

STEM Teaching and Learning Strategies of High School Parents With Homeschool Students

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Abstract

The purpose of this research study was to investigate the teaching and learning strategies used by homeschool parents with high school students. A qualitative case study was used which began with the administration of an open-ended questionnaire to a homeschool community in the southern United States. Twenty-nine parents completed the questionnaire, and 10 of those volunteered to participate in the follow-up procedures, which included interviews, observations, and document collection. Results indicate that parents use a variety of teaching and learning strategies including individualized instruction, mastery learning, self-directed study, collaboration with peers and adults, and application and connection of information.

Keywords

homeschool, homeschooling, STEM, teaching and learning

Introduction

Since the establishment of the legal right to homeschool and with the recent growth in the Internet and other technologies, the homeschooling movement has seen a dramatic increase in recent years (Isenberg, 2007). Estimates from

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the National Center for Educational Statistics in 2011 placed the number of homeschooled children in the United States at approximately 1.77 million (Noel, Stark, & Redford, 2015). This reflects a growth in homeschooling from the estimated 1.5 million homeschooled students in 2007. Along with an increase in number, there had also been an increase in the percentage of school-age children who were being homeschooled, rising from 2.9% in 2007 to 3.4% in 2011 (Noel et al., 2015). However, since these numbers only capture the then-current homeschooling population, it is estimated that even more students, who were enrolled in public or private institutions at the time, have experienced home-based education at some point during their educational careers (Geary, 2011).

The homeschooling trend is not limited to the United States. Other countries, including Canada, Australia, France, and the United Kingdom, have also seen a growth in homeschooling in recent years (Korkmaz & Duman, 2014; Ray, 2015). In the United Kingdom, recent surveys estimate that approximately 1% of the school population or 170,000 students have experienced homeschooling (Smith & Nelson, 2015). However, the registration and monitoring system in the United Kingdom is complex, and the number of homeschooling families seems to be rising (Badman, 2009; Hopwood, O'Neill, Castro, & Hodgson, 2007; Smith & Nelson, 2015).

The recent growth in homeschooling has led to a diversification in the motivations and background characteristics of homeschooling families, and access to the Internet and other resources has led to broadening of the instructional methods and activities used by homeschooling families (Hanna, 2012; Isenberg, 2007; Noel et al., 2015). Research has also shown that parents have diversified their methods of homeschooling incorporating a vast array of resources such as tutors, learning groups, and outside resources (e.g., libraries, museums) (Boschee & Boschee, 2011; Hanna, 2012; Muldowney, 2011).

Problem Statement

The current growth in the number of homeschooled students, as well as the diversification in the methods and activities used by parents for homeschooling, has the potential to profoundly impact parents, students, and their communities (Murphy, 2014) with the expansion of teaching and learning strategies used in a homeschool environment. However, very little quality research exists about the teaching and learning strategies used in a homeschooling environment, specifically in the area of science, technology, engineering, and mathematics (STEM) education. Research in homeschooling has primarily focused on the areas of parental motivation and the academic and social outcomes of homeschooling (Kunzman & Gaither, 2013). Studies

that have examined the daily curricular activities of homeschooling parents indicate that parents often use many different styles and activities for educating their students (Hanna, 2012).

Studies have shown that homeschooling parents rely on a wide range of curricular choices, a homeschool support network, and a mix of educational options for each child. Curricular choices include co-ops, online courses, self-paced classes, and video tutorials (Carpenter & Gann, 2016; Hanna, 2012; Muldowney, 2011). Specifically in STEM education, homeschooling parents often seek guidance from free-choice learning resources, which are resources outside of formal education settings such as local clubs and museums (Bachman, 2011). This diversity in resources and approaches to homeschooling points to a need for research focused on the parents as teachers and the types of teaching and learning strategies they use. This investigation of daily activities can help garner a more complete perspective on the practices and curriculum of this school reform effort, specifically in STEM education.

