

Successful Online Learning: What Does Learner Interaction with Peers, Instructors and Parents Look Like?

WHITNEY KEATON

George Mason University

wgarret2@gmu.edu

ANDREW GILBERT

George Mason University

agilbe14@gmu.edu

The student perspective in research of K-12 online and STEM education is largely absent but is important for understanding how both of these areas can come together to best serve students. This study used teacher ratings, school data and student interviews to investigate the perceptions students in online STEM courses have of their past and current educational experiences. Using an adaptation of Moore's Framework of Interactions (Moore, 1989), the academic and extracurricular behaviors of these students were examined in relation to their interactions with others, specifically instructors, parents, and peers. It was found that the interactions that students have with these stakeholders are different in this setting as compared to a traditional learning environment. Teachers in online schools serve the role of a facilitator that students felt was important to their success, but was not their only source of instruction. Parents took on many roles in this setting, including monitoring, motivating, instructing and organizing. Learner-learner interaction looked the most different compared to traditional schools because these participants generally had little interaction with peers due to time and distance constraints. Implications of these findings for students, schools, education, and research are given.

While distance and correspondence education in various forms has been around for over a century, online education as we know it today is a fairly new phenomenon. It started in the late 1990's because of some state and federal mandates to introduce more online and blended learning (Barbour, 2014), but since has taken an important seat at the educational table, particularly during the current pandemic. These schools started as public institutions but have since expanded to many public and private offerings throughout the country and were present in 48 states within the past decade (Hawkins, Graham, Sudweeks & Barbour, 2013). Most public school districts across the nation are providing some type of virtual learning for credit recovery, students with health needs, and many other reasons (Archambault, Kennedy, Shelton, Dalal, McAllister, & Huyett, 2016). According to the 2015 Keeping Pace Report, hundreds of thousands of students are enrolled in full-time online schools, while millions are taking supplemental online courses in addition to attending a physical school (Gemin, Pape, Vashaw, & Watson, 2015). The current Covid-19 pandemic has highlighted virtual education in a way that has never been done before and made it a viable and necessary option for many making it important to study further. While the methods of delivery can vary between different online schools, the access and flexibility that these schools provide has the potential to fill a void in the current education system.

Information or data about the perceptions and experiences that students have in online STEM courses could explain what is and is not working to identify possible solutions. Students' voices are important to tell us how they feel about their educational experiences and what works for them. Most current research in these areas focuses on school structures (Means, Wang, Young, Peters-Burton & Lynch, 2016; Peters-Burton et al., 2014; Roblyer, 2008), teachers' perspectives (Borup, 2016; Bruce-Davis et al., 2014; DiPietro, Ferdig, Black, & Preston, 2010), or parent involvement (Borup, 2016; Hasler-Waters & Leong, 2014). While researchers have started to look at the students' perspective (Borup, Chambers, & Stimson, 2019; Hawkins et al., 2013; Kim, Park, Cozart & Lee, 2015; Oviatt, Graham, Borup & Davies, 2016; Turley & Graham, 2019), there is little in the current literature about online education specifically from the student voice and this is important for us to be able to build strong programs (Waters et al., 2014). Finding information from all stakeholders is important because it can help us to develop knowledge that can make these areas of education more robust.

BACKGROUND

The types of interaction framework developed by Moore (1989) provides a foundation for discussing behaviors and interactions in online settings. He explained that there are three types of interaction in distance education: learner-content, learner-instructor, and learner-learner. Learner-content interaction is when students have internal discussions about the information they encounter in the course or elsewhere. Learner-instructor is the most commonly understood interaction and involves instructors stimulating student's interest of what is being taught. This type of interaction also involves helping students organize and self-direct their learning, so this could also be expanded to students' interactions with advisors/mentors. Drysdale, Graham, and Borup (2014) looked at a *shepherding* program at an online high school that paired each student with an online mentor to help facilitate their learning and communications. They found that this relationship involved many of the characteristics that Moore included in the learner-instructor relationship, such as building caring relationships, understanding student backgrounds and facilitating content interaction. In addition to mentors, it is also essential to online education to look at the interactions that learners have with their parents. Hasler-Waters and Leong (2014) described the changing parental role in online education to include organizing, motivating, and monitoring and Borup (2016b) explained that parental involvement is important to student success, so learner-parent interactions should be included when exploring important interactions in online education.

The last type of interaction described by Moore is learner-learner interaction. This is essential for learning and is an important skill for students' future involvement in society (Moore, 1989), and while it is difficult in online education, it is important to incorporate. Moore's types of interactions can be a basic framework to pull from when discussing types of behaviors in online education. This study will look specifically at the interactions that online students have with others humans, namely instructors, peers and their parents.

The Handbook of Research on K-12 Online and Blended Learning (Kennedy and Ferdig, 2018) explained that the existing research does not adequately support the effectiveness of online schools and more research in this area is needed. Current projects like the "No Significant Difference (NSD)" research being done by the National Research Center for Distance Education and Technological Advancements (DETA) compile studies that look at characteristics of effective online education in order to help with closing any gap between virtual and traditional education. These types of projects are a step in the right direction and this study can add to that body of knowledge. One area that needs more answers is attrition rates; high attrition rates

are a troubling fact of online education and the reasons that this needs to be identified (Turley & Graham, 2019). Also, determining how successful students behave and interact differently than those who are not as successful is an important piece of this puzzle, since much of the research in this area has solely used quantitative data on student performance and retention. In addition to these quantitative approaches, there has been considerable qualitative work to find teachers' and parents' perspectives, but students' voice can be an important addition to this area of research to help better understand student success in online schools. Learning more about student perceptions and behaviors will help to enrich online programs and assist students to be more successful in an educational setting that is becoming more popular each year.

