy of this form to keep.

PURPOSE AND BACKGROUND

You are invited to participate in a research study to investigate how preservice teachers engage during informal, outdoor learning activities, and how they perceive they can use informal learning environments during their future teaching career. The information gathered will be used as part of a case study that represents my thesis project. You are being asked to participate because you fit the general demographic of students enrolled in your General Science course.

PROCEDURES

If you agree to be in this study, you will participate in the following:

- Collection of video, audio, and eye-tracking data during the 90-minute field trip to the Meadows Center for Water and the Environment. Video, audio, and eye-tracking data will be collected via eye-tracking glasses that you will wear during the duration of the field trip. The eye-tracking glasses have a front facing camera and microphone which will capture video and audio data documenting your field trip environment and experience. They also have cameras in the frames of the glasses which will capture data about the position of your eyes and pupil dilations. These data will only be used to identify moments when you are engaged, and document the environment you are in. We will not collect any identifying data from the eye-tracking glasses.
- Submittal of your field trip notes from the field trip immediately after the field trip (scanned via a portable scanner). Submittal of notes will take no extra time beyond typical class time.
- Submittal of your homework responses associated with the field trip prior to grading (no grade data will be collected). Submittal of notes will take no extra time beyond typical class time.
- One, 45-minute interview, approximately one week after the field trip. Interview questions will address how you think you can use outdoor learning environments during your future career, as well as basic information pertaining to your experiences during the field trip. Interviews will be recorded via a portable recording device. The researcher may

also take notes during the interview.

We will set up a time for you to meet one of the investigators at the Supple Science Building prior to the field trip. You will first complete the field trip, then you will submit copies of your notes and homework responses, then you will participate in the 45-minute interview approximately one week after the field trip.

RISKS/DISCOMFORTS
There are no anticipated risks associated with this study. Regardless, we will make every effort to protect participants' confidentiality.

In the unlikely event that some of the survey or interview questions make you uncomfortable or upset, you are always free to decline to answer or to stop your participation at any time. Should you feel discomfort after participating and you are a Texas State University student, you may contact the University Health Services for counseling services at list (512) 245-2208. They are located at 5-4.1, 601 University Dr, San Marcos, TX 78666.

BENEFITS/ALTERNATIVES
There are no anticipated direct benefits to subjects. The knowledge accumulated will provide information about how pre-service teachers learn and engage in informal learning environments, and how they perceive they can use these resources in their future careers. This has the potential to help preservice teachers be more prepared for their future teaching career, and also provide insight for informal learning institutions to improve their programs to best meet teacher needs.

EXTENT OF CONFIDENTIALITY
Reasonable efforts will be made to keep the personal information in your research record private and confidential. Any identifiable information obtained in connection with this study will remain confidential and will be disclosed only with your permission or as required by law. The members of the research team, the and the Texas State University Office of Research Compliance (ORC) may access the data. The ORC monitors research studies to protect the rights and welfare of research participants.

Your name will not be used in any written reports or publications which result from this research. Data will be kept for three years (per federal regulations) after the study is completed and then destroyed.

PAYMENT/COMPENSATION
As part of compensation, to ensure proper data collection, and to maintain proper hygiene during data collection, you will be provided a new, Texas State University baseball hat to wear during the 90-minute field trip. You will be allowed to keep this hat regardless of whether or not you follow through with the entirety of the study.

PARTICIPATION IS VOLUNTARY

You do not have to be in this study if you do not want to. You may also refuse to answer any questions you do not want to answer. If you volunteer to be in this study, you may withdraw from it at any time without consequences of any kind or loss of benefits to which you are otherwise entitled.

QUESTIONS

If you have any questions or concerns about your participation in this study, you may contact the Principal Investigator, Sara Salisbury: 412-716-0458 or sls402@txstate.edu.

This project 2017593 was approved by the Texas State IRB on March 30, 2017. Pertinent questions or concerns about the research, research participants' rights, and/or research-related injuries to participants should be directed to the IRB Chair, Dr. Jon Lasser 512-245-3413 – (lasser@txstate.edu) or to Monica Gonzales, IRB Regulatory Manager 512-245-2314 - (meg201@txstate.edu).

DOCUMENTATION OF CONSENT

I have read this form and decided that I will participate in the project described above. Its general purposes, the particulars of involvement and possible risks have been explained to my satisfaction. I understand I can withdraw at any time.

_____	_____
Print name of study participants	Date
_____	_____
Signature of study participant	Student ID number

APPENDIX C: EC-6 ESL GENERALIST DEGREE PLAN

TEXAS STATE®

College of Education Undergraduate Advising

Catalog: 2018 (*Effective Fall 2018*)
Total: 125 Credits

Degree: Bachelor of Science | **Major:** Interdisciplinary Studies | **Certification:** EC-12 Special Education

NOTE: It is your responsibility as a student to know the requirements of your degree program and to take the courses required for graduation. For guidance about course sequencing, application processes, GPA, and other graduation requirements, see the following: (1) Undergraduate Catalog, (2) Degree Audit, (3) Degree Planning tab of www.education.txstate.edu/advising, and (4) your Academic Advisor.

INSTITUTIONAL REQUIREMENT — **1 Hour**

_____ US 1100: University Seminar (1-Hr Open Elective if Exempt)

FOREIGN LANGUAGE PROFICIENCY

_____ Satisfied two years of same language in High School **OR**

☐ Choose one language to satisfy 1410 **AND** 1420:
☐ ARAB, ASL, CHI, FR, GER, ITAL, JAPA, LAT, POR, SPAN

CORE CURRICULUM — **42 Hours**

Communication
_____ (010) ENG 1310: College Writing I
_____ (010) ENG 1320: College Writing II

Mathematics
_____ (020) MATH 1315: College Algebra

Life and Physical Sciences
_____ (030) PHYS 1310: Elementary Physics I
_____ (030) PHYS 1320: Elementary Physics II

Language, Philosophy, and Culture
_____ (040) PHIL 1305: Philosophy & Critical Thinking **OR**
(040) PHIL 1320: Ethics & Society

Creative Arts
_____ *Select one course from:*
(050) ART, DAN, MU, or TH 2313: Intro to Fine Arts

