STEAM EDUCATION

Accessibility, Availability and Equity in Northern New Mexico

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STEAM Education:
Accessibility, Availability, and Equity in Northern New Mexico

An Interactive Qualifying Project
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ABSTRACT

Students in northern New Mexico lack accessible, available, and equitable opportunities for STEM education compared to the rest of the country. The goal of this project was to assist the Northern New Mexico STEAM Coalition in the procurement and analysis of STEM course data to create a baseline understanding of the factors that can hinder students from receiving such an education. Our findings show that factors such as inexperienced educators and limited access to STEM course offerings have led to low proficiency rates in math and science, and that these factors have only been exacerbated by the pandemic, which has also created additional barriers. Our deliverables included an assessment framework, a website, and a survey to evaluate informal STEM programs.

EXECUTIVE SUMMARY

Introduction and Background

STEM education is becoming increasingly more important as the number of STEM careers continues to grow. The number of STEM occupations in the United States is projected to increase by 8% from 2019 to 2029 (Employment in STEM occupations, n.d.). Careers in the STEM field will continue to grow, and STEM education plays a crucial role in preparing students for the workforce.

Schools that offer a curriculum and programs based in science, technology, engineering, and math consistently demonstrate higher test scores. A recent study shows that students who attend STEM-focused schools perform higher in math and English assessments (Scott, 2012). However, students in northern New Mexico face challenges in receiving an accessible, available, and equitable STEM education. Factors such as inexperienced educators, limited course selection, and social and financial obstacles have led to some of the lowest proficiencies in math and science seen across the country. Only thirty-one percent of students in New Mexico met the mathematics ACT College Readiness Benchmark and twenty-eight percent met the science benchmark in 2016 (ACT, Inc., 2016). Feeling that something needed to be done to improve their children's education, parents have filed lawsuits against the state such as Yazzie v. New Mexico. While the judges have ruled that the state has failed to provide students, especially those who are low-income, English language learners, and at-risk, with a sufficient public education, evidence of improvement is lacking (Martinez v. New Mexico Timeline, 2019).

There are two main ways that students may engage in STEM subjects: formal STEM education and informal STEM education. Formal STEM education involves traditional education that is taught in the classroom provided by trained educators within schools. Formal education in the US is typically provided by charter schools, selective schools, and comprehensive public schools. Each school has its own way of providing a STEM education, some categories of STEM curricula are STEM-focused, specialized STEM courses, and Career and Technical Education (CTE).

Informal STEM education refers to the extracurricular programs and activities that help students learn and develop curiosity in science, technology, engineering, and mathematics. Students participating in these programs are given the opportunity to explore topics outside of a school's science curriculum as well as real-world applications for STEM. In New Mexico, some organizations that facilitate informal STEM education are the National Informal Science Education Network (NISE Net), the Institute of STEM Education of New Mexico (ISE NM), the Afterschool Alliance, and the PED Bureau of Math and Science. These organizations support STEM educators, provide resources to secure funding, and are connected with various STEM institutions throughout New Mexico.

The Northern New Mexico STEAM Coalition (NNMSC) is an initiative that is building a network of diverse stakeholders in seven counties, eighteen Tribes, and twenty school districts who are willing to share data and coordinate regional efforts to strengthen STEAM education in the area. The NNMSC has not collected or analyzed enough data to determine the current state of STEM education in northern New Mexico. We assisted the NNMSC, by procuring and analyzing data on STEM education in northern New Mexico in order to create a baseline understanding of the state of accessibility, availability, and equity among rural and non-rural schools in northern New Mexico. Due to the time and data constraints of this project, we focused on only the accessibility, availability, and equity of the science, technology, engineering, and math components of STEAM education. In order for education to be "accessible," it must anticipate financial, social, or technological barriers that students will face, and be proactive in creating ways so that all students can participate (Kyriakides & Creemers, 2018). Available education refers to whether students have the ability to have access to classrooms, courses, or materials within specific courses (Ibid). Equity is focused on providing individual students with the tools they need to thrive in the classroom (Equality vs. Equity, 2018). Equity along with accessibility is what happens when schools enable their educators to go the extra mile to give students the fair shot at the quality education they deserve.

Research Methods

To accomplish our goal, we:

1. Developed measurable definitions of accessibility, availability, and equity in the context of STEM education;
2. Examined, analyzed, and created a summary of key findings from the New Mexico Public Education Department (PED)’s STEM education data from the 2018-19 and 2019-20 school years;
3. Investigated the accessibility of learning formats of STEM courses in northern New Mexico for the 2020-21 school year

To complete these objective, we initially conducted research on assessment frameworks, contacted the PED with a data request, and carried out a survey of STEM educators from the seven northern counties. With the research and data we collected, we compiled a list of components that could be used to measure accessibility, availability, and equity for the first objective, and then integrated these components into our analyses for the second and third objectives for which we utilized descriptive analysis and thematic coding.

Findings

Through the analysis of data compiled for our objectives, we produced the following seven findings:

Finding 1: A simple and effective way to evaluate the accessibility, availability, and equity of STEM education from school to school is through a practical assessment framework.

Finding 2: Non-rural school districts offer more STEM courses than rural school districts by far. This trend is consistent when looking at AP/IB course offerings, total course offerings, and remedial course offerings with rural schools lagging in their offerings.

Finding 3: Wide-spread poor proficiency rates in math and science in northern New Mexican schools suggest that STEM education is inadequate. Enrollment figures for STEM courses strongly support this finding in all but a few charter/private schools.

Finding 4: The majority of school districts in northern New Mexico had mostly American Indian/Alaskan Native and Hispanic students enrolled, and the districts with a majority of Hispanic students enrolled typically had lower science and math proficiency rates.

Finding 5: For most of the school districts of northern New Mexico, the diversity of educators was not proportionate to the diversity of the students.

Finding 6: At least fourteen schools have chosen online learning for the 2020-21 school year and have reached a 1:1 ratio of student to learning device.

Finding 7: As many schools of northern New Mexico have turned to online or distanced learning, educators are struggling to ensure students are engaged as they adapt to new methods of course delivery.

Recommendations

In order to further promote accessibility, availability, and equity across northern New Mexico, we proposed recommendations designed to further the efforts of the Northern New Mexico STEAM Coalition and others.

Recommendation #1: The Public Education Department (PED) & Northern New Mexico STEAM Coalition should apply the STEM Education assessment framework across all schools within the northern counties.

Recommendation #2: The Northern New Mexico STEAM Coalition, experts in STEM Fields, and K-12 educators should work together to develop ways to provide students with innovative lessons in STEM education.

Recommendation #3: The Northern New Mexico STEAM Coalition should continue to run the Distance Learning Survey we developed with improvements.

Recommendation #4: The Northern New Mexico STEAM Coalition should sponsor another team from WPI to conduct research similar to what we have accomplished with the Higher Education Department (HED) STEM education data.

Recommendation #5: The Northern New Mexico STEAM Coalition should sponsor another team from WPI to study informal education’s impact on students’ interest in STEM in northern New Mexico and initiate the survey our team created.

Deliverables

Our deliverables include:

- an informational STEM education website (https://sites.google.com/view/steam-education-in-nnm); and
- several infographics.

The website is designed for stakeholders and others interested in our final project to view all of our findings on one platform. The website includes our findings, recommendations, infographics we created, our framework assessment, ArcGIS maps, and final report.

Our infographics displayed information on measuring accessibility, availability, and equity in STEM education, access to highly qualified teachers, inadequate secondary STEM education in New Mexico, and benefits and examples of informal STEM education. These infographics are included on our website and serve to be an understandable and engaging way to display some of our findings.

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Our team would like to thank…

- **Our sponsor Jennifer Case Nevarez of the Community Learning Network** for her enthusiasm for the improvement in STEM education and sponsoring our project.
- **Our faculty advisor Seth Tuler** for his constant guidance and support throughout the entire semester.
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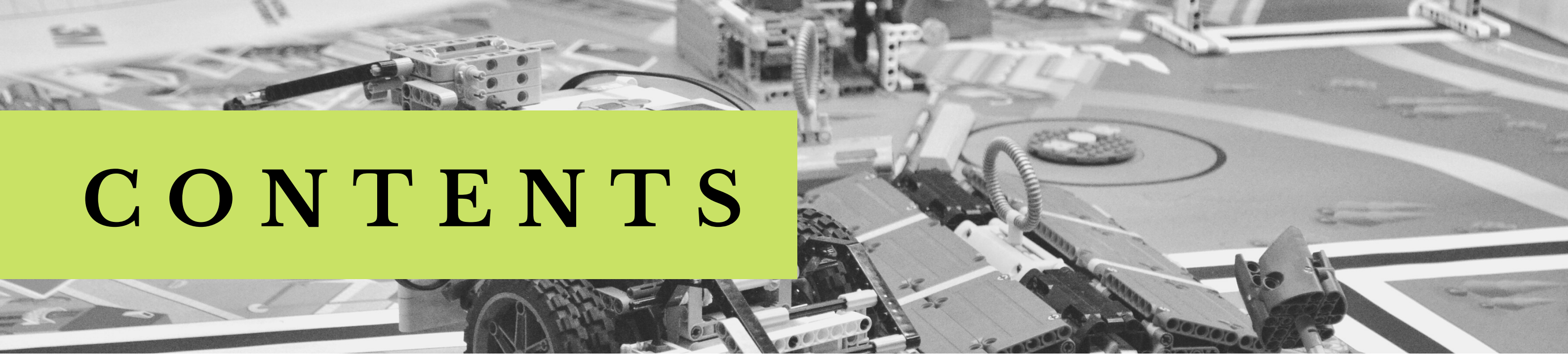
- **The educators of northern New Mexico** who provided our team with invaluable responses to our distance learning survey.
- **Worcester Polytechnic Institute** for continuing to provide students with the opportunity to make a difference abroad despite the challenges of the COVID-19 pandemic.