Despite data and public perceptions that shows less success or no significant difference in K-12 online education, programs like NSD and other current trends due to the upswing in online education because of the pandemic give us reason to be optimistic about online student achievement. The outlook for success in online education is encouraging. Kim et al. (2015) conducted a survey study of 100 students in an online mathematics course at a virtual high school and examined the performance and effort regulation of the students. They observed that online education and traditional education are now largely considered equal, but supporting online students' effort regulation is important to helping them succeed. A meta-analysis compiled by the U.S. Department of Education in 2009 came to a similar conclusion of success (Means et al., 2009). It found that on average students in virtual learning environments performed modestly better than their traditional school peers. This study did have limitations since many of the participants were only taking online courses that are supplemental to their traditional coursework. While they found that students taking all or part of their classes online performed better, this result is not generalizable to the larger online learning community and creates a need for more research in fully online high schools as will be done in the current study. Also, it is important to note that many traditional school programs are recognizing the essential role of online learning in our society and have begun to make online courses a requirement for high school graduation (Borup et al., 2013). Archambault et al. (2019) found that "nearly all school districts across the nation are providing some form of online education" (p. 304).

While there is research that shows promise in this field, there are also some studies that show that online performance indicators are lagging behind. Michigan's *K-12 Virtual Learning Effectiveness Report* discovered that the data collection process for evaluating online school effectiveness is concerning because of the lack of consistency in the naming of these programs and the way that schools mark their virtual enrollments (Fre-

idhoff, DeBruler, & Kennedy, 2014). The National Education Policy Center reported that of the three states that use Adequate Yearly Progress (AYP) to indicate how well they meet state standards, only a few of the virtual schools met the AYP targets (Miron & Gulosino, 2016). They also found that data for other effectiveness, such as graduations rates and standardized tests, were difficult to collect, but when available often showed that online schools were trailing behind traditional schools on these measures. Stanford's CREDO report also showed that the study's 158 online public charter schools, compared to traditional counterparts, had significantly weaker academic growth amongst their students (Woodworth et al., 2015).

Research in the characteristics that make online schools and their students successful is emerging. It is essential that online schools are designed using evidence-based practices. Black et al. (2008) stated, "due to the general public's distrust of distance education, curricula for online learners must equal if not exceed the quality of those in use in traditional environments" (p. 33-34). Teachers in virtual education often have to prove themselves in a way that a traditional classroom teacher never would. This needs to be done through a high degree of presence by the teacher, so that students, their parents, and all other stakeholders are able to clearly see what and how the teacher is working with and for the students. A large part of being an online teacher happens behind the scenes, with prepping synchronous class sessions, grading students work, and creating the asynchronous content that makes up a good portion of these courses, so making sure that teachers are seen as available and necessary to student success is essential (Borup et al., 2014). This makes it even more important that researchers accurately identify how we can make this type of education compete with, or even exceed, its traditional counterparts.

Teachers must be able to make a connection with their students despite not being in person with them. To do this, teachers must be available to their students. While there are opponents that believe that technology impedes effective communication, with one specific concern being that there is a greater potential for misunderstanding in email communications (Thomson, 2010), the proponents of virtual schools claim that the communication and interaction is satisfactory (Belair, 2012). Turley and Graham (2019) discovered that the students they surveyed found teacher interaction to increase their satisfaction with the course. Interaction is important both academically for student achievement, and also socially for student satisfaction with the school.

A common reason for attrition is the lack of social interaction and isolation (Hawkins et al., 2013). Academic interaction is especially important between students and teachers for student satisfaction and success. Research has shown that teacher practices are most important factors in determining

student and school success (Belair, 2012). It is important that teachers are prepared to teach in virtual education with sound communication skills. In one study a survey was given to students at a virtual high school and showed that the quality and frequency of interaction between students and teachers impacted student completion rates (Hawkins et al., 2013). Interestingly, Borup et al. (2013) found the opposite correlation between learner-instructor interaction and completion rates. Because of the varying need for this type of interaction, just like in traditional settings, the extent of student and teacher interactions should vary with the degree of learner autonomy (Belair, 2012).

The Community of Inquiry is made up of teaching presence (design, facilitation and direction), social presence (ability of participants to project their personal characteristics to the community) and cognitive presence (extent to which participants are able to construct meaning through sustained communication). These factors allow the interactions that online teachers have with their students to be more clearly evaluated and defined because it breaks down the teaching, social and cognitive presence variables from previous research into more specific and measurable identifiers that take into account the whole student-teacher relationship. Borup et al. (2014) examined teaching presence and teacher roles by doing faculty interviews at an online high school. Using this data and the existing Community of Inquiry framework, they came up with a new construct for teacher engagement that includes additional teacher roles. This idea of teacher engagement found that teachers design learning activities, facilitate communication with students and parents, provide instruction, nurture a caring environment, and motivate and monitor student learning.

A meta-analysis of research from traditional education settings looked at the influence of parental involvement and found that parental involvement is associated with high student achievement (Jeynes, 2007). Parents' understanding of their role in their child's education is usually a result of the type of schooling they grew up with (Borup, 2016). While parental involvement is an important feature in traditional schools, it is especially important that this is investigated in online schools. Online learning is different from traditional education, not only in the physical distance and technologies used, but also in the roles that all participants are responsible for. Parents become facilitators or coaches for their child's learning. Teachers tend to be more of content experts, designers and facilitators, and parents become responsible for managing and guiding their children (Hasler-Waters & Leong, 2014). Borup et al. (2014) believed that "online teachers' motivational strategies can be more effective when supported by parents" (p. 802).