American History
_____ (060) HIST 1310: History of United States to 1877
_____ (060) HIST 1320: History of United States from 1877

Government/Political Science
_____ (070) POSI 2310: Principles of American Government
_____ (070) POSI 2320: Functions of American Government

Social and Behavioral Sciences
_____ (080) GEO 1310: World Geography

Component Area
_____ (090) COMM 1310: Fund. of Human Communication
_____ *Select one course from:*
(090) ENG 2310: British Literature before 1785
(090) ENG 2320: British Literature after 1785
(090) ENG 2330: World Literature before 1600
(090) ENG 2340: World Literature after 1600
(090) ENG 2359: American Literature before 1865
(090) ENG 2360: American Literature after 1865

MAJOR: Interdisciplinary Studies — **28 Hours**

_____ PHYS 1110: Elementary Physics Lab
_____ MATH 2311: Principles of Mathematics I
_____ MATH 2312: Informal Geometry
_____ BIO 1320: Modern Biology
_____ GS 3310: General Science (Fall/Summer I)
_____ GS 3320: General Science II (Spring/Summer II)
_____ SPED 2360: Survey of Exceptionality
_____ SPED 3338: Educ. Student w/ Emotion/Behavior Disorder
_____ SPED 3390: Assessing Students w/ Disabilities
_____ SPED 4381: Educ. Stud. w/ Intellect. & Develop. Dis.

EDUCATOR PREPARATION — **54 Hours**

_____ CI 3338: Social Studies in Elementary & Middle School
_____ CI 4350: Math in the Integrated Elementary Curriculum
_____ CI 4355: Science in Elementary Education
_____ SPED 4340: Eval.-Based Instrct. Prac. Stud. w/ Mid-Mod
_____ SPED 4345: Teaching Language Arts to Stud. w/ Dis.
_____ SPED 4374: Classroom & Behavior Mgmt for Stud. w/ Dis.
_____ SPED 4389: Special Education Practicum

Education Core
_____ CI 3325: Adolescent Growth and Development
_____ CI 4332: Secondary Teaching: Curriculum & Technology

ESL Blocks
_____ [ESL] CI 3332: Foundations of Bilingual & ESL Education
_____ [ESL] CI 4360: Meth. & Materials, Teach, ESL Content

High School Field-Based Block
_____ CI 4343: Instructional Strategies for Secondary Teacher
_____ RDG 3323: Teaching Reading in the Content Areas

Elementary Field-Based Block
_____ RDG 3315: Assessing Literacy: EC-6
_____ RDG 3321: Literacy Instruction for EC-6
_____ CI 4325: Classroom Mgmt. & Teacher/Student Relation.

Student Teaching
_____ EDST 4380: Student Teaching All-Level I
_____ EDST 4381: Student Teaching All-Level II

APPENDIX D: EC-12 SPECIAL EDUCATION DEGREE PLAN

TEXAS STATE

College of Education Undergraduate Advising

Catalog: 2018 (*Effective Fall 2018*)
Total: 125 Credits

Degree: Bachelor of Science | **Major:** Interdisciplinary Studies | **Certification:** EC-6 ESL Generalist

NOTE: It is your responsibility as a student to know the requirements of your degree program and to take the courses required for graduation. For guidance about course sequencing, application processes, GPA, and other graduation requirements, see the following: (1) Undergraduate Catalog, (2) Degree Audit, (3) Degree Planning tab of www.education.txstate.edu/advising, and (4) your Academic Advisor.

INSTITUTIONAL REQUIREMENT — **1 Hour**

_____ US 1100: University Seminar (1-Hr Open Elective if Exempt)

FOREIGN LANGUAGE PROFICIENCY

_____ Satisfied two years of same language in High School **OR**

☐ Choose one language to satisfy 1410 **AND** 1420:
☐ ARAB, ASL, CHI, FR, GER, ITAL, JAPA, LAT, POR, SPAN

CORE CURRICULUM — **42 Hours**

Communication
_____ (010) ENG 1310: College Writing I
_____ (010) ENG 1320: College Writing II

Mathematics
_____ (020) MATH 1315: College Algebra

Life and Physical Sciences
_____ (030) PHYS 1310: Elementary Physics I
_____ (030) PHYS 1320: Elementary Physics II

Language, Philosophy, and Culture
_____ (040) PHIL 1305: Philosophy & Critical Thinking **OR**
(040) PHIL 1320: Ethics & Society

Creative Arts
_____ *Select one course from:*
(050) ART, DAN, MU, or TH 2313: Intro to Fine Arts

American History
_____ (060) HIST 1310: History of United States to 1877
_____ (060) HIST 1320: History of United States from 1877

Government/Political Science
_____ (070) POSI 2310: Principles of American Government
_____ (070) POSI 2320: Functions of American Government

Social and Behavioral Sciences
_____ (080) GEO 1310: World Geography

Component Area
_____ (090) COMM 1310: Fund. of Human Communication
_____ *Select one course from:*
(090) ENG 2310: British Literature before 1785
(090) ENG 2320: British Literature after 1785
(090) ENG 2330: World Literature before 1600
(090) ENG 2340: World Literature after 1600
(090) ENG 2359: American Literature before 1865
(090) ENG 2360: American Literature after 1865

MAJOR: Interdisciplinary Studies — **19 Hours**

_____ PHYS 1110: Elementary Physics Lab
_____ MATH 2311: Principles of Mathematics I
_____ MATH 2312: Informal Geometry
_____ BIO 1320: Modern Biology
_____ GS 3310: General Science (Fall/Summer I)
_____ GS 3320: General Science II (Spring/Summer II)
_____ FCD 1355: Introduction to Family Relationships **OR**
FCD 3355: Family Relationships

SUPPORT COURSES — **9 Hours**

_____ ESS 3321: Teaching Elem. Children Physical Activity **OR**
H_ED 3321: Health in the School Setting

Select any two courses from:
☐ ARTT 3370: Arty Theory & Practice **OR**
☐ MU 3370: Music for the Elementary Classroom **OR**
TH 3370: Creative Drama

EDUCATOR PREPARATION — **54 Hours**

_____ CI 3338: Social Studies in Elementary & Middle School
_____ CI 4350: Math in the Integrated Elementary Curriculum
_____ CI 4355: Science in Elementary Education
_____ SPED 4344: Educating Students in Mild Disabilities