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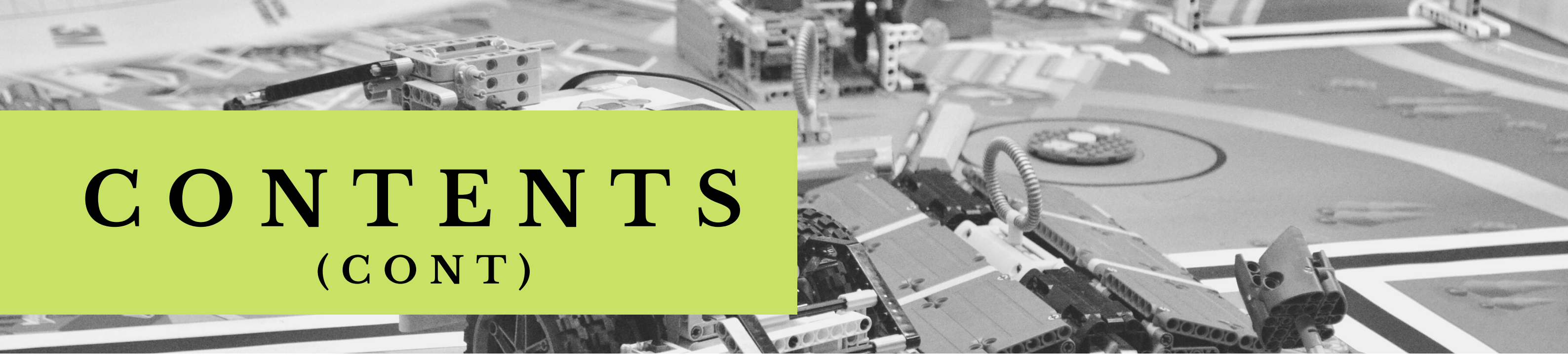

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ABBREVIATIONS & ACRONYMS

Acronym	Definition
AP	Advanced Placement
CLN	Community Learning Network
CTE	Career and Technical Education
HED	Higher Education Department
HQT	Highly Qualified Teacher
IB	International Baccalaureate
LMS	Learning Management System
NNMSC	Northern New Mexico STEAM Coalition
PED	Public Education Department
SFIS	Santa Fe Indian School
STEAM	Science, Technology, Engineering, Art, Math
STEM	Science, Technology, Engineering, Math

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1. INTRODUCTION

As society evolves, scientific and technological issues increasingly dominate the national discourse, from debates on climate change to concerns regarding genetically modified food and the use of vaccines (Smithsonian Science Education Staff, 2013). New advancements in medicine, genetics, energy, and communications directly affect our everyday lives making it critical that as consumers and citizens we are able to make informed opinions regarding these topics if we are to fully participate in developing society (Ibid.). A rounded education in STEM subjects can provide the foundation of knowledge needed to become involved in these conversations. STEM education is defined as "an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering and mathematics in contexts that make connections between schools, community, work, and the global enterprise enabling the development of STEM literacy…" (Goldhaber et al, 2014). Students studying STEM contexts also learn skills such as adaptability, social skills, complex communication, non-routine problem solving, self and group management, and systems thinking through group activities, laboratory investigations, and various projects (Bybee, 2010).

Students from communities in northern New Mexico face challenges in the accessibility, availability, and equity of STEM education across their school districts. In 2016, only thirty-one percent of students in New Mexico met the mathematics ACT College Readiness Benchmark and twenty-eight percent met the science Benchmark (ACT, Inc., 2016). Both benchmark metrics exhibited decreases from the 2015 report which shows that the proficiency of students of New Mexico in STEM is not making any improvements. Barriers including lack of proper instruction, cultural influence, poverty, and gender and racial stereotyping are affecting students' interest in STEM education and only growing worse during the COVID-19 pandemic (Berwick, 2019; Castleman, 2014; Dee, 2017).

Efforts have already been made in northern New Mexico to address the challenges in overcoming barriers in an accessible, available, and equitable STEM education. For example, in the midst of the COVID-19 pandemic, the Northern New Mexico STEAM Coalition (NNMSC) is offering online resources for students and their educators to continue their STEM education at home through their STEAM hub (n.d.). These resources range from walkthroughs of experiments to guides on how to create video lessons. Although one sponsor of the NNMSC, The Los Alamos National Laboratory Foundation, works to promote racial and social equity among STEM programs, students are still facing these challenges in the classroom. An ongoing court case decided that New Mexico came short of meeting their constitutional obligation to provide an equal opportunity public education free to oblige the rights of students. This is the Yazzie v. New Mexico case, and it returned to court a second time in an attempt to close the case only to be kept open as the state of New Mexico failed to improve education sufficiently to satisfy the aforementioned constitutional obligation (Martinez v. New Mexico Timeline, 2019).

The goal of this project was to assist the Northern New Mexico STEAM Coalition in the procurement, management, integration, analysis and reporting of STEM education data in order to create a baseline picture and understanding of STEM education, access and equity among rural and non-rural schools in northern New Mexico. To accomplish our goal, we completed a series of individual objectives:

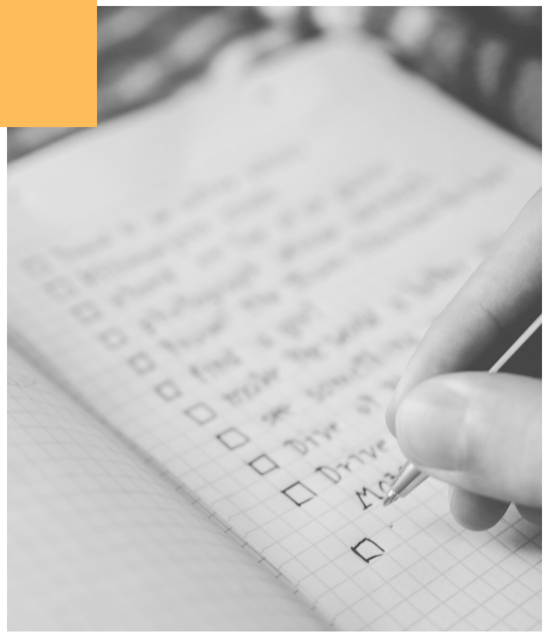
- Develop a measurable definition of accessibility, availability, and equity in the context of STEM education
- Examine, analyze and create a summary of key findings from PED STEM education data from the 2018-19 and 2019-20 school years
- Investigate the accessibility of learning formats of STEM courses for the 2020-21 school year.

At the end of the project, we provided the sponsor with the following deliverables: an informational STEM education website (https://sites.google.com/view/steam-education-in-nnm) and several infographics.

2. BACKGROUND

In this chapter, we discuss the relevance of STEM education in the United States, how it is obtained in northern New Mexico, how it is assessed, and factors that affect it. Because STEM education can improve critical thinking and problem solving skills, a focus on making quality STEM education universally accessible, available, and equitable can support the goal of improving the state of New Mexico's STEM education programs.

2.1 Goals & Importance of STEM Education



The United States Committee on STEM Education created three goals in 2018 for the future of STEM education in the next five years (Committee on STEM Education of the National Science & Technology Council, 2018):

1. Build strong foundations for STEM literacy by ensuring every student has the opportunity to master basic STEM concepts and become digitally literate;
2. Increase diversity, equity, and inclusion in STEM and provide all Americans with access to a high-quality STEM education, especially those in groups which are underserved and underrepresented in STEM fields; and
3. Prepare the STEM workforce for the future by creating authentic learning experiences that encourage and prepare students to pursue STEM careers.

These goals capture the range of the purpose of our project and reflect the types of skills and knowledge needed for the nation to grow and develop in an increasingly science- and technology- driven world.

The importance of these goals is confirmed by findings from academic studies that consistently show the value of a rounded STEM curriculum in early education to create active and productive thinkers (Executive Office of the President, 2014). For example, schools implementing STEM curricula and programs have shown higher test scores in their students as well. In a recent study that focused on the characteristics of STEM-focused high schools in several regions of the United States, it was found that "students who attended STEM-focused high schools outperformed their peers in mathematics and reading or English on end-of-course assessments" (Scott, 2012). An integrated STEM curriculum can become another approach to solving current world issues, such as energy efficiency, environmental quality, and resource use (Bybee, 2010).

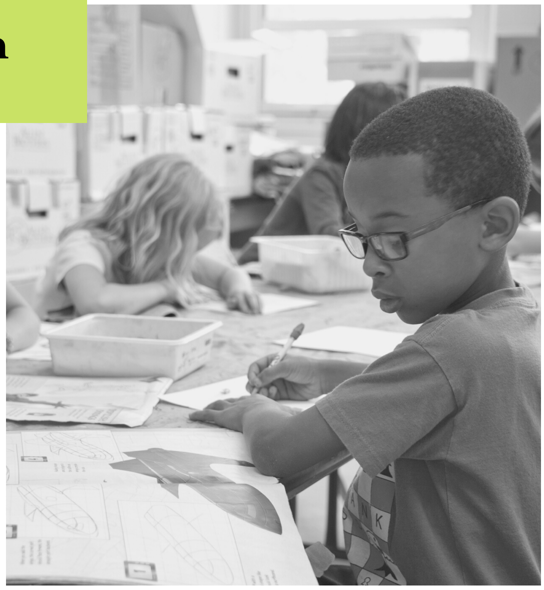
STEM education is also paving the way for more careers in these fields. It is projected that there will be an 8% increase in the number of STEM occupations available from 2019 to 2029 (Employment in STEM occupations, n.d.). As the STEM industry continues to grow in importance, careers in these fields will continue to increase, and STEM education plays a significant role in preparing students to seek job opportunities in the industry.

2.2 Ways to Access Available STEM Education

There are two main ways STEM education can be accessed by students:

1. Formal STEM education involving traditional education that is taught in the classroom within schools and
2. Informal STEM education consisting of after-school and out-of-school programs that students can participate in outside of school hours.

2.2.1 Formal STEM Education



Formal education occurs within classroom settings and is provided by trained educators. In the United States, there are several types of schools from which students can obtain a variety of teaching styles, curricula, and learning opportunities. These include: *charter schools*, *selective schools*, and *comprehensive public schools* (U.S. Department of Education, 2019). When considering a commitment to studies in STEM subjects, schools can be further categorized as being *STEM focused*, offering *specialized STEM programs*, or featuring *Career and Technical Education (CTE) programs*. In the following paragraphs, we will look into defining these types of schools through the analysis of three schools within northern New Mexico.

Charter schools are those which operate independently from many established local and federal regulations that apply to traditional public schools. Within these schools, parents, community leaders, and education entrepreneurs are given the freedom to provide students with an innovative, custom education of increased opportunity (U.S. Department of Education, 2019). For example, in Rio Rancho, New Mexico, the ASK Academy's status as a charter school makes it possible for educators to stimulate grade 6-12 students' interests in the STEM career pathways of biomedical sciences or engineering and design through courses such as genetics, pharmacology, microbiology, and others that are not offered in the traditional school setting (Career Pathways, n.d.). Lessons from the academy immerse students in a unique course experience through project based learning, guest speakers, field trips, lab exercises, and small animal dissections (About ASK, n.d.).