Borup (2016b) surveyed and interviewed teachers at a virtual high school about the roles of parents in the school. The findings framed the approach of the current study as it relates to students' utilization of support systems. He

found that helping students organize, motivating, and monitoring students topped the list of parental roles. Parent communication is also a necessary part of student success and parents can model this for their child so that they can better communicate with their teachers (Belair, 2012). Interestingly, Jeynes (2007) found that in traditional settings the subtle aspects of parental involvement, such as parental styles, had more of an impact on student success than the more demonstrative aspects of parental involvement, like parent attendance at school functions. Borup's (2016) findings show that the role of parents in online education is more geared towards the demonstrative aspects of parenting because of the distance between the student and teachers. In other words, parents have to play a larger role in the day-to-day actions of the students in an online setting. Both Jeynes' and Borup's findings made this important aspect of online education difficult to define and therefore make recommendations to parents, but Jeynes (2007) emphasized that "parental involvement generally improves the relationship between parents and teachers, which likely affects school outcomes positively" (Jeynes, 2007, p. 101).

Depending on the organization of the school, there may be on-site facilitators or advisors who support students in addition to the support that they receive from parents and teachers. Oviatt et al. (2016) surveyed K-12 students in an online independent study program at a large university to determine what supports they found to be important to their success. While parents topped the list, it was also found that on-site facilitators and mentors were important to the students. It was also found that students preferred to get help from local resources rather than online resources that the provider supplied. Borup et al. (2019) found that the majority of support for the students they surveyed and interviewed came from on-site facilitators rather than parents or teachers. Other resources in the community and within the school are also important and need to be utilized for students to get the best experience from online education.

There are some significant concerns about parental involvement that need to be considered. In Borup's (2016) study, teachers believed that overly engaged parents could act as an obstacle to their child's learning. As with most students in all learning settings, the types of necessary parent engagement will vary based on the student's needs, and some parents are unprepared or unable to provide the support that their student needs. Because of the decreased amount of synchronous contact students have with teachers, parents of online students have a new and different role than roles that they understand from their own experience in brick-and-mortar schools. Therefore, parents may need training and support to better understand their role as a facilitator or coach (Hasler-Waters and Leong, 2014).

Although learner-learner interactions were not found to be important for academic success, they are still a necessary part of an online school design,

learner satisfaction and decreased attrition. Borup et al. (2013) explained that social interaction is important because it allows students to see their instructors and peers as real people. Not being able to see others as “human” in an online environment can be a negative consequence of online learning, but when done properly, social interaction can avoid this consequence. In a survey done during Borup et al.’s (2013) study, 95% of the students said that learner-learner interaction was valuable to them. Hawkins et al. (2013) contended that isolation and disconnection were the biggest influences on disengagement and dropping out of online schools.

Students can interact in a variety of ways in online learning environments. Interviews of online teachers showed that online discussion boards were even more useful than face-to-face discussions in a traditional classroom because students could take time to reflect on their responses (Borup, 2016). Students not only collaborate within class, but also in extra-curricular clubs and even at in-person events hosted by the online school. These activities are important to student satisfaction and retention, leading to engagement which allows for success. Fortunately, virtual environments are often collaborative and require students to work together (Barab et al., 2000). Borup (2016a) found that students could interact to collaborate with one another, instruct each other, encourage one another or befriend each other, but with all of these positives, his interviews also showed that interaction could potentially lead to negatives such as bullying and cheating. Research seems to show that the positives of student interaction outweigh the negatives and with awareness of the potential negatives, hopefully online schools can mitigate them.

The student and school features that have been discovered in the literature are mostly related to behaviors of the students, and their support systems. It is important to hear from the students to find out more about what experiences students have throughout school and what behaviors they have that may, or may not, fit into what research has already found. Without specifically talking to students, we are lacking a big area of knowledge that can better inform online courses as they evolve in the future. Also, focusing on behaviors that can be taught and practiced is a tangible way to better inform the field. Cognitive skills are not the only requirements for success and students need to be active participants in their education and research in this field.

Based on the importance of online education in today’s educational system and the need for more information about interactions in online schools and how students can be successful, the research questions for this study were:

- What types of interactions do students have with their teachers, peers and parents in online STEM courses?

- Do these interactions contribute to their success in those courses?

METHODS

This study investigates the perceptions, experiences and behaviors of on-line STEM students comparing both high and low-achieving students. Data for this study was collected in the following three phases: teacher ratings, student interviews, and artifacts/classroom data. Twelve students were sampled for interviews and class artifacts based on relative success identified by teachers. Each student participated in an approximately thirty minute interviews. Samples of students' STEM classwork and classroom data about each participant were also collected.

Participants and Sampling

Students in grades 9-12 at a private full-time online high school, which is given the pseudonym American Online High School (AOHS) for this study, were invited to be the participants in this study. The students at this school are from a large variety of locations and backgrounds. Students invited to this study have been with AOHS for at least one full school year and most of the students have attended a brick-and-mortar school at some point in their school career. Some of the reasons students are in an online school revolve around an extracurricular endeavor that takes up a lot of their time and requires scheduling flexibility, while others have not found success at brick-and-mortar schools for a variety of reasons including learning disabilities, lack of appropriate challenge and bullying. The program at AOHS provides both synchronous and asynchronous learning opportunities. Students interact with teachers synchronously during live class sessions, at virtual help desks and during school hours via synchronous text chat. There are also daily asynchronous assignments and assessments for the students to complete in each course. Students interact with their peers during synchronous classes and in clubs that are offered by the school.