The purpose of this study was to investigate the teaching and learning strategies used by parents or guardians of high school homeschooled students. This study sought to capture information on the STEM teaching and learning strategies used by a select group of homeschooling parents or guardians in a community in the southern United States and how those teaching and learning strategies are incorporated into homeschooling activities. This research focuses on the parental viewpoint as teacher of their child and what types of teaching and learning strategies parents use with their children in STEM education. The research question that guided this study is

Research Question 1: What STEM teaching and learning strategies are used by parents or guardians in a homeschooling environment?

Literature Review

This study investigated the teaching and learning strategies used by parents within a specific homeschooling community. The theoretical foundation for this investigation drew from two areas: literature dealing with homeschooling methods and curricula and literature on general teaching and learning practices. Within the homeschooling literature, research has primarily been conducted in the United States and the United Kingdom as they represent the largest markets for homeschool research currently (Jamaludin, Alias, & DeWitt, 2015), although other international studies, including research in Turkey, Australia, and China, are included as well. In examining teaching and learning strategies, this study concentrated on four large overarching views of learning, which encompass many of the teaching and learning strategies

used in educational settings today: behaviorism (Skinner, 1938), information processing (Anderson, 1990), individual constructivism (Piaget, 1970), and social constructivism (Vygotsky, 1980; Woolfolk, 2007).

Homeschooling Literature

Homeschooling is “the education of school-aged children under general parental monitoring, replacing full time attendance at a traditional campus” (McKeon, 2007, p. 13). In the homeschooling process, parents become the teachers of their students (Shepherd, 2010). Oftentimes one parent, usually the mother, is the main overseer of the schooling for the children (Lois, 2006). Homeschooling parents often use a variety of formal and informal education settings and activities, such as traditional lectures, online classes, museums, and clubs, to provide educational opportunities for their students (Bachman, 2011; Hanna, 2012). This combination leads to a variety of curriculum practices and teaching methods within this group.

Homeschooling families use a wide range of both curriculum practices and teaching methods to educate their children (Boschee & Boschee, 2011; Hanna, 2012; Hopwood et al., 2007; Seibert, 2002; Swanson, 1996). Many homeschool parents report using published curriculum and oftentimes combining curriculum from multiple sources (Boschee & Boschee, 2011; Hanna, 2012; Swanson, 1996). However, they feel freedom in modifying and adjusting the curriculum to meet the individual needs of students (Boschee & Boschee, 2011; Parsons & Lewis, 2010). Many parents also indicate that after having become acclimated to homeschooling they are more flexible in their approach; they change and adapt their practices based on new information (e.g., contemporary curriculum) and new resources (e.g., advanced technology) (Hanna, 2012; Parsons & Lewis, 2010).

Besides simply purchasing curriculum, many parents often use an eclectic mix of teaching methods or homeschooling styles and use multiple resources, spaces, and community members to provide educational opportunities for their children (Hanna, 2012; Kraftl, 2013; McKeon, 2007; Seibert, 2002). Homeschool families may participate in a homeschool cooperative—a group of parents who gather regularly to collectively teach courses (Anthony, 2015; Muldowney, 2011). These cooperatives often offer a large amount of support for homeschooling parents by providing a source for curriculum, instruction, and extracurricular opportunities (Anthony, 2015; Anthony & Burroughs, 2012).

Some parents may use a textbook-based teaching style or online learning environment, which mimic a more traditional approach, to recreate a “school-like” atmosphere at home with students spending a large amount of time

reading and participating in traditional teaching activities such as practice problems and worksheets (Anthony & Burroughs, 2012; Sheng, 2015). Others choose to use no guiding curriculum and instead allow students to pursue whatever interests them, often called “unschooling” (Clements, 2002; English, 2015; Seibert, 2002). Students may engage in different learning activities within a specific method or style such as self-study, online lectures or videos, or direct teaching by parents, community members, or private tutors (Anthony & Burroughs, 2012; Cardinale, 2013; Clements, 2002; Swanson, 1996). Homeschooling parents are often able to capitalize on the flexible nature of the homeschooling environment to promote student engagement and learning, through both traditional school-like activities as well as opportunities to incorporate learning into everyday interactions and experiences (Bachman & Dierking, 2011; Kraftl, 2013).