Education Core
_____ CI 3310: Public Education in Multicultural Society
_____ CI 3315: Human Dev.: Learn & Being in Social Cont.
_____ ECE 4300: Lang. of Children: 1st & 2nd Lang. Acquisition
_____ RDG 4320: Language & Literacy in Diverse Communities

ECE and ESL Blocks
_____ [ECE] ECE 4310: Seminar for Teachers of Young Children
_____ [ECE] ECE 4352: Curriculum for Pre-K & Kinder. Teaching
_____ [ESL] CI 3332: Foundations of Bilingual & ESL Education
_____ [ESL] CI 4360: Meth. & Materials, Teach. ESL Content

Field-Based Block
_____ RDG 3315: Assessing Literacy: EC-6
_____ RDG 3321: Literacy Instruction for EC-6
_____ CI 4325: Classroom Mgmt. & Teacher/Student Relation.
_____ RDG 3320: Integrating Reading & Writing

Student Teaching
_____ EDST 4687: Student Teaching EC-6

APPENDIX E: SEMI-STRUCTURED INTERVIEW PROTOCOL

1. What did you think of the Meadows Center field trip?
    a. Probe: What about the trip made it (participant's own description)?

2. What was your favorite part about the field trip?
    a. Probe: Why was (participant's own description) your favorite part about the field trip?

3. What was your least favorite part about the field trip?
    a. Probe: Why was (participant's own description) your least favorite part about the field trip?

4. What were you hoping to learn during the field trip?

5. How do you feel about using outdoor spaces to teach in your future career?
    a. Probe: What were your feelings about this before the field trip?

6. Provide me with an example of how you might use outdoor spaces to teach in your future career.
    a. Probe: In what ways could teaching in the outdoors influence student learning?
    b. Probe: What do you think could prevent you from teaching in the outdoors?
    c. Probe: What factors would influence your choice to teach in the outdoors in your future career?

7. I generated an experience profile based on the data we collected during your field trip. Would you be willing to compare your recollection of your experiences during the field trip to my interpretations of your experience? This is called member checking, and would help us maintain the trustworthiness of our findings.

8. Is there anything else you would like to add?

APPENDIX F: GS 3320 LAB NOTEBOOK PROMPTS

I. Field Trip Notes

(To be written during the activity.) Write notes in the order you do the activity.

Boat

1. State 2 facts given during the ride. (Spend most of the time looking at the lake, not writing.)

Macroinvertebrate Sampling

1. Name and sketch a bug found during bug picking.
2. What does it mean that this bug is found in the lake?

Wetlands/ Aquarium

1. Name 2 endangered species on view in the aquarium.
2. Describe 1 of the species and its habitat.
3. Name 2 invasive species found at Spring Lake.
4. State an additional fact given on the Wetlands.

APPENDIX G: GS 3320 HOMEWORK ASSIGNMENT

Boat

1. What would you expect your class (give grade level) to learn from taking the boat ride?

Macroinvertebrate Sampling

1. Was there a change of your opinion of the Bug Picking activity before and after it was conducted? Explain.
2. Is this a beneficial activity for children? Explain

Wetlands/ Aquarium

1. What is the purpose of walking over the boardwalk as opposed to viewing the lake from the shore?
2. How long would you want your class (give grade level) to be in the aquarium at Meadows Center?
3. What assignment would you make for your students so that they get maximum benefit from being in the aquarium at Meadows Center?

Overall

1. Which activity (Boat, Bug Picking, Food Web) is the best example of learning as a scientist? Explain.
2. If you took students on a field trip to Meadows Center and could only do 2 activities, which would you do? Explain.

APPENDIX H: DESCRIPTIVE CODING CODEBOOK

Engagement Action	Description
	Behavioral
Answering questions	Participant answers questions posed in notes, Meadows Center materials, or by the docent, IA, and/or other students.
Asking questions	Participant asks a question to the docent, instructional assistant, and/or other students (e.g., "What kind of duck is that?"
Speaking	Individual moments of speaking that does not involve asking questions, answering questions, or thinking noises (e.g., "The water is so pretty!")
Digital Documentation	Participant uses phone to take a picture of object or text during fieldtrip.
Following explicit directions	Participant follows explicit directions provided by the docent and/or IA.
Hand motions	Participant uses hand motions (e.g., waving) to communicate to with other persons around him/ her.
Mimicking	Participant clearly copies another student, or the docent or mimics their actions without explicit instruction.
Moving closer	Participant explicitly attempts to move closer to an object while visually focusing on the object.
Paying attention	Participant is explicitly paying attention to either the docent or to a focal point (e.g., organism, plaque) presented by the docent.
Physical interaction	Participant physically touches or handles materials in the aquarium, bug-picking, and wetlands walk activities.

(continued)

Engagement Action	Description
Behavioral (continued)	
Reading	Participant reads notes, assignment prompts, and/or Meadows Center materials.
Response to external cues	Participant clearly responds to external cues from other persons around them (e.g., docent pointing to and describing organism).
Shaking head	Participant shakes head either up and down for any reason other than to answer a question.
Sharing notes	Participant shares their notes from the fieldtrip with other students.
Singing or humming to self	Participant sings or hums to themselves
Thinking noises	Participant makes inaudible noise whilst paying attention to object (e.g., "hmmm…")
Writing notes	Participant writes notes in response to required laboratory notebook prompts.
Yawning	Participant yawns
Affective	
Emotional reactions	Participant responds to external stimuli via emotional response. Participant does not indicate what the response is in response to.
Humor	Participant engages in explicit moments of laughter, sarcasm, or joking around.
Laughing	Participant laughs
Personal perceptions and opinions	Participant explicitly expresses personal opinions about external stimuli.
Storytelling	Personal connection back to previous experiences based on external stimuli

(continued)

Engagement Action	Description
	Cognitive
Hypotheticals	Participant verbally presents hypothetical situation.
Problem-solving	Participant explicitly attempts to solve a problem.
Referencing previous knowledge and experiences	Participant explicitly references previous experiences and knowledge through actions such as recognizing or comparing.
Synthesis	Participant synthesizes answer based on verbal, or read prompts, or
Verbalizing thought process	Participants verbally explains thought process.
	Agentic
Addressing new topics visual observation	Participant visually focuses on non-target object while the docent is focusing on another subject.
Interacting with an unintroduced activity	Participant interacts with an activity that was not introduced as part of the field or by the docent.
Addressing new topics via questions	Participant asks a question about a non-target object while the docent is focusing on another subject.
Addressing new topics via statements	Participant makes a statement about a non-target object while the docent is focusing on another subject.