Mathematics and Science teachers at AOHS were asked to complete a rubric to identify the relative achievement level in STEM courses for each of their current students. At AOHS, there are only a few teachers in each content area. The teachers involved in this research included one science teacher who teaches mostly biology courses and science electives, one mathematics teacher who teaches the lower grades (8-10) in the Mathematics courses, and one teacher who was split between mathematics and science teaching higher level Mathematics courses and Physics. The teachers who assent to this were sent an online rubric in which they listed each of their current students. They then rated each of them using a scale of 1-4 on

six areas. The teachers were instructed to rate the students relative to one another and avoid giving all students the same score in each area. A four, for example, should only have been given to the top ten percent of students in any of the six areas. There was a total of 156 students rated between all three teachers with 67% of them being female students and the other 33% were males.

The scores on these rubrics were analyzed by averaging the scores for each student to create one overall rating per student. Because this study is focused on high school students, any student in eighth grade was removed from the list of potential participants. Also, because this study was done early in the school year and to ensure that students had some experience to reflect on, any student that was new to the school in that school year was removed. The average scores for all remaining students were then placed in order and split into evenly spaced groups of low, average, and high achieving students. Then, four students from each group were selected by purposeful sampling in order to maximize the variety of grades and genders. Race and other demographic data were not be able to be ascertained until students were already selected for the study, so those could not play a part in the sampling process.

Four high-achieving, four average and four low-achieving students were then invited to participate in this study. These twelve participants are from varying grades (three 9th grade, two 10th grade, three 11th grade, and four 12th grade) and genders (seven male and 5 female). The total of twelve participants was selected because this is a grounded theory study in which theories need to be identified and a study done by Guest, Bunce and Johnson (2006) showed that saturation occurred with the first twelve interviews when they analyzed a total of sixty interviews. The only specific inclusion criterion was that they have been in the online high school for at least one year in order to make sure that they had a full year of online STEM courses to reflect on during their interview.

Data Collection and Analysis

Interviews were scheduled with students to take place via Skype video or audio conference. The students use Skype to communicate with teachers, advisors and other students regularly, so they were familiar with using this media. Each interview was recorded and started with an explanation of the study. An interview protocol was followed but the interviews were semi-structured and allowed for flexibility to discover any emergent concepts. Each interview lasted for approximately thirty minutes, but varied based on the students' answers and the topics that were discussed. Various school data about each participant were also collected using the school data base and teacher sources. This included time logged into their STEM courses.

es, percentage of synchronous STEM classes attended, and quarter grades. These data were entered into the spreadsheet along with the participants' teacher ratings from phase one.

In order to interpret the interviews and artifacts, analysis was done with open coding, using constant comparative analysis, to see what themes emerged. This method was chosen because it was anticipated that everything was not known that influences the success of these students. This was done through a constructivist-interpretivist lens because event narratives can change depending on the perspectives of the participants (Schwartz et al., 2013).

Interviews were transcribed and checked for accuracy by also sending them to each participant for member checking. Pseudonyms were assigned to each participant. They were then coded using an iterative process. Each interview was read to find any major themes that emerged or anomalies compared to the other participants. Open coding was then done to highlight areas of importance that emerge from the interviews. Areas related to Moore's (1989) three types of relationships were specifically looked for during this process. Each interview was transcribed and coded before moving onto the next one in order to incorporate new concepts into the next one (Starks & Brown Trinidad, 2007). Each interview was revisited after discovering new themes in the others so that anything possibly missed could be investigated. Once categories were identified within the interviews, axial coding was conducted using a "themes X data matrix" as described by Maxwell (2012) that lists the main research questions, categories and data that supports them. This allowed connections to be seen between the categories and develop themes among the data. The coding was reviewed by another researcher to further validate the themes and theories.

The school data collected were used to further deepen the themes found in the interviews and artifacts. This was done using exploratory data analysis in order to see if any trends emerged or if, instead, it was found that there are no correlations. This information was also added to the matrix and compared to the themes that have developed up to this point. While this is a qualitative study, some of this quantitative data is interesting and was included on a basic level in the findings of this study.

Limitations

There were some important limitations to this study that are necessary to consider. The sample size was small which means this is not generalizable. Along the same lines, the participants were a specific sample of the online education landscape at a setting with a fairly selective admission process and a high tuition. This could be considered a limitation, but most of the current research in online education has been done in cyber charter schools

which are public (Borup, 2016; Hawkins et al., 2013; Hasler-Waters & Leong, 2014). Since online private students are a population that has not been studied to a great extent, this study will add a necessary piece to the body of knowledge surrounding online education. In addition, this qualitative design will require students to self-report their demographics and behaviors, but triangulating with artifacts and school data will help minimize this limitation.

FINDINGS

Instructors, parents and peers all hold unique and important roles for students in online courses. The role of the instructor shifts to that of a content creator, course designer, and facilitator. Parents take on more of the day-to-day oversight and peer interaction is much less prominent than in a traditional school. Defining these roles and identifying their strengths and weaknesses can help build more robust online classrooms. All of these interactions will be discussed in detail with evidence found through these interviews.