When looking specifically at homeschooling methods in STEM education, the research shows the use of an eclectic mix of styles and resources designed around meeting the needs of the students (Bachman & Dierking, 2011; Jones, Cardella, Paulsen, & Wolsky, 2015). Homeschooling families tend to focus on lifelong learning in STEM education by promoting natural curiosity and engagement with information. They find creative ways to promote their child’s interest, even without the traditional school setting, through what could be considered an “informal” approach to STEM education (Bachman, 2011; Bachman & Dierking, 2011). Parents also tend to take advantage of free-choice learning opportunities in STEM, outside of formal education settings, such as museums, zoos, and local engineering camps (Bachman, 2011; Jones et al., 2015).

In homeschool education, parents are considered the teachers for their child’s educational needs. Despite this unique position, parents argue that they are capable of creating the necessary learning environment and effectively fulfilling the role of a teacher for their child (Green & Hoover-Dempsey, 2007; Port, 1989; van Schalkwyk & Bouwer, 2011). Parents see themselves as learners in the process, alongside their students, and are willing to change and adjust methods after they see the benefit to their students (Danley, 1998; Orloff, 2006). Parents evolve and change their approaches based on available resources and their child’s interests (Bachman, 2011; Hanna, 2012). Most homeschooling parents also rely heavily on a homeschool community for resources and activities for their children, often consulting with other homeschooling parents regarding curriculum choices, tutors, or general homeschooling methods (Bachman, 2011; Clements, 2002; Hanna, 2012). Despite these resources and support, parents draw from family and community members. Fulfilling the roles of both parent and teacher brings a unique set of challenges for parents of homeschooled students, including managing

the role of both parent and teacher and finding time for themselves as they are constantly involved with educating their children (Lois, 2006, 2010; Shepherd, 2010; Vigilant, Anderson, & Trefethren, 2014). Specifically in STEM education, parents express concerns about not knowing what their children need and, therefore, uncertainty in providing the necessary resources (Jones et al., 2015).

Theoretical Foundation

A variety of theories in educational literature examines processes of human learning. Learning theories view knowledge in unique ways, and from this view of the learning process comes specific teaching strategies that can be used in a classroom environment. Two prominent learning theories emerge from research literature to support this investigation.

The behavioral view of learning focuses on the actions (behaviors) of a student and the training of those behaviors. The cognitive view of learning focuses on the thought processes involved in learning (Ormrod, 2008; Woolfolk, 2007). Most learning theories prescribe to one of these main views of learning. However, it should be noted that different views and theories should not be seen as competing; rather, the theories together represent an inclusive view of human learning (Duit & Treagust, 1998; Ormrod, 2008; Woolfolk, 2007). No single theory represents everything that is known about human knowledge (Ormrod, 2008; Woolfolk, 2007). The primary function of the theories is to provide teachers and learners with an understanding of the basic mechanisms that underlie human learning so that teachers can design environments and use instructional strategies that facilitate effective learning (Ormrod, 2008).

Combined, these theories provide a lens through which the researcher can examine homeschool parents' teaching and learning strategies. The theories form the basis for the majority of teaching and learning strategies used in educational environments, which would include the homeschooling environment (Woolfolk, 2007). Each learning theory presents a variety of education implications, especially in the areas of teaching strategies, learning strategies, and instructional activities (Ertmer & Newby, 2013; Ormrod, 2008). Since the researcher sought to identify teaching and learning strategies used in a homeschooling environment, a foundational understanding of the learning theories from which teaching and learning strategies have emerged is necessary. The goal of this research was neither to identify specific theories at work in homeschooling nor to determine which learning theories accurately represent parents' perceptions; rather, the goal for this investigation was for the learning theories to provide a theoretical framework for the researcher to collect and analyze the data.

Four learning theories provided the basis for investigating parents' teaching and learning strategies and activities in homeschooling: (a) behaviorism, (b) information processing, (c) individual constructivism, and (d) social constructivism. The behavioral theory of learning evolved from the work of Skinner (1938, 1953, 1954), who viewed learning as the acquisition of facts and concepts that occurs through practice and direct instruction (Ormrod, 2008; Woolfolk, 2007).