APPENDIX I: ENGAGEMENT ACTION TABLES

Leighla		
Engagement	Engagement Actions (n)	Percent (%) (% of total engagement)
Behavioral Engagement	506	70.3%
		(% of Behavioral Engagement)
Conversation	*127*	*25.1%*
Paying attention	*97*	*19.2%*
Writing notes	*62*	*12.3%*
Reading	*46*	*9.1%*
Queues	*40*	*7.9%*
Asking questions	*39*	*7.7%*
Hand motions	*37*	*7.3%*
Answering questions	*23*	*4.5%*
Moving closer	*17*	*3.4%*
Physical interaction	*6*	*1.2%*
Shaking head	*4*	*0.8%*
Digital documentation	*3*	*0.6%*
Thinking noises	*3*	*0.6%*
Following explicit directions	*2*	*0.4%*
Affective Engagement	159	22.1%
		(% of Affective Engagement)
Laughing	*67*	*42.2%*
Emotional reactions	*35*	*22.0%*
Opinions and perceptions	*32*	*20.1%*
Joking	*22*	*13.8%*
Storytelling	*4*	*2.5%*
Cognitive Engagement	43	6.0%
		(% of Cognitive Engagement)
Referencing previous knowledge/ experiences	*38*	*88.4%*
Synthesis	*5*	*11.6%*
Agentic Engagement	12	1.7%
		(% of Agentic Engagement)
Addressing new topics via questions	*4*	*33.3%*
Addressing new topics via statements	*4*	*33.3%*
Addressing new topics via visual observation	*4*	*33.3%*

APPENDIX I: ENGAGEMENT ACTION TABLES

Olivia		
Engagement	Engagement Actions (n)	Percent (%) (% of total engagement)
Behavioral Engagement	395	70.9%
		(% of Behavioral Engagement)
Paying attention	*102*	*25.8%*
Conversation	*79*	*20.0%*
Response to external cues	*40*	*10.1%*
Thinking noises	*27*	*6.8%*
Asking questions	*26*	*6.6%*
Reading	*23*	*5.8%*
Moving closer	*22*	*5.6%*
Writing notes	*21*	*5.3%*
Answering questions	*20*	*5.1%*
Hand motions	*13*	*3.3%*
Physical interaction	*8*	*2.0%*
Shaking head	*6*	*1.5%*
Yawning	*5*	*1.3%*
Following explicit directions	*2*	*0.5%*
Singing or humming to self	*1*	*0.3%*
Affective Engagement	134	24.1%
		(% of Affective Engagement)
Emotional responses	*65*	*48.5%*
Laughter	*42*	*31.3%*
Opinions and perceptions	*20*	*14.9%*
Joking	*7*	*5.3%*
Cognitive Engagement	15	2.7%
		(% of Cognitive Engagement)
Referencing previous knowledge/ experiences	*12*	*80.0%*
Synthesis	*3*	*20.0%*
Agentic Engagement	12	2.3%
		(% of Agentic Engagement)
Addressing new topics via questions	*8*	*66.7%*
Addressing new topics via statements	*2*	*16.7%*
Addressing new topics via visual observation	*2*	*16.7%*

APPENDIX I: ENGAGEMENT ACTION TABLES

Aurora		
Engagement	Engagement Actions (n)	Percent (%) (% of total engagement)
Behavioral Engagement	524	79.3% (% of Behavioral Engagement)
Paying attention	*144*	*27.5%*
Response to external cues	*68*	*13.0%*
Conversation	*64*	*12.2%*
Asking questions	*55*	*10.5%*
Reading	*50*	*9.5%*
Writing notes	*37*	*7.1%*
Answering questions	*27*	*5.2%*
Hand motions	*21*	*4.0%*
Physical interaction	*12*	*2.3%*
Digital documentation	*11*	*2.1%*
Moving closer	*11*	*2.1%*
Following explicit directions	*10*	*1.9%*
Thinking noises	*9*	*1.7%*
Sharing notes	*3*	*0.6%*
Shaking head	*1*	*0.2%*
Affective Engagement	121	18.3% (% of Affective Engagement)
Laughter	*59*	*48.8%*
Opinions and perceptions	*31*	*25.6%*
Emotional responses	*16*	*13.2%*
Joking	*15*	*12.4%*
Cognitive Engagement	7	1.1% (% of Cognitive Engagement)
Synthesis	*6*	*85.7%*
Referencing previous knowledge/ experiences	*1*	*14.3%*
Agentic Engagement	9	1.4% (% of Agentic Engagement)
Addressing new topics via questions	*4*	*44.4%*
Addressing new topics via visual observation	*3*	*33.3%*
Addressing new topics via statements	*2*	*22.2%*

APPENDIX I: ENGAGEMENT ACTION TABLES

Bernard		
Engagement	Engagement Actions (n)	Percent (%) (% of total engagement)
Behavioral Engagement	507	63.1% (% of Behavioral Engagement)
Conversation	*222*	*43.8%*
Asking questions	*101*	*19.9%*
Paying attention	*47*	*9.3%*
Response to external cues	*29*	*5.7%*
Answering questions	*25*	*4.9%*
Reading	*18*	*3.6%*
Writing notes	*17*	*3.4%*
Moving closer	*14*	*2.8%*
Hand motions	*11*	*2.2%*
Singing or humming to self	*8*	*1.6%*
Physical interaction	*7*	*1.4%*
Thinking noises	*3*	*0.6%*
Mimicking	*2*	*0.4%*
Following explicit directions	*1*	*0.2%*
Shaking head	*1*	*0.2%*
Sharing notes	*1*	*0.2%*
Affective Engagement	225	28.0% (% of Affective Engagement)
Laughter	*74*	*32.9%*
Opinions and perceptions	*70*	*31.1%*
Emotional responses	*60*	*26.7%*
Joking	*19*	*8.4%*
Storytelling	*2*	*0.9%*
Cognitive Engagement	28	3.5% (% of Cognitive Engagement)
Referencing previous knowledge/ experiences	*20*	*71.4%*
Synthesis	*8*	*28.6%*
Agentic Engagement	43	5.4% (% of Agentic Engagement)
Addressing new topics via questions	*30*	*69.8%*
Addressing new topics via visual observation	*8*	*18.6%*
Interacting with an unintroduced activity	*3*	*7.0%*
Addressing new topics via statements	*2*	*4.7%*