Selective schools tend to have a much more vigorous selection process requiring that students meet specific qualifications (NSW Department of Education, 2020). The Santa Fe Indian School (SFIS) is a selective school established by the federal government in 1890 initially meant to assimilate Native American children. Today, their purpose has changed to provide native children with an education that addresses the standards set by the state of New Mexico and Common Core, and to provide students with lessons in the ten elements and core values common to most native communities (About SFIS, n.d.). Their selective admissions process is based on the percentage of a student's native American blood, current transcripts, letters of recommendation, and scores from an entry exam. Unlike the ASK Academy, SFIS does not offer a strictly STEM-focused curriculum. Instead, students are immersed in courses relevant to their environment in New Mexico through programs such as Agriscience. Through this program, students are partnered with local and Indigenous community members to incorporate field-based lessons on the design and management of agriculture systems (Agriscience, n.d.).

Comprehensive schools are possibly the most common type of formal education, in which anyone is allowed to attend. Usually run by the local education authority, these schools do not have any type of selection process or enrollment based on exam scores (What are the different types of schools?, 2017). In addition to offering common STEM courses such as biology, chemistry, algebra, and precalculus, these schools may also offer STEM CTE programs. The goal of a CTE program is to prepare students for STEM-related careers, often with the broader purpose of preventing students from dropping out through increased engagement (National Research Council, 2011). This goal is typically achieved by providing students with the opportunity to explore, select, and define a STEM career or field of interest and develop soft skills. Northern New Mexico has multiple comprehensive public schools with programs such as that of Santa Fe High School. Their mission is to provide their students with a "visionary, innovative, and positive learning environment" in STEM that is accomplished further through courses in computer science, culinary arts, and engineering courses that can spark students' career interests (Career Tech. Ed., n.d).

2.2.2 Informal STEM Education

Informal STEM education refers to the extracurricular programs and activities that students are able to participate in outside of regular school hours. While participating in these programs, students learn and develop curiosities in science, technology, engineering, and mathematics through various hands-on learning projects in topics that go beyond what is taught in their school's curriculum. Three major effects of participating in STEM programs and extracurricular activities are an increase in participants' interest in STEM careers, an improved ability to draw connections between school work and its applications in daily life, and an improvement in STEM-related skills (Baran, et al., 2019). Shown in Table 1 are examples of the major contributors to informal STEM education in New Mexico.

Table 1: *Major Informal STEM Programs in New Mexico*

Organizations	Description
Cafe Scientifique	"Run by teens for teens," Cafe Scientifique offers the general public academically unconventional venues like cafes, theatres, libraries, etc. for scientists to come and discuss a wide range of scientific studies, subjects, and topics.
Girls Who Code	"On a mission to close the gender gap in tech," Girls Who Code is an organization devoted to providing women computer science education through both in-person programming lessons and online resources and programs. While it has a few locations in New Mexico, it has reached 300 million people globally through its online resources, campaigns, books, and advocacy.
NM Mesa	NM MESA is a pre-college program that prepares students for college and careers in STEM related fields by supporting middle and high school programs for students.
RoboWAVE	RoboRAVE is a robotics program that teaches participants the fundamentals of designing a robot to perform a multitude of tasks. The program also serves as an international robotics competition for teams to test their robots in different events.

2.3 Measuring STEM Success

Measuring how well STEM education is implemented in school curricula requires clearly defined metrics to identify how the inclusion of STEM curricula impacts student performance. A large-scale study on identifying effective approaches in STEM by the National Research Council of the National Academies identified a set of metrics divided into the categories of outcome based criteria, criteria based on school type, and criteria based on school level practices and instruction (2011; Table 2). These categories were used to assess the equity, accessibility and quality of an education effectively within the scope of our project.

Table 2: *Our Utilization of NRC Educational Metrics*

Criteria	Data	Usage
Outcome Criteria	• Grade distributions • Proficiency rates • Enrollment in advanced courses	To comparatively assess the success in implementation at each school relative to other schools at a glance
School Type Criteria	• Charter/private vs. public schools • School size • Location (rural vs. urban) • Grades taught	To explain trends seen in analysis of outcome based criteria based on demographics, available resources, etc.
School Level and Instructional Practice Criteria	• Course scheduling (quarter- vs. semester- vs. trimester-based) • Average class size • Choice of LMS • Implementations of technology • Lecture delivery methods	To link trends found with school type criteria to most probable exact causes of these trends

These criteria cover a broad enough scope to account for all factors that can affect the successfulness of a STEM education while still sorting these factors discretely enough to allow for trends to be identified. These trends are largely identified through a sequential process:

1. Outcome based criteria are established as they can be determined using readily available educational data such as that from standardized testing, transcript records, course catalogs, etc..
2. School type criteria are used to identify trends that exist in the outcome based criteria, for example: rural schools trend towards having lower enrollment in advanced courses
3. School level and instructional practice criteria are used to identify the specific causes of the trends found when utilizing school type criteria. To continue the previous example, it may be found that rural schools have smaller class sizes which prevent advanced courses from being feasible to offer, explaining why such a trend was evident.

This process was used to develop the STEM framework discussed later in this paper.

2.4 Factors Affecting Accessible, Available, and Equitable STEM Education

On July 9th, 1868, the 14th Amendment of the U.S. Constitution was ratified as one of three Reconstruction Era amendments passed to establish civil rights for all persons of color. Section I of the Amendment prevents states from creating or enforcing any law "which shall abridge the privileges immunities of citizens," and from "depriving any person of life, liberty, or property" (The 14th Amendment, n.d.). Today, the 14th Amendment is interpreted to ensure that when a state establishes a public school system, no child can be denied equal access to this education based on their race, ethnicity, religion, sex, citizenship, or socioeconomic status ("Your Right to Equality in Education," n.d.). However, in New Mexico, lawsuits such as Yazzie Martinez v. New Mexico have been filed against the state for violating the rights of low-income, English language learner, at-risk students, especially Latinos and Native Americans, through the failure to provide them with a sufficient public education (Martinez v. New Mexico Timeline, 2019). In this section we discuss the factors that can affect the accessibility, availability, and equity of education for the students of northern New Mexico including: inexperienced educators, limited course selection, social and financial obstacles, and the COVID-19 pandemic.

2.4.1 Inexperienced Educators

In the United States, the challenge currently faced by many school districts is staffing classrooms with educators who are qualified in the core STEM subjects (Goldhaber et al, 2014). Major causes of this national shortage stem from several factors including a reduced number of incoming certified STEM teachers, the inability to retain certified STEM teachers, and the lack of systematic professional development (Hutchison, 2012). Figure 1 shows that the percentage of national school-level STEM vacancies is nearly triple that of those in English and Social Studies.

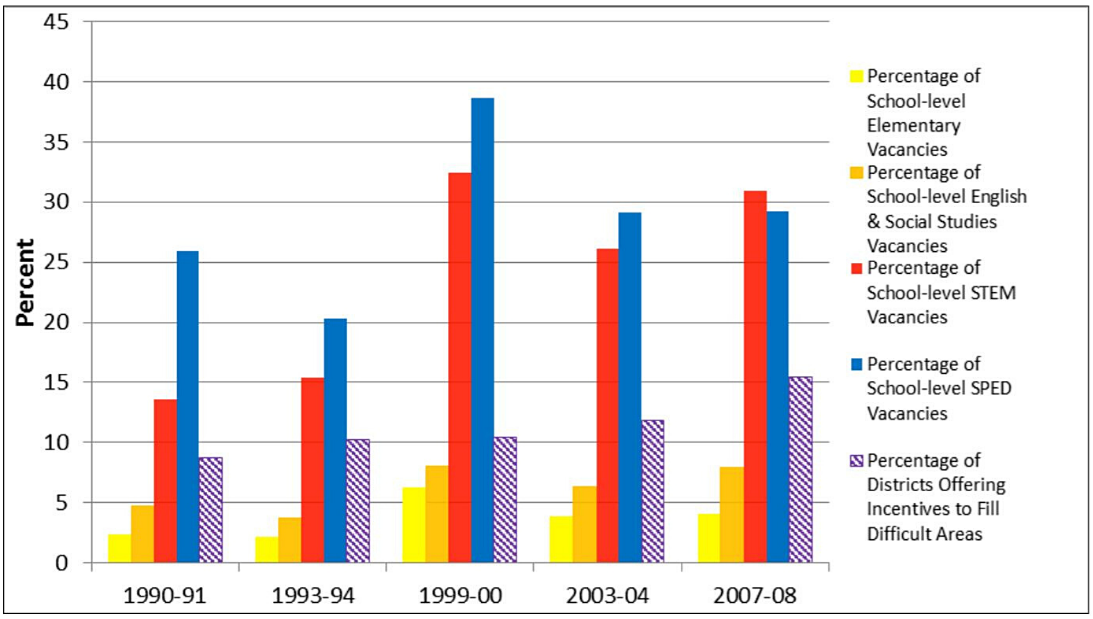


Figure 1: *Percentage of difficult-to-fill teacher vacancies over time, from Goldhaber, Krieg, Theobald, & Brown's "Why Don't We See Better Alignment Between Supply and Demand?"*

According to the 2001 reauthorization of the federal Elementary and Secondary Education Act (ESEA), the term "highly qualified teacher" (HQT) is defined as a teacher who holds (1) a bachelor's degree, (2) state certification, and (3) demonstrated subject matter knowledge. Under this act, states are also required to develop equity plans meant to ensure that poor and minority children are not disproportionately assigned to be taught by unqualified, inexperienced, or out-of-field teachers (Wayne et al, 2017).

Recent data from the Public Education Department (PED) in New Mexico shows that in 2020, the number of classrooms missing a teacher fell for the first time in three years. However, this trend coincides with a rise in the number of educators with a bachelor's degree stepping into classrooms without any prior teacher training (Ulloa, 2020). The reasoning behind this: in order to fill vacant positions, the PED is offering two- to three- year alternative teaching licenses to college graduates lacking degrees in education. These temporary teaching licenses are meant to help these graduates get their foot through the door of the school while they pursue online courses in education (Ibid). According to PED data, there were a total of 466 teachers on alternative licenses in 2014 and this has since increased to 2,352 in 2020 (Figure 2).