Learner-Instructor Interactions

Moore (1989) labelled learner-instructor interactions to be one of the important interactions within an educational setting. In an online setting, learner-instructor interactions can be defined as any type of communication between a student and teacher or anyone who helps them with course content. This can include synchronous interactions like live classes and phone calls to asynchronous communications such as emails and feedback on coursework. Interaction in class with the teacher can help to create a connection for some while others said that the fear of having to interact preventing them from attending. This seems to go along with the self-efficacy of each student. Most students only reach out to STEM teachers outside of synchronous classes when necessary for clarification on an assignment. Only a few used the teacher as a resource to better understand the content.

Structured Synchronous Learner-Instructor Interactions

At AOHS, students had the opportunity to interact with their instructors during synchronous class sessions and in a variety of synchronous and asynchronous ways outside of those live classes. Participants said that they interacted with teachers during synchronous classes included, interactive games, problem solving and discussions using the chat box and via the microphone. Jaime talked about how interactive her math and science teachers are during synchronous classes and how she feels that interaction created a connection between students and teachers, “well, they both try to be pretty interactive. I know in my math class, he always does problems with

us and he's really interactive there, and he talks to everyone personally." Dawn likes that her teachers can give instant feedback during live lessons to help with confusing topics in her STEM classes. Some of the students interviewed mentioned that teachers who made class fun through these interactions encouraged them to attend class more often.

Unstructured and Asynchronous Learner-Instructor Interactions

The interactions that learners and instructors have outside of synchronous classes vary a bit more. Some interacted regularly with their STEM teachers, while others did not interact at all with them outside of class. Most of these interactions outside of class were for clarification of coursework rather than for help with understanding content. Christopher, a senior who wanted more challenge in his education, explained that he sometimes attends his teachers' help desk to get some enrichment and help better understanding content. Many of the students also cited using Skype or email to send similar questions to their teachers. While it was not mentioned often in the interviews, occasionally, a participant did use their teachers help for content understanding. For instance, Heather shared, "This week I did a lab in physics and part of my data was really off, so I went over it with my teacher and she helped me a little bit".

The time and distance issues in online education that can cause social isolation might also lead people to believe that students do not have easy and regular access to their teachers, but the data collected for this study showed the opposite. About half of the students interviewed mentioned that teachers in this online environment are accessible and was something they liked about the program. Sara compared this to her experience in a traditional school saying, "they cheer you on more than they do in a brick-and-mortar school." While teachers were not asked about their official availability, some of these students seemed to feel that teachers were not only accessible during the school day, but also outside of normal school hours. For example Damian shared, "All the teachers are very open and you can, most of the time, ask them questions at any time of the day, which is really nice." Teacher availability seems to tie back into the flexibility that students needed. While not every student interviewed relied on teacher support, they all liked knowing that when they needed to, they could contact their teachers and get a fairly quick response. This did not always mean these communications would take place during traditional school hours or by traditional means, but the teacher presence is still necessary.

Benefits and Drawbacks of Learner-Instructor Interaction

The two main areas in which students feel they benefit from teacher interaction in their STEM courses is to create a feeling of connection and also to make class more enjoyable, both of which could increase engagement.

An increase in student engagement in a course could have a positive effect on their overall success in the course, making these areas important to investigate. Mia explained it well when she said the following:

I kind of feel like we [the teachers and I] have a bit more of a connection. Obviously, there's only so much we can do, since we are homeschooled and everything is online. But, that kind of allows it to kind of feel like, 'Oh, I have a teacher. She's actually a person. I can talk to her.' It doesn't feel so distant.

The lack of socialization and resulting disconnection are central to understanding the learner-instructor interaction. The instructor seems to assume the role of a peer when it comes to the feeling of community. The engagement aspect of STEM classes and having student motivation can also be greatly affected by the interactions that learners have with their teachers.

It is important to note that of the twelve students interviewed, there seemed to be a connection between the number of online synchronous classes that students attended and the rating given from their STEM teachers. Of the top third of group, all of them attended at least 70% of the synchronous classes, with three of the four attending 100%. In the bottom third of the rating, with the exception of one student, they all attended less than 17% of the synchronous classes. The remainder of the students varied greatly in their attendance. This implies a possible relationship between students' overall success in a STEM class and the effort they put into this synchronous type of learner-instructor interaction.

A small number of those interviewed explicitly said that they did not feel synchronous teacher interaction was beneficial in these classes. Two students specifically said that they do not like to attend or participate in synchronous classes because of having to talk to the teacher or the fear of getting and answer wrong. For example, Evelyn said that she does not feel that live classes are helpful but it is important to note that she also explained that she has an outside tutor who helps with her math and science courses. This factor could be a big reason that her level of interaction with her teachers is low and she is still able to feel like she is getting the understanding she needs to be successful. Jerry, who mentioned that he prefers to have little social interaction, does not like to interact with his teacher during synchronous classes because he is concerned about getting the answers wrong. Sara said something similar about synchronous classes; she felt that being expected to interact during synchronous classes was a deterrent to her attending them live and she preferred to watch the recordings at a later time instead.

“Other” Instructors

In an online setting, the instructor can take on different roles from those in a traditional setting, but through these interviews it was found that multiple people can serve in the instructor role. This could include parents, tutors, or even advisors. Several students who were rated by their STEM teacher in the middle of this group mentioned working with some type of tutor for their STEM courses. This is interesting because these students did not utilize the teacher for this purpose, but still feel they benefit from the extra help. Dawn, a junior in high level STEM courses, gets help from a previous Biology teacher. This seemed to be someone with whom she had formed a connection with at her old school and was comfortable going to for help with science content. Heather and Ella both explained that they also prefer working with an in-person tutor rather than the teacher of their class. Heather explained, “I have a tutor that I see twice a week and she helps explain and do things with me in person that are more confusing.” Mia had struggled with mathematics classes in the past. This year she had been working with a tutor and that had helped her to significantly improve her grade.