APPENDIX I: ENGAGEMENT ACTION TABLES

Tara		
Engagement	Engagement Actions (n)	Percent (%) (% of total engagement)
Behavioral Engagement	422	64.8% (% of Behavioral Engagement)
Conversation	*134*	*31.8%*
Queues	*58*	*13.7%*
Asking questions	*49*	*11.6%*
Paying attention	*33*	*7.8%*
Reading	*29*	*6.9%*
Moving closer	*27*	*6.4%*
Answering questions	*25*	*5.9%*
Writing notes	*20*	*4.7%*
Hand motions	*18*	*4.3%*
Physical interaction	*15*	*3.6%*
Following explicit directions	*6*	*1.4%*
Thinking noises	*6*	*1.4%*
Digital documentation	*1*	*0.2%*
Shaking head	*1*	*0.2%*
Affective Engagement	188	28.9% (% of Affective Engagement)
Emotional responses	*58*	*30.9%*
Opinions and perceptions	*54*	*28.7%*
Laughter	*41*	*21.8%*
Joking	*32*	*17.0%*
Storytelling	*3*	*1.6%*
Cognitive Engagement	36	5.1% (% of Cognitive Engagement)
Referencing previous knowledge/ experiences	*25*	*69.4%*
Synthesis	*6*	*16.7%*
Verbalizing thought process	*2*	*5.6%*
Generating Hypothetical thoughts	*2*	*5.6%*
Problem-solving	*1*	*2.8%*
Agentic Engagement	8	1.2% (% of Agentic Engagement)
Addressing new topics via visual observation	*3*	*37.5%*
Interacting with an unintroduced activity	*2*	*25.0%*
Addressing new topics via questions	*2*	*25.0%*
Addressing new topics via statements	*1*	*12.5%*

REFERENCES

Adams, J. D., & Branco, B. (2017). Extending classrooms into parks through informal science learning and place-based education. In Preparing Informal Science Educators, 1, 337-354.

Aker, L. B. (2016). *A meta-analysis of middle school science engagement.* (Doctoral dissertation). Retrieved from http://digitalcommons.spu.edu/soe_etd/10

Alon, N. L., & Tal, T. (2016). Fieldtrips to natural environments: How outdoor educators use the physical environment. *International Journal of Science Education*, Part B, 1-16.

Anderson, D., Lawson, B., & Mayer-Smith, J. (2006). Investigating the impact of a practicum experience in an aquarium on preservice teachers. *Teaching Education*, 17(4), 341-353. doi: 10.1080/10476210601017527

Appleton, J. J., Christenson, S. L., & Furlong, M. J. (2008). Student engagement with school: Critical conceptual and methodological issues of the construct. *Psychology in the Schools, 45*(5), 369-386. doi:10.1002/pits.20303

Appleton, J. J., Christenson, S. L., Kim, D., & Reschly, A. L. (2006). Measuring cognitive and psychological engagement: Validation of the Student Engagement Instrument. *Journal of School Psychology*, 44, 427-445.

Archambault, I., & Dupéré, A. (2016). Joint trajectories of behavioral, affective, and cognitive engagement in elementary school. *The Journal of Educational Research, 0*(0), 1-11. doi:10.1080/00220671.2015.1060931

Ateşkan, A., & Lane, J. (2016). Promoting fieldtrip confidence: Teachers providing insight for preservice education. *European Journal of Teacher Education*, 39(2), 190-201. doi: 1 0.1080/02619768.2015.1113252

Avraamidou, L. (2014). Developing a reform-minded science teaching identity: The role of informal science environments. Journal of Science Teacher Education, 25, 823-843. doi: 10.1007/s10972-014-9395-y

Avraamidou, L. (2015). Reconceptualizing elementary teacher preparation: A case for informal science education. *International Journal of Science Education, 37*(1), 108-135. doi:10.1080/09500693.2014.969358

Azevedo, R. (2015). Defining and measuring engagement and learning in science: Conceptual, theoretical, methodological, and analytical issues. *Educational Psychologist, 50*(1), 84-94. doi: 10.1080/00461520.2015.1004069

Baird, J. R., Fensham, P. J., Gunstone, R. F., & White, R. T. (1991). The importance of reflection in improving science teaching and learning. *Journal of Research in Science Teaching*, *28*(2), 163-182.

Bell, J., Falk, J., Hughes, R., Hunt, G., Parrish, J., Ruffin, M., Sacco, K., & Troxel, G. (2016). Informal STEM Education: Resources for Outreach, Engagement and Broader Impacts. *Science Education (CAISE)*.

Ben-Eliyahu, A., Moore, D., Dorph, R., & Schunn, C. D. (2018). Investigating the Multidimensionality of Engagement: Affective, Behavioral, and Cognitive Engagement Across Science Activities and Contexts. *Contemporary Educational Psychology, 53*, 87-105.

Blumenfeld, P., Kempler, T., & Krajcik, J. (2006). Motivation and cognitive engagement in learning environments. In K. Sawyer (Ed.), *Cambridge Handbook of the Learning Sciences* (pp. 475 - 488). New York: Cambridge University Press.

Boyce, C. J., Mishra, C., Halverson, K. L., & Thomas, A. K. (2014). Getting students outside: Using technology as a way to stimulate engagement. *Journal of Science Education and Technology, 23*(6), 815-826. doi:10.1007/s10956-014-9514-8

Braund, M., & Reiss, M. (2006). Towards a more authentic science curriculum: The contribution of out-of-school learning. *International Journal of Science Education*, *28*(12), 1373-1388.