The information processing theory of learning comes from the work of Anderson (1974, 1976) and builds on the behavioral theory. Information processing subscribes to the idea that prior knowledge influences how new information is processed. In teaching and learning, there are effective strategies to assist in the processing of new information. Strategies may include teaching methods for helping students pay attention, connect new information to prior knowledge, and providing cues for recall (Ormrod, 2008; Schunk, 2008; Woolfolk, 2007).

Individual constructivism was spawned primarily from the work of Piaget (1928, 1970) who viewed knowledge as being actively constructed, rather than simply acquired, by individuals. Individual constructivism promotes teaching and learning strategies that encourage interactions with the environment and multiple learning opportunities (Duit & Treagust, 1998; Ormrod, 2008; Woolfolk, 2007).

Finally, social constructivism comes from the work of Vygotsky (1980, 1997) who viewed amassment of knowledge very similar to individual constructivism only with an added focus on the social and cultural aspects of knowledge construction. This view of learning has given rise to teaching strategies such as collaborative activities in which students have opportunities to socially construct information (Ormrod, 2008; Schunk, 2008; Woolfolk, 2007).

This study used the existing literature as a foundation for understanding current research into homeschooling methods and practices and investigating teaching and learning strategies used in the homeschool environment. This study examined the teaching and learning strategies used by a small sample of parents in a homeschool community. Although the results of the study may not be generalizable to all homeschooling families, the qualitative case study showcases the types of teaching strategies and the ways in which homeschooling parents actively participate in their child's education.

Method

This research study utilized a qualitative case study approach to describe the teaching strategies of a small sample of homeschooling families. Case studies

revolve around the use of a bounded system in which the researcher seeks to produce detailed, rich descriptions within a specific context (Creswell, 2014; Yin, 2013). The information gathered during this study fits directly within a case study approach by focusing on the teaching and learning strategies of a purposefully selected group of homeschooling parents.

This case study was completed in two phases. Participants for both phases of this case study were recruited from within a purposefully selected, local, homeschool, cooperative learning group, with which the researcher has had a 2-year association. The learning group, often called a co-op, consisted of a group of parents who gathered to collectively teach classes and provide support for each other. The director of the learning group served as a record keeper for homeschool families and oversaw the learning group. This group was purposefully selected because the researcher already had a 2-year involvement with this group. This prior involvement allowed the researcher to establish the rapport necessary for gaining access to participants. The researcher recruited homeschool parents and guardians from within the purposefully selected co-op learning group as study participants. Participants were designated as “teachers” for their high school students. The teachers were parents or guardians who coordinated the homeschool activities for their high school students, whether teaching the students themselves or coordinating the child’s educational activities. In addition to being the teacher, participants were required to have at least one student who was taking at least one high school-level course.

The first phase of the research consisted of an open-ended, online questionnaire sent to the entire co-op. Co-op members who chose to participate were asked to answer questions about their teaching and learning strategies used in STEM education within the questionnaire. No identifying information was requested in the questionnaire, unless the participants volunteered for the second phase of the study.

The second phase of the case study followed the questionnaire with observations, interviews, and document collection from 10 homeschooling parents. Observations were conducted at a mutually agreed upon time, at a location chosen by the participant. The researcher observed the parent’s interaction with a typical STEM educational activity. After the observation, the parent was invited to participate in a follow-up, semi-structured interview and asked to volunteer documents, such as activity descriptions, assignments, and course syllabi, which pertained to the stated research purpose and question. These parents were assigned pseudonyms for data analysis and reporting.

To establish trustworthiness, the researcher triangulated the responses to the open-ended questionnaires and interview questions, field notes of

observations, and documents such as STEM assignments. Member checks were also conducted to establish credibility (Stake, 2010).

Context of the Participants

All participants for this research were active members of the same home-school cooperative learning group (co-op) within a community in the southern United States. The co-op is a group of homeschooling families who gather one day a week throughout the school year to teach courses to their students. The co-op offers a variety of courses, including science, math, languages, arts, and computer programming. During the week, students work on course assignments with their parents and then gather at the co-op to participate in labs, projects, or lectures to supplement what they learned that week. Families have complete choice over the type and number of courses they participate in at the co-op. There is no legal requirement to teach or complete co-op courses to homeschool in this specific state.