The “other” instructors who supported students blurred the definition and role of the instructor in an online school. The interactions that learners have with their instructors seem to vary greatly for those who have tutors and those who do not. It is important to note that about a third of the students interviewed use a tutor for STEM courses as it is likely that this percentage is much higher than the students in a traditional public or private classroom.

Learner-Parent Interactions

Because of the lack of physical presence of teachers and classmates, parents’ roles change a lot in the online school setting. According to the interviewed students, parental involvement ranges from no to daily monitoring, but a majority of students indicated that their parents had little involvement in their school. When comparing this involvement with the teacher ratings of each of the students, there does not seem to be a trend with the success level of students and their parental involvement. Some students specifically said that their parents were not involved, such as Heather who explained that this is how her education has been since she was young. The other end of the spectrum was Sam who had daily parental involvement, especially with organizing and monitoring. Many others said that their parents were peripherally aware of their progress, but allowed them to be independent.

Parental involvement in this setting is exceptionally different from that of traditional education and parents can serve many different purposes depending on their own experiences and their child’s needs. Through these

interviews, the four areas that stood out as roles held by the parents were organizing, monitoring, encouraging and instructing. Each of these were experienced to different degrees by the participants, but each of these categories was evidenced by multiple students explaining examples of how they interact with their parents.

Organizing

During the interview, Christopher reflected on when he was not being successful in his courses and he mentioned that his parents sometimes help to come up with a strategy for doing better. This describes one of the many parental roles that the students mentioned. While it was mentioned by several, organization was the area that parents seem to assist the least according to the students. Only two students specifically said that their parents help with organizing their workload or structuring a schedule but others talked about this area in a vague way. Evelyn explained that her mom is home to help her with setting up labs for science and organizing her coursework. Simon, a senior who was rated as the lowest of the participants, was the only student who specifically said that this was an important role his mom played in his schoolwork. He said, "Usually in the beginning of the week, on Monday, she'll write down everything I have due for the week and then make sure throughout the week I'm getting that done consistently until I'm done with it." This level of parental involvement in the area of organization was far above and beyond what most of the other students' parents seem to do.

Monitoring

Monitoring their child's work is another way that parents seem to be involved in their child's schooling. This was the area with the highest level of involvement from parents according to those interviewed in this study. Only one student said that their parents never checked her grades. While the intervals at which it was done for the rest varied, all other parents checked grades on a regular basis. For example, Mia's parents only check her grades a few times a quarter, but it is something they sit down and do together. Both Evelyn's and Jaime's parents check their grades more regularly and talk to them about any grades that are low. This is an important parental role in most educational environments and this role might be seen in parents at a traditional school as well, but these students seem to be aware of their parents monitoring habits.

Encouraging

Most of the students cited their parents' encouragement being through talking about and planning for the future. Jaime mentioned that her parents often remind her, "Good grades are the key to the future." A few had consequences to their online schooling or extracurricular activities if they

did not succeed in school. For example, Craig said that his parents tell him, “this is what you have to do, and if you don’t do it, you don’t race.” Still other parents used external rewards to motivate them such as Damian who gets cash for good grades. Even those students who did not have a specific consequence or reward were able to cite an example of how their parents motivate and encourage them. Dawn’s parents are both doctors and she said they often encourage her to look into interesting topics making STEM classes interesting for her.

Encouragement from parents seems to be an important parental role in this setting but how that is defined varies by student. Each student was able to discuss this aspect fairly easily, even those who stated that their parents have no involvement in their schooling.

Instructing

The nature of an online school means that students are not physically with their teachers and do not always have immediate access to them. Because of this, sometimes other individuals play this role. In some situations, the parent is actually the first person that the students go to when they are struggling in class. While parents in a traditional setting might help their child with content understanding after school hours at home, this is usually secondary to the teacher’s instruction and does not take place during the school day in a brick-and-mortar school. Sometimes parents who are at home with students in online school are the first available person, they often serve in this role. Craig said, “I usually have question about something that I just kind of bounce it off them and see if they know anything before I ask the teacher.” According to the participants, most of the parents have served in the instructing role for their STEM courses at some point. While this seems to be fairly informal for most, it seems that students regard their parents as a resource they can go to for help with content when needed. One interesting example of this was Jaime whose mom helped her learn computer science over the summer just for fun. Mia and her mom have a similar relationship with their interest in research. She stated, “My mom also does a lot of medical research and stuff, so we are constantly looking up things and constantly finding new things to kind of debate over and things like that.” Dawn’s parents are doctor’s so they use their knowledge in mathematics and science to help her in class and expand upon what she is learning in class by suggesting additional topics and resources.

The Inconsistent Role of Parents

While most of the participants in this study were able to think of an example of their parents involvement in their coursework, there was no consistency of how involved they were or the roles that they fulfilled. Because of the unique nature of the interactions in this school, parents can and do

hold a variety of roles. The traditional role of a parent blurs into that of the teacher and peer at times. Without a clear definition of what this role requires, parents and students can be left to guess at how the interaction should look and this could be detrimental to the student's success. Because parents are often new to this type of education, they may not understand their role and this could lead them to have too much or too little oversight of their child's schooling. Many parents, just like students, also have time constraints that prevent them from being able to properly carry all the weight of the learner-parent interactions necessary in an online school.