Bukor, E. (2015). Exploring teacher identity from a holistic perspective: reconstructing and reconnecting personal and professional selves. *Teachers and Teaching,* 21(3), 305-327.

Calderhead, J., & Robson, M. (1991). Images of teaching: Student teachers' early conceptions of classroom practice. *Teaching and Teacher Education*, *7*(1), 1-8.

Chase, P. A., Hilliard, L. J., Geldhof, G. J., Warren, D. J., & Lerner, R. M. (2014). Academic achievement in the high school years: The changing role of school engagement. *Journal of Youth and Adolescence*. 43(6), 884-896.

Chin, C., & Osborne, J. (2008). Students' questions: a potential resource for teaching and learning science. *Studies in Science Education*, *44*(1), 1-39.

Cox-Petersen, A. M., Marsh, D. D., Kisiel, J., & Melber, L. M. (2003). Investigation of guided school tours, student learning, and science reform recommendations at a museum of natural history. *Journal of Research in Science Teaching*, *40*(2), 200-218.

Day, C., Kington, A., Stobart, G., & Sammons, P. (2006). The personal and professional selves of teachers: Stable and unstable identities. *British Educational Research Journal*, *32*(4), 601-616.

Eccles, J. S. (2016). Engagement: Where to next? *Learning and Instruction, 43*, 71-75. doi:10.1016/j.learninstruc.2016.02.003

Eick, C. J., & Reed, C. J. (2002). What makes an inquiry-oriented science teacher? The influence of learning histories on student teacher role identity and practice. *Science Education*, *86*(3), 401-416.

Falk, J. H., Storksdiek, M., & Dierking, L. D. (2007). Investigating public science interest and understanding: Evidence for the importance of free-choice learning. *Public Understanding of Science, 16*, 455-469. doi: 10.1177/0963662506064240

Falk, J. H., & Gillespie, K. L. (2009). Investigating the role of emotion in science center visitor learning. *Visitor Studies, 12*(2), 112-132. doi: 10.1177/0963662506064240

Falk, J. H., & Storksdiek, M. (2010). Science learning in a leisure setting. *Journal of Research in Science Teaching, 47*(2), 194-212. doi:10.1002/tea.20319

Falk, J. H., & Dierking, L. D. (2010). The 95 percent solution. *American Scientist, 98*(6). Retrieved from http://www.jstor.org.libproxy.txstate.edu/stable/25766726

Falk, J. H., Randol, S., & Dierking, L. D. (2011). Mapping the informal science education landscape: An exploratory study. *Public Understanding of Science, 21*(7), 865-874. doi:10.1177/0963662510393606

Falk, J. H., & Needham, M. D. (2013). Factors contributing to adult knowledge of science and technology. *Journal of Research in Science Teaching, 50*(4), 431-452. doi:10.1002/tea.21080

Falk, J. H., et al. (2016). Correlating science center use with adult science literacy: An international, cross-institutional study. *Science Education, 100*(5), 849-876. doi:10.1002/sce.21225

Fanning, A. (2016). *Learning through nature: A study of a next generation science standards based teacher workshop that blends outdoor learning experiences with formal science.* (Masters dissertation). Retrieved from http://pdxscholar.library.pdx.edu/open_access_etds/2731/

Farmer, J., Knapp, D., & Benton, G. M. (2007). An elementary school environmental education fieldtrip: Long-term effects on ecological and environmental knowledge and attitude development. *The Journal of Environmental Education, 38*(3), 33-42. doi:10.3200/JOEE.38.3.33-42

Fiedler, M. L. (1975). Bidirectionality of influence in classroom interaction. Journal of Educational Psychology, 67, 735–744. doi: 10.1037/0022-0663.67.6.735

Finn, J. D., & Rock, D. A. (1997). Academic success among students at risk for school failure. *Journal of Applied Psychology*, 82(2), 221. doi: 0021-9010fl7/S3.00

Finn, J. D., & Zimmer, K. S. (2012). Student engagement: What is it? Why does it matter? Handbook of Research on Student Engagement, 1, 97-131.

Finn, J. D. (1989). Withdrawing from school. Review of educational research, 59(2), 117-142. Retrieved from https://pdfs.semanticscholar.org/221e/ec4c94a3484f6a025d2477b65f00c481c541.pdf

Fredericks, J. A., Blumenfeld, P. C., & Paris, A. (2004). School Engagement: Potential of the Concept, State of the Evidence. *Review of Educational Research, 74*(1), 59-109. doi: 10.3102/00346543074001059

Fredericks, J. A. et al. (2016). Using qualitative methods to develop a survey measure of math and science engagement. *Learning and Instruction, 43*, 5-15. doi:10.1016/j.learninstruc.2016.01.009.

Fredricks, J. A., & McColskey, W. (2012). The measurement of student engagement: A comparative analysis of various methods and student self-report instruments. In Handbook of Research on Student Engagement (pp. 763-782). Springer US. doi: 10.1007/978-1-4614-2018-7_37

Fredricks, J., McColskey, W., Meli, J., Mordica, J., Montrosse, B., & Mooney, K. (2011). Measuring student engagement in upper elementary through high school: A description of 21 instruments. Issues & Answers. REL 2011-No. 098. Regional Educational Laboratory Southeast.

Geddis, A. N., & Roberts, D. A. (1998). As science students become science teachers: A perspective on learning orientation. *Journal of Science Teacher Education*, *9*(4), 271-292.

Gilje, Ø., & Erstad, O. (2017). Authenticity, agency and enterprise education studying learning in and out of school. *International Journal of Educational Research*, *84*, 58-67.

Greene, B. A. (2015). Measuring cognitive engagement with self-report scales: Reflections from over 20 years of research. *Educational Psychologist, 50*(1), 14-30. doi:10.1080/00461520.2014.989230

Hakkarainen, P., Saarelainen, T., & Ruokamo, H. (2007). Towards meaningful learning through digital video supported, case based teaching. *Australasian Journal of Educational Technology*, *23*(1).

Holmqvist, K., Nyström, M., Andersson, R., Dewhurst, R., Jarodzka, H., & Van de Weijer, J. (2011). *Eye tracking: A comprehensive guide to methods and measures*. Oxford, UK: Oxford University Press.