Twenty-nine parents and guardians from the co-op completed the open-ended questionnaire. These 29 participants collectively had 35 high school students. Six participants indicated that they had more than one high school-level student. From the open-ended questionnaire, 10 parents volunteered to participate in the follow-up procedures. All the 10 participants were the mothers of their students. Each participant had either one or two high school-level students. Cara, Anna, Susan, Alisa, Casey, and Dottie (pseudonyms) all had two students taking high school-level STEM courses. Glenda, Cheryl, Lacy, and Deb (pseudonyms) each had one high school-level student. All the mothers in this sample were using the co-op for at least one STEM-related course.

Presentation of Findings

Throughout the analysis of the data collected, four main categories arose that were directly connected to the purpose and research question. Each category dealt with a different broad type of teaching strategy used by the parents in this study within a homeschool learning environment. The first category speaks to the individualized nature of teaching and learning. The second category deals with the extensive use of self-directed study as a teaching strategy. The third describes the use of collaboration within the homeschool environment, and the fourth category examines the use of application and connection strategies used by parents with their students. Each of these categories is expounded individually in the following sections.

Individualized Instruction

The category of individualized instruction refers to ways that homeschool parents in this study often customized both the curriculum as well as instructional strategies, depending on the needs of their student. Parents were cognizant of the methods that promoted learning for their student and then used those methods to provide customized instruction for their students. This individualized instruction often led to students using specific resources to meet their learning and instructional needs. Parents used a mix of instructional methods, combining resources such as video tutorials, hands-on learning through manipulatives and experiments, and textbook readings and homework problems to customize the exact learning pathway taken by their students. For example, Deb, in her interview, commented that at first her daughter was using DVDs for math instruction; however, Deb realized that her daughter understood math better by reading and taking notes instead of listening to a lecture.

This same type of thinking was repeated numerous times in both questionnaire responses and interviews, as parents stated that they first assessed what the learning needs were for their students before determining the best strategies and resources to meet their needs, thus creating individualized instruction for their students. Parents were observed discussing with their student the types of activities from which the students would learn best and creating customized schedules for the work students would complete. The following excerpts taken from both interviews and questionnaires demonstrate this individualization and customization:

She would rather read something on her own than have it lectured or read to her. She likes to read it, re-read, take notes, understand it. She has a process of learning.

If I see a “gap” in learning or understanding, we try to figure out a resource, be it a person, a hands-on experiment, a website, etc. to “see” how the concept works.

When resources became available to me, I made the decision on what would best fit that child and their learning styles.

These quotes show how parents seek to understand their student’s learning style and customize instruction to meet specific instructional needs.

Within the main category of individualized instruction, two specific types of teaching strategies emerged in the data analysis that further reflect this category and exemplify in greater detail how parents customized learning

pathways for their students. These two subcategories are mastery learning techniques and one-on-one tutoring. These two subcategories are discussed in further detail below.

Mastery learning techniques. Mastery learning techniques refer to teaching strategies that encourage students to master material before progressing in the curriculum. These types of teaching techniques emphasize the need for students to truly understand the concepts rather than simply move through a textbook or assignment for the sake of completion (O'Connor, 2011). Parents who used these types of techniques were more focused on their students true understanding of the material rather than finishing a textbook or giving a grade. In this way, students continued to receive individualized instruction based on the concepts or problems they were struggling to understand. Parents seemed to emphasize this type of learning, especially when it came to science and math courses.

Mastery learning techniques translated to the use of different activities and strategies in a homeschooling environment, as evidenced across multiple sources of data. In observations, interviews, and subsequent document collection, parents documented how they had students to correct items on homework and tests and instructed them on how to go back and relearn material they had missed. Documents also showed how students spent time correcting notes and homework problems for missed conceptions.

In the interviews and questionnaires, parents also discussed the need for students to understand material and not just move through the curriculum, as seen in the following excerpts:

Don't just do the assignment to get it checked off, but understand what you are doing.