Learner-Learner Interactions

Students at an online high school are often in a different location than their peers. With this and the fact that students at this school are often busy with their many extracurricular activities, it was found in this study that learner-learner interactions are not as prevalent as they would be in a traditional school. These interactions could take place academically, such as during synchronous classes, or socially, like at in-person school events. While the frequency is less and these interactions look different than brick-and-mortar school, most of the students interviewed are happy with the amount of social interaction that they get at this school and also socialize with students outside of the school. For those who have made connections through the school, they feel it helps them want to stay at the school.

Academic Learner-Learner Interactions

Synchronous classes were one way that students could interact with their classmates about the content in their STEM courses. For students that attend synchronous classes, they interacted through the chat box and in breakout rooms with their peers. These interactions tended to be related to encouraging one another or working together to better understand content. Jaime felt that chatting during class helped answer questions or share thoughts on the topic. Jerry, who did not come to this school looking for social interaction, also liked to work with his classmates, specifically in breakout rooms, during synchronous classes. He mentioned that he feels his peer interactions have always been positive. Simon was surprised at how he benefits by this learner-learner interaction during synchronous classes, "with all the other students in that class with you, they're asking questions that you might have not known to ask, or things you might have actually not understood that you thought you did." Some students also used the chat box to encourage one another. This not only helped the students feel more comfortable in their class, but also helped students feel more connected to one another.

Most participants mentioned discussion boards when asked about asyn-

chronous interaction with peers, but their participation seemed to be motivated largely because these activities were graded assignments. Two of the higher rated students mentioned using Skype to interact with classmates related to class. Dawn said that she and her friends have a study group via Skype. This seems to be an interesting spin on the learner-learner interaction that is more similar to that of the brick-and-mortar model than most of the others that were mentioned.

Social Learner-Learner Interactions

There are various virtual and in-person social opportunities for the students at AOHS, and some participants also mentioned engaging in social interaction with their peers in more informal ways. Most social interaction for these students happened through clubs at the school and social media. These social interactions seem to be positive for the students who have chosen to take part. For instance, Dawn found that her membership in the National Honor Society allowed her to make friends with other members. She mentioned that the connections she has made through this club have also allowed her to create some academic connections and find friends who she can work together with on coursework. In addition to the virtual interactions that Dawn has with her peers, she also attends some in-person gatherings and interacts via social media. This level of learner-learner social interaction was not the norm among the students interviewed. Most said they had minimal social interactions with others through club Skype group chats or an occasional in-person event. In contrast, Jerry was surprised by the amount of social interaction available. He left his old school because of some social issues and came to this school so that he would not have to interact with peers, but has found that the experience is more positive here. Others, like Sara and Heather, said that they had made a couple close friends at the school that they communicate with regularly via various social media.

Benefits and Obstacles of Learner-Learner Interaction

For the students who have taken advantage of the various means of peer interaction available to them, most felt it was beneficial by providing help with coursework and social connectedness. A few students felt that interactions with classmates helped them with course content because they can share ideas and resources during synchronous classes, but social connectedness was the more common way that learner-learner interactions could help students in this school. While these social interactions may not help with their success in class directly, they could help students be more satisfied with the school and possible help retention of these students. The online school environment is unique and not something that many other stu-

dents their age have experienced. This can make it lonely without having some connections within the school. Simon said it well when he stated, “it’s someone who’s in the same situation as I am in terms of school, so it’s kind of easier to relate to them and stuff.”

While some of the students either worked to have and maintain interactions with their peers, others did not come to this school expecting it to be possible and were pleasantly surprised at the opportunities. However, several students said that they did not find this interaction to be beneficial academically and chose not to make an effort in this area. For those who wanted more of academic or social interactions, many of them said it was not realistic for them because of time or distance constraints.

Craig stated that “there’s probably some really cool people that I could have been friends with over the years if I just talked to people. But unfortunately, I’ve just been so busy that I haven’t been able to really do anything.” He believed that the time that he commits to his extracurricular activities in addition to the time he spent on school, left little to no time for social interactions. There were several other examples like this in the participants that were interviewed and this is not surprising since their commitment to an extracurricular activity outside of school is often the reason for choosing this school. Distance was another reason that a few students mentioned for not being able to have more interactions with peers. While the school does offer some in-person events, many of the students live all over the country or even internationally. With lack of socialization being such a common criticism of this type of school, it is unfortunate that students who desire these interactions are not able to access them.

IMPLICATIONS

Having a better understanding of the perceptions, experiences, and behaviors of online STEM students with various level of success leads to a better understanding of online education than we currently possess. Much of the research done previously in online schools was not content specific and does not look at the student perspective, rather looked at teacher perceptions (i.e. Borup, 2016a; Drysdale et al., 2014) or overall online school models and best practices (i.e. Freidhoff et al., 2014; Waters et al., 2014). This study contributes to the operation, pedagogy and nature of interaction for students enrolled in online learning contexts. These implications are essential for online educators to best meet the needs of their students.

Implications for Practice

In order to best serve the students who are taking STEM courses at these

schools, we need to understand who they are and how they are most successful. The results of this study demonstrate pathways to improve courses in online setting and provides insight to others in similar contexts. With the concern of high attrition rates in these schools (Turley & Graham, 2019), students are currently not being adequately served and companies could lose money as a result. If we better know who is taking these courses and why, we can make sure the course designs better fit their needs. Teaching presence in Garrison et al.'s (2000) Community of Inquiry Framework includes course design as an important component so that could be a focus of online instructors as they look for ways to increase learner-instructor interactions. Online educators can determine what the behaviors of the successful students look like and develop programs and courses to encourage these behaviors.