Jarodzka, H., Scheiter, K., Gerjets, P., & Van Gog, T. (2010). In the eyes of the beholder: How experts and novices interpret dynamic stimuli. Learning and Instruction, 20(2), 146-154. doi: 10.1016

Järvelä, S., Järvenoja, H., Malmberg, J., Isohätälä, J., & Sobocinski, M. (2016). How do types of interaction and phases of self-regulated learning set a stage for collaborative engagement? Learning and Instruction, 43. doi:10.1016/j.learninstruc.2016.01.005

Jarvis, T., & Pell, A. (2002). Effect of the challenger experience on elementary children's attitudes to science. *Journal of Research in Science Teaching*, *39*(10), 979-1000.

Jeffery-Clay, K. R. (1998). Constructivism in museums: How museums create meaningful learning environments. *Journal of Museum Education*, *23*(1), 3-7.

Jonassen, D. H., & Strobel, J. (2006). Modeling for meaningful learning. In D. Hung (Ed.), & M. S. Khine (Ed.), *Engaged Learning with Emerging Technologies* (pp. 1-27). Springer, Dordrecht.

Jung, M. L., & Tonso, K. L. (2006). Elementary preservice teachers learning to teach science in science museums and nature centers: A novel program's impact on science knowledge, science pedagogy, and confidence teaching. *Journal of Elementary Science Education*, 18(1), 15-31. doi: 10.1007/BF03170651

Kamarainen, A. M. (2013). EcoMOBILE: Integrating augmented reality and probeware with environmental education fieldtrips. *Computers & Education*, (68), 545-556. doi:10.1016/j.compedu.2013.02.018

Kim, M., & Dopico, E. (2016). Science education through informal education. Cultural Studies of Science Education, 11(2), 439-445. doi: 10.1007/s11422-014-9639-3

Kinner, V. L., Kuchinke, L., Dierolf, A. M., Merz, C. J., Otto, T., & Wolf, O. T. (2017). What our eyes tell us about feelings: Tracking pupillary responses during emotion regulation processes. *Psychophysiology*. doi: 10.1111/psyp.12816

Kisiel, J. (2013). Introducing future teachers to science beyond the classroom. *Journal of Science Teacher Education*, 24(1), 67-91. doi: 10.1007/s10972-012-9288-x

Koenigs, S. S., Fiedler, M. L., & Decharms, R. (1977). Teacher Beliefs, Classroom Interaction and Personal Causation1. *Journal of Applied Social Psychology*, 7(2), 95-114. doi: 10.1111/j.1559-1816.1977.tb01332.x

Kostiainen, E., Ukskoski, T., Ruohotie-Lyhty, M., Kauppinen, M., Kainulainen, J., & Mäkinen, T. (2018). Meaningful learning in teacher education. *Teaching and Teacher Education*, 71, 66-77.

Kruger, J. L., & Doherty, S. (2016). Measuring cognitive load in the presence of educational video: Towards a multimodal methodology. *Australasian Journal of Educational Technology*, 32(6). doi: 10.14742/ajet.3084

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry* (Vol. 75). London, UK: SAGE Publications.

Louv, R. (2005). Last child in the woods: saving out children from the nature-deficit disorder. Algonquin Books, Chapel Hill, NC.

Marks, H. M. (2000). Student engagement in instructional activity: Patterns in the elementary, middle, and high school years. *American Educational Research Journal*, 37(1), 153-184. doi: 10.3102/00028312037001153

Marshall, S. P. (2007). Identifying cognitive state from eye metrics. *Aviation, Space, and Environmental Medicine*, 78(5), B165-B175. doi: 35400014938998.0180

Mason, L., Pluchino, P., & Ariasi, N. (2014). Reading information about a scientific phenomenon on webpages varying for reliability: An eye-movement analysis. *Educational Technology Research and Development*, *62*(6), 663-685. doi: 10.1007/s11423-014-9356-3

Mason, L., Pluchino, P., Tornatora, M. C., & Ariasi, N. (2013). An eye-tracking study of learning from science text with concrete and abstract illustrations. *The Journal of Experimental Education*, *81*(3), 356-384. doi: 10.1080/00220973.2012.727885

Maynard, T., & Waters, J. (2007). Learning in the outdoor environment: A missed opportunity? *Early Years, 27*(3), 255-265. doi:10.1080/09575140701594400

Mayer, R. E. (2002). Rote versus meaningful learning. *Theory into practice*, *41*(4), 226-232.

McDaniel, J. E. (1991, April). Close encounters: How do student teachers make sense of the social foundations. Paper presented at the annual meeting of the American Educational Research Association, Chicago.

McCallie E, Bell L, Lohwater T, Falk JH, Lehr JL, Lewenstein BV, Needham C, Wiehe B (2009) Many experts, many audiences: Public engagement with science and informal science education. A CAISE Inquiry Group Report, Washington DC.

McKinnon, M., & Lamberts, R. (2014). Influencing science teaching self-efficacy beliefs of primary school teachers: A longitudinal case study. *International Journal of Science Education, Part B*, *4*(2), 172-194. doi: 10.1080/21548455.2013.793432

McMeeking, L. B., Weinberg, A. E., Boyd, K. J., & Balgopal, M. M. (2016). Student perceptions of interest, learning, and engagement from an informal traveling science museum. *School Science and Mathematics*, *116*(5), 253-264. doi: 10.1111/ssm.12176

Miller, B. W. (2015). Using reading times and eye-movements to measure cognitive engagement. *Educational Psychologist, 50*(1), 31-42. doi:10.1080/00461520.2015.1004068

Mintzes, J. J., Wandersee, J. H., & Novak, J. D. (1997). Meaningful learning in science: The human constructivist perspective. In In G. D. Phye (Ed.) *Handbook of Academic Learning* (pp. 405-447). San Diego: Academic Press.

Mony, P. R., & Heimlich, J. E. (2008). Talking to visitors about conservation: Exploring message communication through docent–visitor interactions at zoos. *Visitor Studies*, *11*(2), 151-162.