If something's going on, instead of cramming everything all in, we can work with him a little bit and hopefully make it easier to really learn the material instead of have a cursory look at something and then move on."

[Child's name] wants to have a deeper understanding, he doesn't want to just survive. That's why we sort of dive deeper.

These excerpts demonstrate parents' commitment to helping their student understand content in the learning process.

One-on-one tutoring. A major instructional activity in which parents were working directly with their student or had hired an expert in the subject to

provide tutoring fell under the category of one-on-one tutoring. Almost every respondent to the questionnaire listed “tutoring” or “one-on-one” tutoring in some form as one of the main instructional activities their child participates in on a regular basis. In multiple observations, parents were seen acting as the tutor for their child through activities, such as leading them through a hands-on experiment, going over math problems and missed test items, discussing material from previously watched lectures and given through co-op courses, and going over questions from assignments and in preparation for tests. In these observations, the tutoring instruction given by the parent was directly related to what the student was struggling with or what the student needed during the session. These tutoring sessions again reflected the use of individual, customized instruction for each student.

Self-Directed Study

Another strategy parents used in STEM education with their high school students was self-directed study. Self-directed study refers to parents transferring the responsibility of learning onto the students, allowing them to make decisions about the amount of time they spend on subjects and the modes of instruction they use. As in the tutoring episodes described above, almost all respondents to the questionnaire listed the use of “self-directed learning,” “independent study,” or mentioned students assuming responsibility for learning. The following quotes from interviews display how mothers viewed the use of self-directed learning in encouraging their student to become independent learners:

I guess I hope that it [self-directed learning] creates an independent nature so when she goes to college, she'll be a little more self-driven instead of just having someone there all the time telling her what to do, when to do it, and how to do it.

I'm not truly a teacher because in order for her to be educated, she needs to learn how to educate herself.

I mean, the kids have to be responsible for their own education. . . . You know, that's what the ultimate goal is by the time they leave is that they own it and are ready to do it.

Each of these excerpts demonstrates that parents wanted their children to be able to learn independently and saw independent learning as a goal of education.

In promoting self-directed learning, parents commented that they encouraged students to research and pursue topics of interest and seek answers to questions on their own, before approaching the parent for help. Casey described a wonderful incident of self-directed learning in STEM education in which she allowed her two students to construct their own desktop computers. The boys had to research the parts they would need—the cost of those parts and how to correctly assemble the pieces to work together. As their teacher, Casey even chose to give the boys course credit for the research and work they did in building the desktop computers because, as she stated in her interview, “I think that’s STEM.” Although other participants may not have had students building computers, they still encouraged students to seek information and take responsibility for their own learning. Lacy stated, “It’s not necessarily that we expect them to know everything, but the expectation is they will work hard to learn what they don’t know.” Dottie, too, focused on her role in providing her children the necessary resources for learning: “For me it’s showing her how to go out and find the resources herself. . . . Go figure out a way to do it.”

The use of self-directed study as a teaching and learning strategy led to the incorporation of multiple types of activities within homeschooling. In questionnaire responses, parents mentioned that students worked independently on textbook readings, homework problems, and worksheets. Parents were observed making schedules for their students and then telling them to complete the work on their own. The documents collected also displayed the types of schedules parents produced for their students, which then allowed the student to work independently at his or her own pace. In fact, in some instances, parents were observed having little to no interaction with their high school students, allowing the student to work independently.

Collaboration

Collaboration within the homeschool learning environment was also a prominent STEM teaching strategy used by participants. Within the initial questionnaire, multiple parents listed “collaboration” or “collaborating with others” as one of their primary teaching strategies. When further data were collected from observations and interviews, the researcher realized that collaboration within a homeschool environment took on two distinct forms. The first was students collaborating with other students, which is typical in most educational environments. However, the second type of collaboration was a student collaborating with his or her parent to both learn and construct knowledge together. In these situations, parents were working with their students as they both sought to understand concepts and material together.