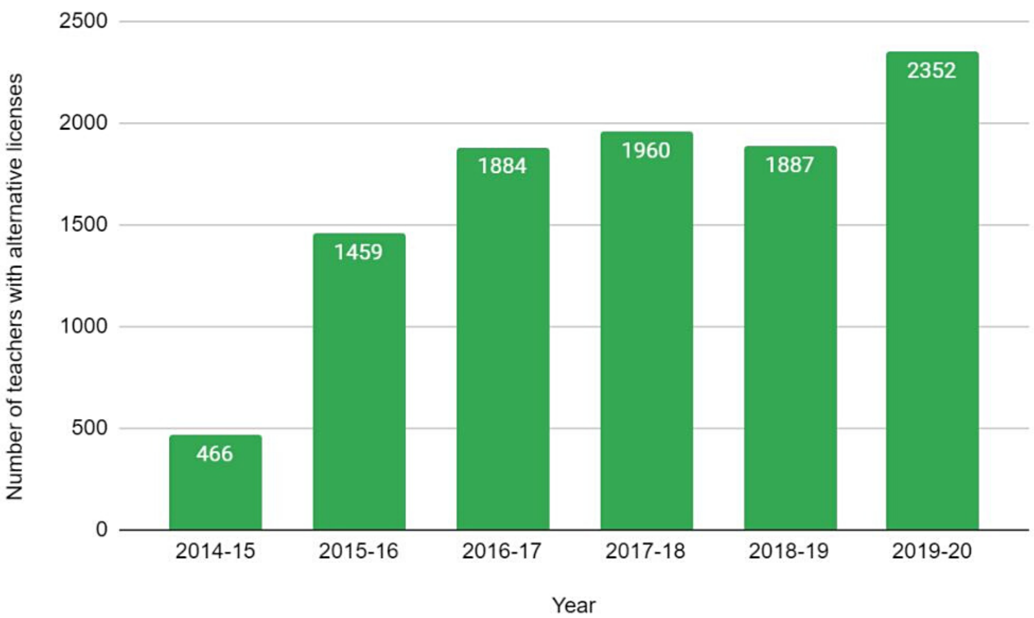
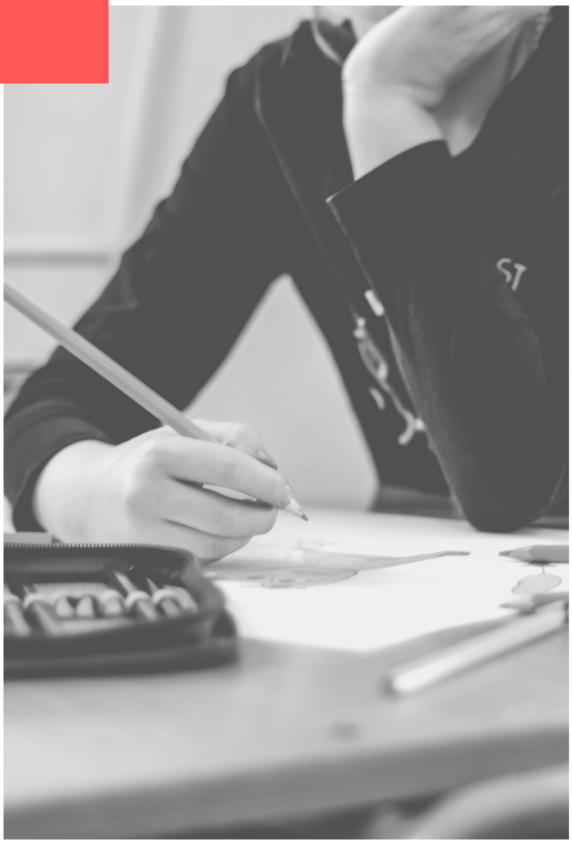


Figure 2: *Number of teachers with alternative licenses vs. Year, adapted from Ulloa's "Teacher shortage deeper, more complex than vacancies suggest", 2020.*

This temporary solution however, is unable to address educators' lack of background in classroom management, lesson planning, and forming relationships with students. While alternative licenses fill this critical need to replace teachers who retire, leave the state, or just up and quit, many incoming teachers stated when interviewed by Ulloa that they do not feel prepared for completing daily tasks such as taking attendance or grading, and need further development in their classic teaching skills (Ulloa, 2020). In school districts such as Hatch Valley Public Schools, where 95% of the students are considered at-risk and require intervention in order to successfully graduate high school, the amount of educators on alternative teaching licenses is nearly double that of schools in non-rural areas. Without confidence in the ability of their educators to provide an engaging education, these at-risk students may become hesitant to enroll in certain courses and complete only the bare minimum of their graduation requirements (Blackley & Howell, 2015). By not providing students with educators who have prior experience or supplemental knowledge typically provided in teacher preparation, schools have marked their students at a disadvantage in obtaining an accessible, available, and equitable education.

2.4.2 Limited Course Selection

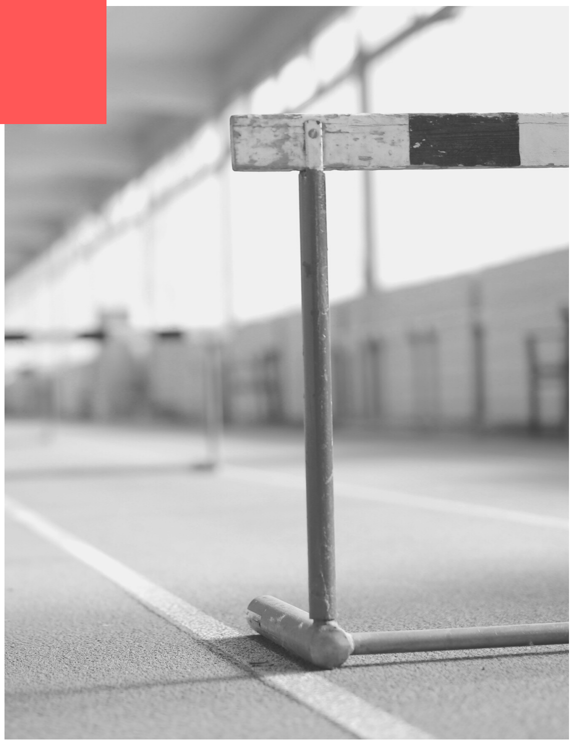


It is now standard practice for the majority of American schools to offer more challenging courses such as Honors level classes in their curricula to benefit students who excel in normal courses and invite more complex classwork. Additionally, many schools also offer a level of courses above these still in the form of either Advanced Placement (AP) or International Baccalaureate (IB) courses, or in some cases both. While the number of such courses being made available by schools and districts is steadily increasing in many places throughout the country, rural schools are universally far less likely than the average to offer such courses and have lower enrollment and achievement rates when they do offer them (Gagnon & Mattingly, 2016). While these courses are technically available, they are largely inaccessible to rural students like many students in northern New Mexico who live far away from their schools and, in many cases, do not have internet access. Gagnon & Mattingly (2016) also remarks on how desirable these more challenging courses are to higher education institutions in their admissions processes, meaning that rural students who do not have access to the courses are left at a measurable disadvantage going into higher education.

Crabtree, Richardson, and Lewis (2019) discuss the so-called “Gifted Gap” in STEM education as the systematic inequality where students who thrive in traditional curricula and educational environments are given special opportunities to participate in courses like those mentioned above. Students who struggle with traditional methods of instruction are prevented from enrolling in these courses and are left behind because of this. These higher level courses often allow students much more freedom in the way they learn, and allow exploration of more complex and focused topics designed specifically as preparation for post-secondary education. However, such higher level courses are very rare in northern New Mexico’s public schools; Students graduating with these courses on their transcript can often skip entry level general courses when entering post-secondary education, whereas a representative from the Community Learning Network disclosed that many students in rural New Mexico have to start their post-secondary education with a considerable number of remedial courses intended to prepare them for standard post-secondary curricula and don’t award any credit towards a degree. This, again, is a scenario in which rural students and students with less access to accelerated and challenging courses in secondary school are left at a marked disadvantage when entering post-secondary education as compared to those who are provided more complete access.

The current systemic complications and disproportionate conditions that exist in STEM education, especially in rural areas that are common in northern New Mexico, are deeply rooted and highly destructive to the goal of accessible, available, and equitable education. Accordingly, there is significant importance in highlighting the difference between accessibility and availability in the context of education as a solution to offer accessible and equitable education to all northern New Mexico students is developed.

2.4.3 Social and Financial Obstacles



There are a number of social and financial obstacles that affect access to STEM education for many students in New Mexico. Gender stereotyping, ethnic and racial biases, and limited financial resources are barriers to students pursuing STEM education (Berwick, 2019; Castleman, 2014; Dee, 2017). While there are overlaps between these obstacles, the challenges each pose are distinct and deserve individual attention.

Gender stereotyping has made it disproportionately more difficult for women to pursue STEM subjects than for men, acting as an obstacle to accessible and equitable STEM education (Berwick, 2019). The biases and stereotypes women in STEM face spur self-doubt in their ability to do math and science (Ibid.). In an Israeli study, math tests taken by male and female students were split into two sets. One set of tests with the students' names written on them was given to teachers, and the other was given to an external grading site with the students' names removed. When graded by the external site, female students were scored significantly higher than male students, whereas their educators had scored them lower (Lavy & Sand). Teachers reinforce this gender bias when they apply these biases to themselves, especially in elementary school where most teachers are women. When female teachers show anxiety teaching math, female students can be negatively affected (Berwick, 2019). Science textbooks strictly depicting male scientists can have the same effect (Ibid.). Interestingly, girls and boys achieve nearly equal test scores in math in both 4th and 8th grade and they enroll in the same amount of advanced science and math courses in high school. In higher education, the gender gap of STEM participation widens (Ibid.). In New Mexico, according to 2017 data compiled by the Education Committee of the States, 570 men were awarded a degree or certificate in computing while only 166 women earned a degree or certificate and 970 men to 275 women earned an engineering degree or certificate in New Mexico. Both of these gaps have only grown since 2001 (ECS, 2018). STEM assessments may also contribute to the gender gap in STEM environments.

Cognitive differences between girls and boys in STEM tend to favor boys in how subject proficiency is assessed (Berwick, 2019). Under a study conducted by Stanford University, the test scores of eight million nationally standardized tests for 4th and 8th graders were analyzed and it was found that 25% of the score discrepancy between boys and girls in grades four and eight correlated with the proportions of multiple choice and open response questions (Reardon et al., 2018). Girls outperform boys in open response questions, but did worse in multiple choice. Without a comprehensive format, these tests fail to assess the knowledge and proficiency of women in STEM which can contribute to negatively impact their self-confidence and sense of belonging (Berwick, 2019).

Typically underrepresented groups in STEM face a similar obstacle to women in the form of ethnic and racial bias.. Underrepresented groups have to deal with implicit biases while trying to establish a sense of belonging in undiverse STEM environments. Bias from teachers in the classroom can influence their judgement in ways that are detrimental to the student by enforcing harsher disciplinary action, having poorer performance expectations, and offering weaker course recommendations (Dee & Gershenson, 2017). For example, in a 2016 research study, non-black teachers had significantly lower expectations of black students (Dee & Gershenson, 2017). Actions like this can be discouraging to students when pursuing a STEM education.