Munn, S. M., Stefano, L., & Pelz, J. B. (2008, August). Fixation-identification in dynamic scenes: Comparing an automated algorithm to manual coding. In *Proceedings of the 5th Symposium on Applied Perception in Graphics and Visualization* (pp. 33-42). ACM. doi: 10.1145/1394281.1394287

Newmann, F. M., Wehlage, G. G., & Lamborn, S. D. (1992). The significance and sources of student engagement. In F. M. Newmann (Ed.), Student engagement and achievement in American secondary schools (pp. 11–39). New York7 Teachers College Press.

National Research Council. (2012). A framework for K-12 science education: Practices, crosscutting concepts and core ideas. Washington, DC: National Academy Press.

National Research Council. (1996). National Science Education Standards. Washington, DC:

National Academy Press.

Ng, W., Nicholas, H., & Williams, A. (2010). School experience influences on pre-service teachers' evolving beliefs about effective teaching. *Teaching and Teacher Education*, *26*(2), 278-289.

Patton, M. Q. (2002). *Qualitative evaluation and research methods*. London, UK: SAGE Publications.

Reeve, J., & Tseng, C. (2011). Agency as a fourth aspect of students' engagement during learning activities. *Contemporary Educational Psychology, 36*, 257-267. doi:10.1016/j.cedpsych.2011.05.002

Reeve, J. (2013). How students create motivationally supportive learning environments for themselves: The concept of agentic engagement. *Journal of Educational Psychology, 105*(3), 579-595. doi:10.1016/j.cedpsych.2011.05.002

Rennie, L., & McClafferty, T. (1995). Using visits to interactive science and technology centers, museums, aquaria, and zoos to promote learning in science. *Journal of Science Teacher Education*, *6*(4), 175-185.

Renninger, K. A., & Bachrach, J. E. (2015). Studying triggers for interest and engagement using observational methods. *Educational Psychologist, 50*(1), 58-69. doi:10.1080/00461520.2014.999920

Ruohotie-Lyhty, M., & Moate, J. (2016). Who and how? Preservice teachers as active agents developing professional identities. *Teaching and Teacher Education*, *55*, 318-327.

Ryan, A. M., & Patrick, H. (2001). The classroom social environment and changes in adolescents' motivation and engagement during middle school. *American Educational Research Journal*, *38*(2), 437-460.

Ryu, S., & Lombardi, D. (2015). Coding classroom interactions for collective and individual engagement. *Educational Psychologist, 50*(1), 70-83. doi:10.1080/00461520.2014.1001891

Saldaña, J. (2016). *The coding manual for qualitative researchers*. London, UK. SAGE Publications, Inc.

Sellman, D., & Bogner, F. X. (2013). Climate change education: quantitatively assessing the impact of a botanical garden as an informal learning environment. *Environmental Education Research, 19*(4), 415-429. doi:10.1080/13504622.2012.700696

Shaffer, D. W., & Resnick, M. (1999). " Thick" Authenticity: New Media and Authentic Learning. *Journal of Interactive Learning Research*, *10*(2), 195.

Sinatra, G. M., Heddy, B. C., & Lombardi, D. . (2015). The challenges of defining and measuring student engagement in science. *Educational Psychologist, 50*(1), 1-13. doi:10.1080/00461520.2014.1002924

Sinatra, G. M., & Hofer, B. (2016). Public understanding of science: Policy and educational implications. *Behavioral and Brain Sciences, 3*(2), 245-253. doi:10.1177/2372732216656870

Slykhuis, D. A., Wiebe, E. N., & Annetta, L. A. (2005). Eye-tracking students' attention to PowerPoint photographs in a science education setting. *Journal of Science Education and Technology*, *14*(5-6), 509-520. doi: 10.1007/s10956-005-0225-z

Stake, R. E. (1995). *The Art of Case Study Research*. London, UK: SAGE Publications.

Stein, S. J., Isaacs, G., & Andrews, T. (2004). Incorporating authentic learning experiences within a university course. *Studies in Higher Education*, *29*(2), 239-258.

Tal, R. T. (2001). Incorporating fieldtrips as science learning environment enrichment–an interpretive study. *Learning Environments Research, 4*, 25-49. doi:10.1023/A:1011454625413

Tal, R. T. (2004). Using a fieldtrip as a guide for conceptual understanding in environmental education: A case study of a preservice teacher's research. *Chemical Education: Research and Practice, 5*(2), 127-142. doi:10.1039/B4RP90016B

Tal, T. (2010). Preservice teachers' reflections on awareness and knowledge following active learning in environmental education. *International Research in Geographical and Environmental Education, 19*(4), 263-276. doi:10.1080/10382046.2010.519146

Taniguchi, S. T., Freeman, P. A., & Richards, A. L. (2005). Attributes of meaningful learning experiences in an outdoor education program. *Journal of Adventure Education & Outdoor Learning*, *5*(2), 131-144.

Tytler, R., & Osborne, J. (2012). Student attitudes and aspirations towards science. In *Second International Handbook of Science Education* (pp. 597-625). Springer Netherlands.

Volet, S., Summers, M., & Thurman, J. (2009). High-level co-regulation in collaborative learning: How does it emerge and how is it sustained? *Learning and Instruction*, *19*(2), 128-143.

Wang, M. T., & Eccles, J. S. (2013). School context, achievement motivation, and academic engagement: A longitudinal study of school engagement using a multidimensional perspective. *Learning and Instruction*, 28, 12-23.

Well, N. M., & Lekies, K. S. (2006). Nature and the life course: Pathways from childhood nature experiences to adult environmentalism. *Children, Youth and Environments, 16*(1), 1-24. Retrieved from http://www.jstor.org/stable/10.7721/chilyoutenvi.16.1.0001

Witcher, A., & Onwuegbuzie, A. J. (1999). Characteristics of Effective Teachers: Perceptions of Preservice Teachers. *Research in the Schools*, 8, 45-57.

Whitesell, E. R. (2016). A day at the museum: The impact of fieldtrips on middle school science achievement. *Journal of Research in Science Teaching*, 53(7), 1036-1054. doi: 10.1002/tea.21322

Zepke, N. (2017). *Student Engagement in Neoliberal Times: Theories and Practices for Learning and Teaching in Higher Education* (Vol. 1). Singapore: Springer Nature.