To promote peer collaboration, parents chose to send their students to different groups, activities, and clubs that met throughout the week in which the students had an opportunity to work with and learn from other students. The primary example of this collaboration was the co-op classes and labs that students attended on Fridays. Participants also remarked in the questionnaire and interviews that students participated in tutoring groups, which consisted of a small group of students under the direction of a tutor, to learn material and work on projects together. Other occasions of peer collaboration were community club-related activities in which students participated. Although multiple technology and science clubs were listed by participants in this study, many had students who were actively involved with a Boosting Engineering, Science, and Technology (BEST) Robotics team for home-school students that was led by a father in the co-op. Parents saw the robotics team as an opportunity to collaborate with peers in a setting that promoted STEM education through the integration and application of math and engineering principles.

Besides arranging collaboration opportunities with peers, observations and interviews revealed that parents themselves spent time collaborating with and learning alongside their children. In the questionnaire, multiple participants reported that they use family discussions and conversations to promote learning. Parents were observed spending time reviewing material with their students, looking up and discussing answers together, and performing a lab together prior to discussing the results. They were also seen working practice problems alongside each other and discussing the steps they took to reach the answers. These situations were not restricted to parents teaching students or correcting wrong answers. Parents, instead, acted as a guide and a coconstructor of knowledge within the learning environment, exemplifying collaboration. In fact, many times the students appeared to be helping their parents understand the material better as they both worked together to gain a deeper understanding.

Application and Connection

Alongside the teaching and learning strategies that have been discussed above, homeschooling parents made the application and connection of knowledge a priority in their students' learning. Participants wanted to ensure that students see how schoolwork is relevant and applicable to "real life" and demonstrate to students how concepts and learning are connected across specific subject domains. This appreciation of application and connection also led parents to search out activities that would enable their students to apply what they were learning (e.g., the robotics team). As Casey commented, "It's

[robotics team] being able to do some hands on project where you see the math and the engineering come together to make a thing that does something, some task, has been wonderful beyond words helpful.” Parents also listed numerous hands-on labs and field trips as ways they promote connections between and application of concepts.

Another way that parents promoted application and connection was to work learning into everyday life. Homeschooling parents in this study were continuously seeking ways to bring learning and education into what they do naturally every day. Casey mentioned that she had some moldy bread that she used to teach her sons biology concepts. A participant on the questionnaire said his or her family discussed the physics concepts of levers while they were outside working with shovels and wheelbarrows, while another said his or her family used a home automobile repair project to discuss mechanics. Deb mentioned that, when her yard was overtaken by a specific species of caterpillars, she had her daughter research and learn about caterpillars and their lifecycle as a biology lesson. Alisa summarized this application of learning in her interview when she stated, “When we go anywhere, it doesn’t matter, so if I see something I’ll stop and just tell them ‘This is what you saw, this is what you learned.’”

Discussion of Findings

The research question that guided this study was, What STEM teaching and learning strategies are used by parents or guardians in a homeschooling environment? In response to that question, this study determined that parents, who participated in this case study, used a very individualized and customizable approach to their students’ education. This approach to teaching relies on understanding the needs of students and using the best resources and educational activities to meet those needs. Along with customizable instruction, parents often use mastery learning techniques, which promote student understanding of material and engage students through one-on-one tutoring, both with the parent and with experts in the community. Mastery learning, which falls under the behavioral view of learning, involves breaking information into small pieces and requiring students to demonstrate mastery of a set of information before moving onto the next set (Ertmer & Newby, 2013; Ormrod, 2008). This same pattern of instruction was seen with homeschooling parents who required students to relearn material and correct or retake tests to demonstrate mastery.

Parents in this case study also relied heavily on self-directed study in STEM education, a teaching strategy that transfers the responsibility for learning under the direction of the student rather than the parent. Parents

monitored their students' progress, sometimes creating schedules for their children to follow but, ultimately, they sought to produce independent learners who could read, practice, and seek information on their own. This led to educational activities that included reading, watching videos, researching, and completing practice problems. While promoting students' independent learning, a component of individual constructivism (Ormrod, 2008), students were also participating in educational activities, such as direct lectures and lots of repetition which are framed by behavioral learning theories and informational processing (Woolfolk, 2007).