The challenge of establishing a sense of belonging in STEM environments is equally critical to increasing representation in STEM (Kricorian et al., 2020). At the University of New Mexico, according to interviews on how well the university has served student populations, it was apparent that Native American and Hispanic students fared worse than their peers in STEM programs. Both populations felt that they were underserved by the school which negatively impacted retention rates largely for the Hispanic population (EPRC, 2016).Students are more likely to pursue a STEM degree when they can identify with peers, mentors, and educators involved with their major (Ibid.). A study conducted with student members of a STEM non-profit organization (mostly consisting of underrepresented groups) revealed that a third of these students already had a parent in STEM and 68% of the students had been encouraged by their parents to pursue a STEM career (Ibid.). Around half of the students surveyed watched movies and shows depicting people of their gender or ethnicity working in STEM careers. These findings show how necessary encouragement and diverse representation of STEM personnel are in influencing underrepresented groups to pursue STEM subjects. Students were also asked if they could name any STEM professionals of their gender and ethnicity and the majority of members of underrepresented groups could not answer this question. Accessibility to culturally relatable STEM professionals and mentors is a significant factor in bolstering interest in STEM subjects and retention rates in STEM courses (Ibid.).

Financial obstacles are also affecting students' STEM education. According to 2017 data compiled by the Education Committee of the States, 54% of New Mexican fourth graders proficient in math did not qualify for free/reduced price lunch compared to the 24% of fourth graders that did qualify. In eighth grade, of the kids proficient in math, 46% did not qualify for free/reduced price lunch compared to the 21% of eighth graders that did qualify. A similar trend exists for science proficiency with differences of approximately 30% and 25% for fourth graders and eighth graders respectively (ECS, 2018). When dealing with limited financial resources, students tend to prioritize tuition over the availability of STEM programs and resources as despite more costly schools often offering more comprehensive lists of STEM programs. Helping students cover the cost of tuition and books allows them to pursue STEM education uninhibited by cumbersome expenses. In a survey of Southwest Virginia Community College's (SWCC's) S-STEM scholarship program, 14% of students identified finances as their main obstacle to pursuing STEM majors, and 95% of the same group said that the coverage of tuition and books was the best aspect of the NSF scholarship program (Henley, 2016). In secondary education institutions, students tend to put more priority on degrees with smaller time commitments. Students working part-time jobs can view STEM majors as too much of a time commitment (Castleman, Long, & Mabel, 2014). A study was done inquiring on the effects of the Florida Student Access Grant on Florida's graduating high school class of 1999-2000. Eligible students that had completed trigonometry or higher in high school earned on average 4.8 more STEM credits than their peers who were just above the eligibility cut-off and did not receive the grant money (Ibid.). This suggests that when students' financial responsibilities are reduced they are able to set aside more time for STEM programs.

2.4.4 Disruptions Caused by COVID-19

The onset of the COVID-19 pandemic has led to the disruption of the education of nearly 1.6 billion learners in more than 190 countries worldwide (UN, 2020). The closure of schools, compounded with the associated public health and economic crisis, has posed a major threat to students and their teachers (Garcia & Weiss, 2020). Pre-existing education disparities have been exacerbated through the reduction of opportunities utilized by vulnerable children, youth, and adults, including those who live in poor or rural areas (United Nations, 2020). Learning losses also threaten to extend beyond this generation into the next, erasing decades of progress in the support of access and retention rates for girls and young women. An estimated 23.8 million children may be forced to drop out of school due to the pandemic's economic impact (Ibid.).

A main factor affecting students' education during the COVID-19 pandemic is the lack of accessibility to technology and other tools needed to support remote learning. Tech-equity issues have always been present in the United States, but the COVID-19 pandemic has only worsened these issues. In a report presented to New Mexico's Legislative Finance Committee, it was found that teachers are unable to contact 1 in 5 New Mexico students and that 33 percent of students are not taking part in remote learning (Barron, 2020). In a nationally representative survey, teachers in districts where more than 75% of students qualify for free or reduced-price lunches reported that over half of their students had to share a device with other family members or friends in order to participate in online learning (Bushweller, 2020). The COVID-19 pandemic has caused many disruptions in education and has worsened the already existing tech-equity issues in the United States.

2.5 Conclusion

New Mexico ranks poorly relative to the rest of the country in almost all areas of pre-collegiate education including quality of education, experience of educators, diversity of teachers, access to courses, and universal equity for all students. These issues extend to STEM and prevent most students from receiving adequate STEM education. Additionally, students in New Mexico face a number of barriers when pursuing a quality education, and the school districts of New Mexico often present educations that are lacking in equity and accessibility. Outstanding court cases exist as a reminder that the United States Constitution promised an equitable and quality education to all students, and that New Mexico largely fails to provide an education that satisfies this Constitutional expectation. A focus on STEM education will help to correct these issues, as STEM education not only better prepares students for technical careers, but also encourages the development of critical thinking and problem solving skills that are applicable in all aspects of life. It is for these reasons that New Mexico must work to implement universally equitable and accessible STEM education. With this project, we plan to identify the specific issues that are preventing universal implementation of equitable and accessible education in northern New Mexico, geographic trends that may exist within these issues, and the direct impacts of the COVID-19 pandemic on STEM education. We will present these issues to our sponsor, the Community Learning Network, to assist in their formation of an action plan that is approachable by and applicable to the relevant school districts. Additionally, we will format the data we use to identify these issues in a number of manners that will allow us to create statistics and rankings that can be used to educate northern New Mexican parents, guardians, students, educators, and community members on the current issues with STEM education in northern New Mexico.

3. RESEARCH METHODS

The goal of this project was to assist the Northern New Mexico STEAM Coalition (NNMSC) in the procurement, management, integration, analysis and reporting of STEM education data in order to create a baseline picture and understanding of STEM education, accessibility, availability, and equity among rural and non-rural schools in northern New Mexico. Our priority was to provide information to the NNMSC that could be used to further expand and open new possibilities for STEM education in northern New Mexico.

During our seven-week research term, we:

1. Developed measurable definitions of accessibility, availability, and equity in the context of STEM education;
2. Examined, analyzed, and created a summary of key findings from the Public Education Department (PED)'s STEM education data from the 2018-19 and 2019-20 school years;
3. Investigated the accessibility of learning formats of STEM courses for the 2020-21 school year.

For the entirety of this project, our team worked remotely from Worcester, Massachusetts and our own hometowns due to the COVID-19 pandemic. While it was extremely disappointing for us to not have the opportunity to conduct the following research in New Mexico, our own experiences with COVID's impact on our education further deepened our understanding of how important the work we have accomplished is for the students, parents, educators, and stakeholders of the Northern NM STEAM Coalition.

3.1 Objective 1 - Develop measurable definitions of accessibility, availability, and equity

Our project focused on measuring accessibility, availability, and equity of STEM education. To develop measurable definitions of these terms in STEM education, we compiled articles and other resources about research that has already been done on measuring these concepts qualitatively. We chose to create a qualitative framework rather than a quantifiable framework because there are many factors of an accessible, available, and equitable STEM education that could not be measured numerically. The STEM Education Quality Framework table developed by the Dayton Regional STEM Center provided a useful framework with examples of components and descriptions to create our own framework for this project (Dayton Regional STEM Center, 2011). To begin developing our evaluation framework, we compiled a list of components and their descriptions to form the basis of our measurements of accessibility, availability, and equity in STEM education. Each component of our framework is a different factor of STEM education that we broke down into the following categories: technology, students, and educators. For example, we created the "Access to Technology for Students and Educators" component to measure how many students and educators have access to or are provided devices by the school and have access to an internet connection. Once the list of components was finalized, the next step was to present the framework in a format that is easy to understand. This framework can also be used for schools and districts in northern New Mexico of any size, location, and type.

3.2 Objective 2 - Examine STEM education data from Public Education Department (PED) for the 2018-19 and 2019-20 school years

In order to begin the process of collecting STEM education data, we submitted a data request to the Public Education Department (PED) via email. The data we requested included which STEM courses are offered at the schools in the northern region and data on student enrollment for these courses from the 2018-19 and 2019-20 school years. In the meantime, our team conducted research on data that was already available publicly on the internet, such as student enrollment demographics by school district, student math and science proficiencies, New Mexico population data, the rural or non-rural status of the northern counties, and data on educator experience and demographics by school district. This data was compiled into Google spreadsheets for analysis and ArcGIS mapping. Once our PED data request was fulfilled, we analyzed the relationships between science and math proficiencies, urbanity of school districts, school enrollment demographics, the diversity and experience of school educators, and school course offerings. We then utilized the evaluative framework to measure the accessibility, availability, and equity of STEM education in northern New Mexico based on data trends we found to be relevant to our identified components.

Relationships Investigated

<u>STEM courses offered versus rural or non-rural status of school districts</u>
Relationships between the amount of STEM courses offered by school districts and the non-rural/rural status of school districts were inferred on. This was done to compare the availability of STEM courses between school districts and investigate which districts, rural or non-rural, have more access to these STEM courses.

<u>Math and science proficiencies versus student ethnicity/race enrollment demographics</u>
Relationships between math and science proficiencies and ethnicity/race demographics by school district were inferred on to determine if poorer proficiency scores correlated with larger percentages of typically underrepresented minorities in STEM.

<u>Educator diversity and experience versus student ethnicity/race enrollment demographics</u>
Relationships between educator diversity experience and ethnicity/race demographics by school district were inferred on to determine if educator demographics resembled student demographics. This metric was intended to evaluate students' accessibility to diverse pools of educators.

We then mapped these data trends using ArcGIS mapping software to better display the data and further investigate trends between the datasets. These maps provided an easier way to organize and communicate the comparisons and relationships we examined.

3.3 Objective 3 - Investigate the accessibility of learning formats of STEM courses for the 2020-21 school year

With the knowledge that nearly twenty-five percent of students in New Mexico do not have internet access at home, we investigated the accessibility of STEM education for the 2020-21 school year as the onset of the COVID-19 pandemic forced them to adapt to new learning formats (McKay, 2020). To investigate this topic, we created a survey of questions based on our sponsor’s interest in obtaining a basic understanding of how students were accessing their education and how much time was dedicated to lessons or courses in STEM. We then analyzed the data collected through the survey using descriptive analysis and thematic coding.

3.3.1 Distance Learning Survey

Using the Google Forms online survey platform, we developed a series of survey questions that were emailed to administrators from each of the public and charter schools within the scope of northern New Mexico to then be distributed to the administrators’ STEM colleagues. Within this email, our team assured educators that their participation in this survey was completely voluntary, and that any information from their responses that would later be used in our report would be stripped of any personally identifiable information in order to maintain confidentiality. A copy of this email can be found in Appendix A, and the full list of survey questions can be found in Appendix B. A sample list of these survey questions are provided in Table 3 below.