Like their traditional counterparts, online schools have the task of preparing students for their courses. Many students, parents, and teachers tend to have more experience in traditional in-person education and we know that the same things that work well in traditional classrooms do not necessarily translate to success in online classrooms (DiPietro et al., 2008). This study identified the behaviors that are not only necessary for success, but that are unique or more important to learning in online environments compared to in-person learning. Schools can then better prepare students from the onset of their online school careers to make these behaviors a habit and potentially lead to increased student success in STEM and better online school retention. One area that online school may consider is to increase opportunities for students to interact with their teachers and peers. This may increase student satisfaction and may lead to higher engagement and therefore, higher levels of learning.

The changed role of parents in online education is not well-defined, but it is this study indicated that the role of parents is vital for student success. The parental role needs to be studied further and more clearly defined. This role may vary by school model and even based on student needs, but there are some areas that parents will have to participate in this type of school where they did not need to in a traditional setting. Hasler-Waters and Leong (2014) suggested that parents may need to be trained in their new role. Oviatt et al. (2016) explained that they found online schools were providing parents with materials to assist their child in these learning environments. This seems like a straightforward solution, but since parents are often not aware of this role or may be resistant to changing the way they interact with their child, some incentive may be needed. A clear and uncomplicated training or professional development for parents could be offered by the school with a tuition break as an incentive for completion. This could help student success and would likely avoid many of the frustrations that parents and

students have getting used to the new setting. If this was done properly, this could even increase retention which is a win-win for all stakeholders.

Implications for Research

In general, expanding online schools in the educational landscape could allow for more choice by families to find what is best for their unique situations. Learning more about what works in these schools and what needs to be improved gets us one step closer to this being an option that more people could consider. In the field of STEM specifically we need to better understand how students learn in these areas, so research focused on STEM learning is important to take place in all settings. Sahin (2013) argued that it is important to prepare students for future demands in STEM which could positively impact society and the economic welfare of our country. Once we know more about both online and STEM learning, it can be tailored to different settings, specifically to online settings.

Other areas of research that still need to be done in online education are the roles of individuals and attrition. An area that was not consistent was the role of the various human interactions in this school. It was clear that these interactions are different from traditional schools and not all students felt they needed or wanted the same types or levels of interactions. For example, it was found that the interaction and involvement of parents was very inconsistent among the students in this study. This was in part due to the parents' abilities and expectations, but was also a function of the students varying need for their involvement. It is important to not assume that teachers, parents, and peers serve the same function that we have always been used to. Being able to further investigate these roles would allow schools to better support these individuals in these changed responsibilities. It is also essential that more research is done in the area of attrition. The inconsistency in the way attrition is recorded and measured for online schools creates a problem in studying this, but it is the biggest concern for student success and satisfaction and needs to be addressed. Researchers have an opportunity to address many of the concerns of stakeholders and help schools avoid this economical and learning loss by learning why students are leaving and how they can better be retained.

CONCLUSIONS

The research in the fields of online and STEM education is growing. While this research begins to answer some important questions, it also raises some concerns. For example, Waters and Leong (2014) explained

that some people think of online school as glorified home schools. With the growing student population in these schools, it is vital that they are clearly defined and differentiated from homeschooling and correspondence schools of the past (Miron & Gulosino, 2016; Waters et al., 2014). Additionally, more of the student perspective in both of these areas could give a more well-rounded view in the literature. Through student interviews, this study looked at experience and behaviors in online STEM courses including how learners interact with the human stakeholders involved.

Teachers in online schools are important to students' success, but in online learning environments are responsible for different aspects of students learning than in a traditional setting (Drysdale et al., 2014). They still create content and facilitate student learning through synchronous lessons, one-on-one assistance and grading coursework, but they are involved with less of the day-to-day tasks of students, such as monitoring their coursework (Borup et al., 2019). Many of these interactions are fulfilled by other stakeholders, such as parents, peers and tutors (Borup et al., 2015; Borup, 2016b). The participants in this study explained that they had opportunities to interact with instructors during synchronous classes, through Skype for individual questions and via email. Not all students found this to be necessary or beneficial but a large amount of the students felt that teachers at this school were readily accessible.

Parental roles in online education are different from the roles that parents hold in traditional education (Borup et al., 2015; Borup, 2016b). Given that most parents went to a traditional school themselves, parents often do not understand this new role clearly. Student reported their parents involved in their schooling at a variety of levels, but the most common way parents were involved was through monitoring coursework. Participants also described their parents helping in the areas of encouraging, instructing and organizing. Because of the lack of definition of this role, online schools would be well served to incorporate some parental guidelines and trainings to help students be more successful in this setting.

The interactions between learners and their peers in the online setting were found to be pointedly different from those in traditional settings (Turley & Graham, 2019). Student reported a much lower amount of interaction with peers than any other group of people. While they were able to cite examples of ways they could interact in class and a few reported some social interactions through clubs and social media, only a few of them felt this was an essential part of their school experience. At the same time, most of them said that the lack of socialization was a drawback of being at online school, but felt they did not have the time in their schedule or distance impeded their ability to have these types of interactions.

The growth of online education could benefit many students who have unique situations requiring flexibility or do not currently have access to high

quality education. Even before the current worldwide pandemic, online education was an emerging player in the educational landscape and improving current and future schools and courses of this type could benefit many students.

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