Collaboration was also an important teaching and learning strategy incorporated by parents in their students' education. This strategy included collaboration activities with peers through homeschool community activities, such as co-op courses, small group projects, and clubs. This strategy also incorporated collaboration with parents in which parents were seen actively guiding and constructing knowledge alongside their students. Both these types of collaboration point back to social constructivism. Peer interaction and collaboration are necessary for the construction of knowledge in a socially mediated setting, and collaboration with adults allows students to actively construct knowledge through the assistance and guidance of the adult learner or more knowledgeable peer (Ertmer & Newby, 2013; Ormrod, 2008; Vygotsky, 1978, 1980).

The application and connection of information in STEM education were also the specific instructional strategies used by homeschooling parents in this case study. Many parents commented that they wanted their students to be able to see how what they were learning in their studies applies to their everyday life. Parents promoted this application by incorporating learning into everyday life, by using hands-on application activities, by participating in STEM clubs and robotics, and by using real-life examples to help their children grasp concepts. Again, parents were observed helping students construct knowledge in real-life settings, which is promoted by both individual and social constructivism (Piaget, 1976; Vygotsky, 1980; Woolfolk, 2007). By helping their student apply and connect information to the students' knowledge of the world, parents promoted components of the information processing theory of learning by making learning meaningful (Schunk, 2008).

Implications and Recommendations

The findings for this investigation have implications both for those families choosing to homeschool and those who are outside the homeschool communities, especially those who may be providing resources and support for

homeschooling parents and guardians. This study reveals some of the teaching and learning strategies that a purposefully selected group of homeschool parents used in STEM education. The methods and strategies found in this study help provide insight to other parents within the homeschooling community who may be seeking new strategies and ideas for educating their high school students. This study also serves to inform those outside of the homeschool community of some of the types of teaching strategies and activities used by some homeschooling families.

This case study also has direct implications for those who are providing resources and support for homeschooling parents. Curriculum and resources in STEM education for homeschooling families should allow for flexible, customizable instruction with the inclusion of multiple types of instructional activities. Any provided curriculum should have practical applications and rely on real-life examples, incorporating familiar equipment for labs or other activities. Resources should help parents and students see connections between disciplines, especially the relationships among the components of STEM. Resource providers should also be aware that some homeschooling parents will be learning alongside of and in conjunction with their children; therefore, resources should be geared to promote that relationship and to provide necessary background information for parents.

Since this research only investigated parents within a purposefully selected community in the southern United States who all participated in the same learning co-op, further research should continue to examine the teaching strategies used by homeschooling parents in different communities, states, and countries. The results detailed here may not be generalizable to all homeschooling parents; therefore, research should also investigate how the community in which homeschool families are actively involved affects the teaching and learning strategies used by parents. Since all the parents in this case study participated in the same co-op learning group, their strategies may have affected their relationships within the community. Further research should expand on exactly what homeschooling entails and how parents use teaching and learning strategies to fulfill the role of teacher for their students in areas outside of STEM education as well.

Conclusion

With the increase in the number of homeschooled children and an increase in the availability and access to resources, research has shown that homeschool parents are diversifying the methods and activities they use with their students (Hanna, 2012). With this diversification comes the need to investigate what teaching and learning strategies parents use in a homeschool

environment, specifically as they relate to STEM education, a lacking component of the homeschool research literature.

The purpose of this case study was to examine the STEM teaching and learning strategies used by a small, purposefully selected group of homeschooling parents of high school students. Results demonstrate that parents often use individualized instruction, which they customize based on their students' needs and available resources. This individualized instruction relies on one-on-one tutoring and the use of mastery learning techniques to maximize student understanding. Parents also promote self-directed learning, encouraging students to take responsibility for their own learning. Other instructional strategies used in STEM education include the collaboration of students with peers and the collaboration of students with parents, as well as the application and connection of information.

Further research should continue to investigate homeschooling parents and their use of instructional strategies in other communities and locations, both in the United States and internationally, to expand on these results and continue to define homeschooling. This research and future studies will continue to provide information necessary for understanding homeschooling as an educational practice as well as provide necessary information for the development of resources to support homeschooling parents.

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