Table 3: *Sample of Questions from Distance Learning Survey*

What type of learning format is your school currently utilizing for the 2020-21 school year?
Are all students issued devices such as a tablet or Chromebook that they may bring home to complete schoolwork?
Are all of the STEM courses that were taught prior to the pandemic continuing to be taught at your school this semester?
What is the structure of distance learning delivery and facilitation for STEM courses?
What platforms and learning management systems (LMS) are being used to support online distanced learning? (i.e. Canvas, PowerSchool, Zoom, Google Hangouts, etc)
In your opinion, is the current work for STEM courses this semester (whether in person, online, or hybrid), comparable to the work that students would normally be doing in school in these courses? Why or why not?

3.3.2 Descriptive Analysis & Thematic Coding

From the survey responses collected, we received information that was both quantitative and qualitative. To analyze the quantitative data, we used descriptive statistics. This form of analysis is usually the first level meant to help researchers make an initial summary of the data to uncover initial patterns. Examples of commonly used descriptive statistics are mean, median, mode, percentage, frequency, and range (Bhatia, 2018). For the purpose of this project, we analyzed the survey data using mean, percentage, and frequency.

To analyze the qualitative data, our goal for analysis was to use thematic coding to identify any patterns in educators' long responses and create meaningful insights. For the four long response questions at the end of our survey regarding the comparability of STEM work for the 2020-21 school year vs. previous years, and the challenges and successes educators and their students are facing, we used the thematic coding technique. Also known as "thematic analysis", this method involves reading through text that is linked by a common theme or idea and categorizing words or phrases into a thematic framework (Mountain, A. & Marshall, H., 2019). Using the long response survey answers, we completed an initial read through to produce a list of initial themes that emerged. During our second read through, we color coded words or phrases based on these themes and any new ones that presented themselves. Upon the completion of color coding, we produced a finalized framework and utilized it in order to draw conclusions about our findings and make recommendations.

3.4 Creation of Deliverables

After speaking with our sponsor and completing some research to better understand what presentations would be most useful in the context of our project, we developed methods for disseminating the findings of our analyses that would be accessible to everyone from the students enrolled in northern New Mexico schools to executives in STEM companies in New Mexico. The main intent was to allow all readers to glean information from our presentations that highlights the current shortcomings of STEM education in northern New Mexico and helps to identify options for improvement at a glance. To do this, we used a number of formats and modes including two websites, ArcGIS interactive maps, single page flyers, a variety of infographics, and social media splash posts.

All of these modes directed readers to the primary website for more information, where the entirety of our data, analysis, and findings can be found, including the information presented in all of these modes. We did this to encourage readers to assess more information and become better educated about STEM education in northern New Mexico. The only information included on this website that is not present in this report is the blog section, which provides an introduction to each individual we interviewed or worked with while completing this project to offer them recognition for their contributions and to identify where we obtained local knowledge.

A list of the at-a-glance presentation modes used and the information presented in each can be found in Table 4 below:

Table 4: *At-a-Glance Presentation Modes and their Utilizations*

Presentation	**Purpose**
Infographics	To highlight key statistics to garner interest with minimal time investment on part of reader
Accessibility, Availability, and Equity Framework	To encourage readers to consider STEM education in more depth and complexity, as well as their own association with or usage of STEM education

While we created these additional modes primarily to direct people to our website, we still designed them to provide useful and applicable information as standalone resources. This was so that readers/viewers could develop informed opinions even if they did not continue to the website.

Lastly, we made a second website similar in function to and containing largely the same content as these modes with the intent of working it into the nmsteamhub.com site created and hosted by our sponsor. With this placement, it was intended to benefit from the farther reach of this more established site while still encouraging individuals to make their way to our site for more information.

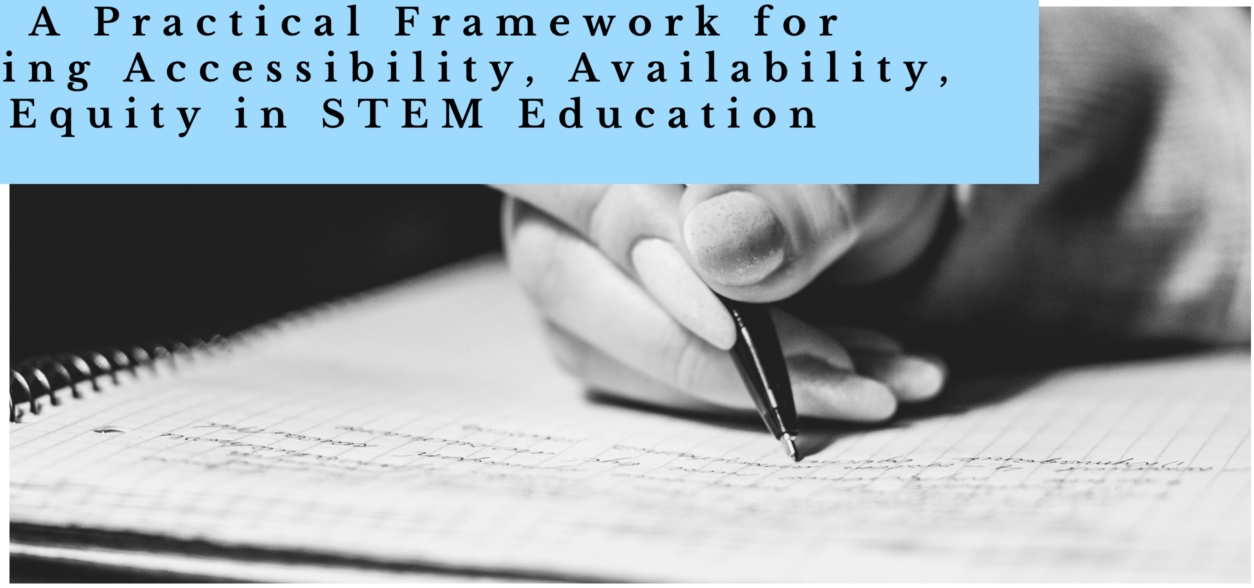

tal logic
Inverter
XOR
X = A ⊕ B
NAND
X = A·B
XNOR
NOR
Ex. 001
Hexadecimal
65536 4096 256 16 1

4. FINDINGS

This chapter reviews our team's findings as a result of the data analysis we conducted for our three objectives. The goal of our research was to create a baseline understanding of the accessibility, availability, and equity of STEM education in northern New Mexico for the 2018-19, 2019-20, and 2020-21 school years. Our findings can be broken down into three main categories:

- A Practical Framework for Assessing Accessibility, Availability, & Equity in STEM Education
- Characterizing STEM Education Accessibility, Availability, & Equity in Northern New Mexico
- An Investigation into Distance Learning Adaptations

4.1 A Practical Framework for Assessing Accessibility, Availability, & Equity in STEM Education



Finding 1: A simple and effective way to evaluate the accessibility, availability, and equity of STEM education from school to school is through a practical assessment framework.

We designed the Accessibility, Availability, & Equity Framework (Appendix C) to be a "traffic-light" style table with three levels: excellent (green/high), good (yellow/medium), and poor (red/low). Within each level, we developed a description of what that level would look like for the given component based off of prior research and literature review. In total, there are fourteen components of this framework that can be used either individually or collectively to measure the accessibility, availability, and equity of STEM education in schools. The "Post-Secondary Degree Pathways" component is specific to higher education institutions and should not be applied to K-12 education. Similarly, the "Adaptations for Distance Learning" and "Availability and Integration of Learning Support" components are specific to education during the COVID-19 pandemic. Descriptions of each component can be found on the next page in Table 5. We were able to utilize this framework to analyze data we collected from the PED to measure how accessible, available, and equitable STEM education was in the school districts of northern New Mexico for some of the components.

Table 5: *Descriptions of each component of the Accessibility, Availability, & Equity framework*

Components	Descriptions
Integration of Social and Cultural Awareness	*Accessible, available, and equitable STEAM education considers a variety of perspectives to build awareness of social, ethnic, and cultural sensitivities in order to foster awareness, sensitivity, and empathy in educational environments*
Accessibility for Students of Diverse Backgrounds	*Accessible, available, and equitable STEAM education includes students of diverse identities including their: ethnicity, race, socioeconomic status, gender, exceptionalities, language, religion, sexual orientation, and geographical area.*
Access to Technology for Students and Educators	*Accessible, available, and equitable STEAM education gives students and educators the ability to access computers, laptops, tablets, the internet, and other technology needed to run the course.*
Considerations in Accessibility of Technology	*Accessible, available, and equitable STEAM education meets accessibility considerations (large legend keyboards, formatting for screen readers, alternative human interface devices)*
Quality of Student and Educator Technology	*Accessible, available, and equitable STEAM education includes functioning and adequate internet access and bandwidth, technology speed and age, ease of use, provided software (LMS and assessments)*
Accessibility to varied STEAM curriculum and course selections	*Accessible, available, and equitable STEAM education provides students with a variety of course offerings that go beyond required science, technology, engineering, and mathematics*
Availability of Teaching Support	*Accessible, available, and equitable STEAM education supplements students' education in the classroom by providing them tutors, academic advisors, and the counselors they need to succeed*
Student and Educator Access to Course Materials	*Accessible, available, and equitable STEAM education provides students and educators with access to learning materials including labs, textbooks, white boards, etc.*
Access to Educators	*Accessible, available, and equitable STEAM education means that all teaching positions are staffed with prepared educators.*
Diversity of Educators	*Accessible, available, and equitable STEAM education includes teachers of diverse ethnicity, race, socioeconomic status, gender, exceptionalities, language, religion, sexual orientation, and geographical area.*
Instruction by Qualified Educators	*Accessible, available, and equitable STEAM education accounts for students learning best with non-standard educational practices and requires qualified and prepared educators to make this possible.*
Post-Secondary Degree Pathways	*Accessible, available, and equitable STEAM education prepares students to enter post-secondary curricula without need for preparatory or remedial courses.*
Adaptations for Distance Learning	*Accessible, available, and equitable STEAM education strives to offer the same quality of education when adapted for distance learning as when in more traditional formats by the effective use of tools like learning management systems (Canvas, Edmodo, Google Classroom, etc.) and virtual meeting systems (Zoom, Google Hangouts, Skype, etc.)*
Availability and Integration of Learning Support	*Accessible, available, and equitable STEAM education is cognisant of the challenges students and educators are facing in the pandemic and allows flexibility in course and assignment delivery to account for complications in distance learning, as well as available student and staff support personnel and resources.*

4.2 Characterizing STEM Education Accessibility, Availability, and Equity in Northern New Mexico

Through our research, we were able to draw conclusions about the accessibility, availability, and equity of STEM education in northern New Mexico in the following categories: STEM course offerings, proficiency rates, student diversity, and educator diversity. Using the data we collected, we were able to measure some but not all of the components from the Accessibility, Availability, & Equity Framework for the school district in northern New Mexico.

Finding 2: Non-rural school districts offer more STEM courses than rural school districts by a large margin.

We sorted out PED STEM course offering data to focus on high school STEM courses offered by school district which can be seen below in Figure 3. We did this because STEM courses in high school offered the most extensive list of courses and the high school course data did not contradict PED student enrollment data unlike the elementary and middle schools. We also sorted out the amount of AP courses each school district offered. Finally, using the National Center for Education Statistics' catalogued information on school districts in the US, we were able to label each district as rural or non-rural by the size of the population of settlements their student pools commute from. After comparing the course offerings between the rural and non-rural school districts, it has been determined that **rural schools offer significantly less STEM courses than non-rural schools**. Non-rural schools on average offer roughly 30 STEM courses compared to rural schools that averaged 16. AP courses follow a similar trend as non-rural school AP course offerings triple that of rural schools with non-rural schools offering on average 2.3 AP courses compared to rural schools' 0.7. It should also be noted that only 4 of the 14 rural schools offer AP courses and Espanola offers 5. While Espanola is classified as a rural district, the majority of rural students live within 5 miles of "urban clusters" (classified by the US Census Bureau as a settlement with a population between 2,500 and 50,000 people) and "urban areas" (classified by the US Census Bureau as a settlement with a population 50,000 people). This suggests that the Espanola school district is not as disadvantaged as rural districts that are further from urban clusters and areas.

Accessible, available, and equitable STEM education provides students with a variety of course offerings that go beyond required science, technology, engineering, and mathematics. **Non-rural school districts on average rank higher than rural school districts in the "Accessibility to varied STEM curriculum and course selections" component of the Accessibility, Availability, & Equity Framework.**

URBANITY-LOCALE	SCHOOL DISTRICT	RURAL/NON-RURAL	TOTAL STEM COURSES	AP
Town Distant	MCCURDY CHARTER SCHOOL	NON-RURAL	14	0
City: Small	MONTE DEL SOL CHARTER	NON-RURAL	16	0
City: Small	NEW MEXICO CONNECTIONS ACADEMY	NON-RURAL	27	4
City: Small	NM SCHOOL FOR THE ARTS	NON-RURAL	14	1
Rural: Remote	ROOTS AND WINGS COMMUNITY	RURAL	-	-
Suburb: Large	SANDOVAL ACADEMY OF BILINGUAL EDUCATION	NON-RURAL	-	-
Town: Remote	TAOS ACADEMY	NON-RURAL	20	0
Town: Remote	TAOS INTEGRATED SCHOOL OF THE ARTS	NON-RURAL	-	-
Town: Remote	TAOS INTERNATIONAL SCHOOL	NON-RURAL	-	-
Suburb: Large	THE ASK ACADEMY	NON-RURAL	26	3
Suburb: Small	THE MASTERS PROGRAM	NON-RURAL	41	1
City: Small	TIERRA ENCANTADA CHARTER SCHOOL	NON-RURAL	17	0
Rural: Fringe	TURQUOISE TRAIL CHARTER SCHOOL	RURAL	-	-
Rural: Distant	WALATOWA CHARTER HIGH	RURAL	10	0
Suburb: Large	BERNALILLO	NON-RURAL	24	2
Rural: Remote	CHAMA	RURAL	17	0
Rural: Remote	CUBA	RURAL	16	1
Rural: Remote	DULCE	RURAL	8	0
Rural: Fringe	ESPANOLA	RURAL	27	5
Rural: Remote	JEMEZ MOUNTAIN	RURAL	11	0
Rural: Distant	JEMEZ VALLEY	RURAL	14	0
Town: Remote	LAS VEGAS CITY	NON-RURAL	26	1
Town: Distant	LOS ALAMOS	NON-RURAL	48	8
Rural: Remote	MESA VISTA	RURAL	11	0
Rural: Remote	MORA	RURAL	14	0
Rural: Distant	PECOS	RURAL	16	2
Rural: Remote	PENASCO	RURAL	17	0
Rural: Fringe	POJOAQUE	RURAL	21	2
Rural: Remote	QUESTA	RURAL	17	0
Suburb: Large	RIO RANCHO	NON-RURAL	64	10
City: Large	SANTA FE	NON-RURAL	55	8
Town: Remote	TAOS	NON-RURAL	32	4
Rural: Remote	WAGON MOUND	RURAL	22	0
Town: Remote	WEST LAS VEGAS	NON-RURAL	24	2

Figure 3: *PED Course Enrollment Data and Non-Rural/Rural Status By School District*

Finding 3: Universally poor proficiency rates in math and science in northern New Mexican schools suggest that STEM education is inadequate.

The PED collects data each year from every school and school district in New Mexico showing what percentage of students finish each grade level at or above the national guidelines for proficiency in math, science, and reading. Of interest in the context of this project are the math and science proficiency rates, which show once again that **New Mexico struggles with providing equitable quality education to all students**.

We ranked each school by proficiency rates from the 2018-19 school year as provided by the PED in both math and science and overlaid it onto an ArcGIS map to aid in identifying any geographic trends. This ranking shows us that more than half of the schools have proficiencies below 18% in math and 37% in science, and the average proficiency rates in math and science in all of the districts are 20.1% and 38.6% respectively. For context, the National Center for Education Statistics tells us that "In 2019, some 69 percent of 8th-grade students performed at or above the NAEP Basic achievement level in mathematics [and] 34 percent performed at or above NAEP Proficient," and the National Science Foundation tells us "33% of eighth graders, and 25% of twelfth graders achieved a level of proficient or higher in mathematics in 2015."

The results of this lack of proficiency achievement can be stated in terms of its effects on New Mexican students; One of the infographics we created, Figure 4 to the right (Tetreault, 2020), shows the most impactful of these effects chronologically through secondary education. The most damaging effect of inadequate quality of education that leaves students shy of expected proficiencies at each grade actually comes to fruition after graduation from secondary school: Our sponsor tells us that of the New Mexican students who pursue post-secondary education, many start well behind expected proficiencies, especially in math, and have to take a number of remedial courses that cost as much, take as long, and have the same workload as credit bearing post-secondary courses, but don't count towards a degree. This results in a degree requiring more time and money to obtain than is typical, and works to discourage students from pursuing a post-secondary degree in the first place.

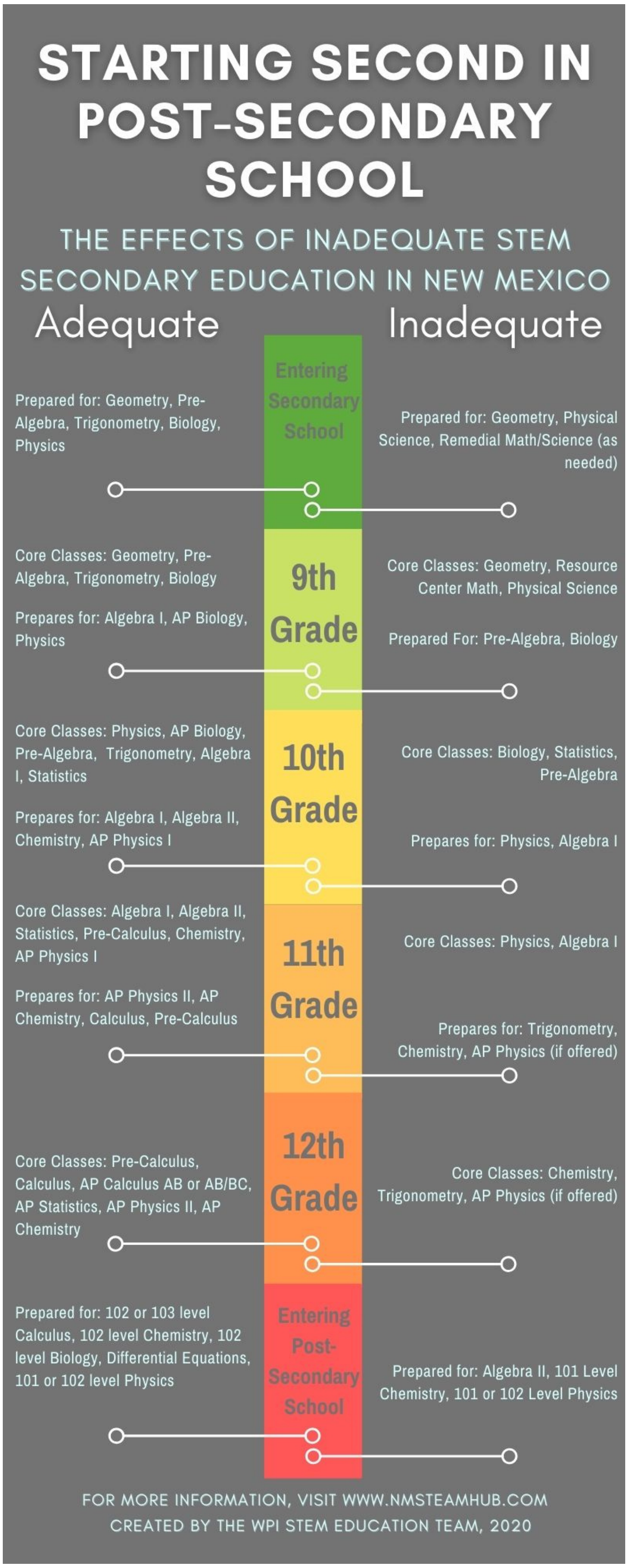


Figure 4: *Starting Second in Post-Secondary School*

As previously mentioned, we found that the great majority of northern New Mexican schools are distinctly poor in math and science proficiencies, with the exception of a few private/charter schools. This overall poor proficiency in math and science shows definitively that New Mexican students are receiving inadequate STEM education; Because STEM education has been proven to encourage the development of critical thinking and creative problem solving skills, it can be safely assumed that addressing the factors discouraging students from enrolling in STEM courses would net an overall improvement in student success. Our other objectives explore exactly what these factors are, but this objective shows that STEM is poorly implemented in northern New Mexican curricula and allows for the above assumption.

In search of what aspects cause so many schools to exhibit such low STEM proficiency rates relative to national averages, we combined data provided by the PED on STEM course enrollment at each school district, data pulled from public NCES records on the total number of students at each school district, and the assumption that on average, students enroll in eight courses per year to create the following ranking (Table 6). This data considers the total number of individual course seats registered in the 2018-19 school year and orders school districts based on the percentage of this total number of courses that are registered in STEM subjects, giving an indication of the percentage of courses the students of a school district actually take that are STEM relevant. Noting the demographics of the top ranked schools shows a clear trend towards charter schools presenting many STEM courses, but on the opposite end also shows that rural schools and schools in economically disadvantaged areas exhibit very low STEM enrollment. This indicates that STEM courses are not available to as large an extent as is necessary to achieve universal STEM proficiency in disadvantaged schools.

Table 6: *Ranking of School Districts by percentage of enrollment in STEM courses out of all courses*

1	98.63%	The Ask Academy	**18**	43.97%	Santa Fe
2	97.97%	Walatowa Charter High	**19**	43.40%	Los Alamos
3	82.30%	Tierra Encantada Charter	**20**	39.57%	Pojoaque
4	76.10%	NM Connections Academy	**21**	35.09%	Bernalillo
5	73.77%	The Masters Program	**22**	34.50%	Roots and Wings Community
6	62.78%	Mora	**23**	30.77%	Dulce
7	58.68%	Cuba	**24**	30.51%	Jemez Valley
8	58.50%	Rio Rancho	**25**	29.63%	McCurdy Charter School
9	57.36%	Chama	**26**	8.99%	West Las Vegas
10	55.97%	Taos International School	**27**	27.35%	Jemez Mountain
11	55.17%	Espanola	**28**	26.67%	Las Vegas City
12	54.40%	Taos	**29**	22.28%	Wagon Mound
13	53.80%	Monte Del Sol Charter	**30**	21.96%	Turquoise Trail Charter School
14	53.76%	New Mexico School for Arts	**31**	19.79%	Sandoval Academy of Bilingual Education
15	53.09%	Penasco	**32**	16.07%	Pecos
16	47.81%	Questa	**33**	15.88%	Taos Integrated Academy for the Arts
17	46.55%	Mesa Vista		**Average**	47.92%

Finding 4: The majority of school districts in northern New Mexico had mostly American Indian/Alaskan Native and Hispanic students enrolled, and the districts with a majority of Hispanic students enrolled typically had lower science and math proficiency rates.

The goal of analyzing student diversity enrollment data was to investigate which ethnic groups may be experiencing barriers to an accessible, available, and equitable STEM education. We found that the **majority of districts in northern New Mexico had mostly American Indian/Alaskan Native and Hispanic students** enrolled which can be seen below in Figure 5. **Only three out of thirty six school districts had a majority Caucasian students enrolled**. The three districts were Los Alamos, Roots and Wings Community, and NM School for Arts. On the other hand, Walatowa Charter High and Dulce school district have over 90% of student enrollment being American Indian/Alaskan Native. When looking at proficiency rates for science, Los Alamos and NM School for Arts were in the top five districts with the highest science proficiency rates as compared to Dulce which had the lowest proficiency rate and Walatowa Charter High which had the third lowest proficiency rate. Los Alamos ranked the highest in math proficiency rates among the thirty six school districts. Meanwhile, Dulce school district ranked lowest in math proficiency rates out of the thirty six districts. Another obvious trend is that the **districts with a majority of Hispanic students enrolled typically had lower science and math proficiency rates**. Data on the race and ethnicity of students and proficiency rates in math and science show a trend that school districts with higher proficiency rates typically had more Caucasian students enrolled than minorities. These findings show that the minority and ethnic students of northern New Mexico are experiencing barriers to an accessible, available, and equitable STEM education. An accessible, available, and equitable STEM education includes students of diverse identities including their race and ethnicity, and currently, the majority of school districts are ranking poorly for the "Accessibility for Students of Diverse Backgrounds" component in the Accessibility, Availability, & Equity Framework. In northern New Mexico, it has become clear that school districts with primarily minority students are not providing the same quality STEM education as schools districts with majority Caucasian students.

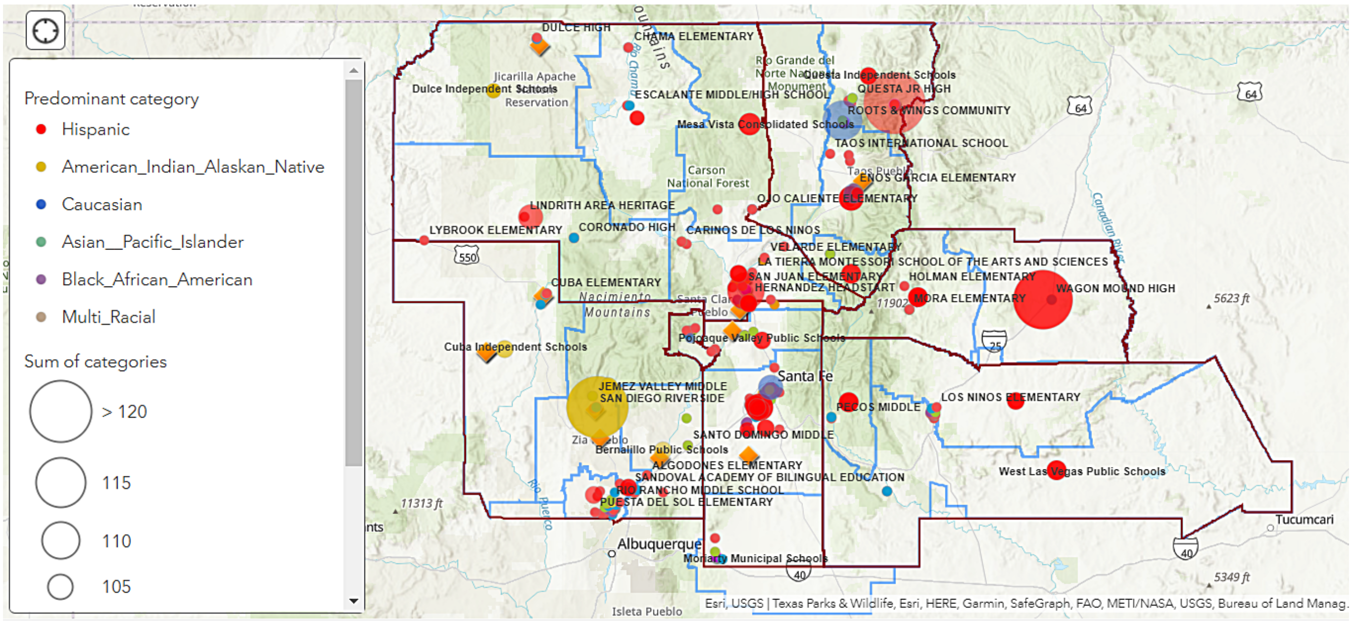


Figure 5: *An ArcGIS map of student diversity in northern New Mexico.*

Finding 5: For most of the school districts of northern New Mexico, the diversity of educators was not comparable to the diversity of the students meaning minority students are underrepresented in STEM education.

During analysis of race and ethnic diversity of educators for each school district in northern New Mexico, a common trend that appeared is that the **diversity of educators was not comparable to the diversity of the students**. A map of the diversity of educators can be seen below in Figure 6. Nineteen of the thirty six school districts had over 50% of their educators identifying as Caucasian while only three out of the thirty six school districts had over 50% of their student enrollment being Caucasian. Because of the lack of diversity among educators in the school districts of northern New Mexico, minority students are being underrepresented in STEM fields in their own school districts which can lead to a lack of motivation to further an education or career in the STEM industry. An accessible, available, and equitable STEM education includes teachers of diverse ethnicity and race which is currently not the case for the majority of schools in northern New Mexico. This means that the majority of the school districts in northern New Mexico rank poorly for the "Diversity of Educators" component on the Accessibility, Availability, & Equity Framework.

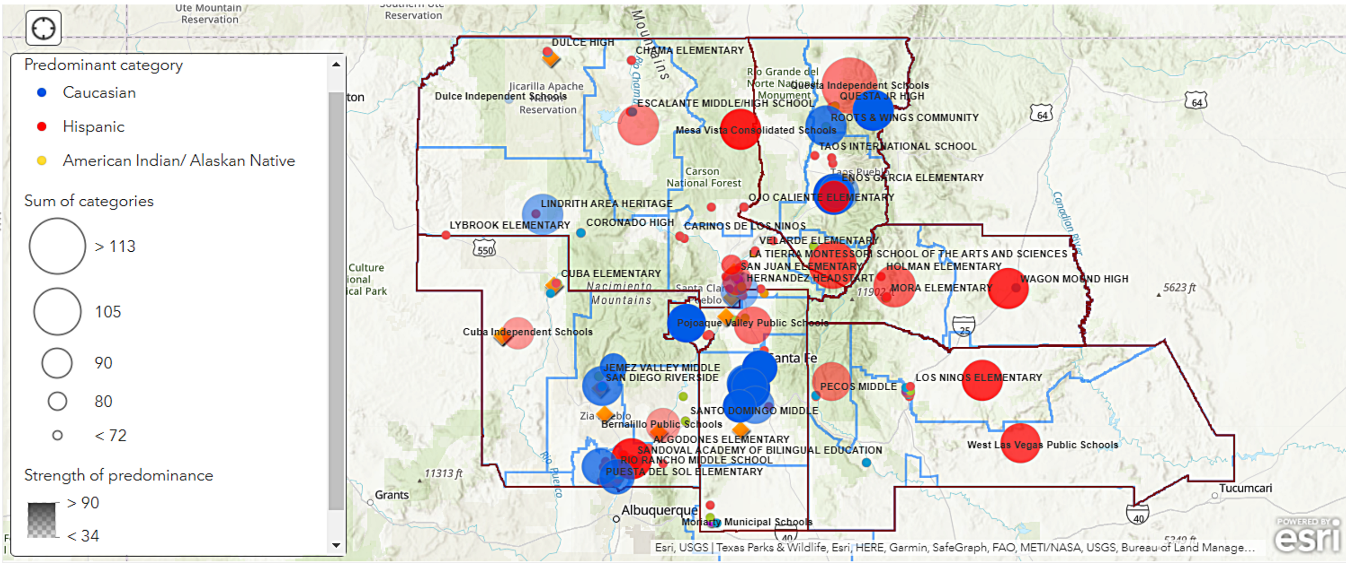


Figure 6: *An ArcGIS map of the diversity of educators in northern New Mexico.*

4.3 Investigation into Distance Learning Adaptations

To investigate the accessibility of the current learning adaptations for students during the COVID-19 pandemic, our team conducted a survey which was sent to the administrators and STEM educators of northern New Mexico. Our goal from this survey was to obtain information that would provide the Northern New Mexico STEAM Coalition with a basic understanding of the current state of STEM education including the learning formats chosen by each school, challenges that educators and their students are facing, and successes with new learning adaptations. Of the one hundred and sixty-one schools that the survey was sent to, only **twenty-nine responses were returned from sixteen different schools** (Table 7). The following section discusses our findings from the analysis of these survey responses.

Table 7: *Schools Represented in Distance Learning Survey Responses*

School	District	County
Amy Biehl Community School	Santa Fe	Santa Fe
Cielo Azul Elementary	Rio Rancho	Sandoval
Desert Sage Academy	Santa Fe	Santa Fe
Dulce Elementary	Dulce	Rio Arriba
Gonzales Community School	Santa Fe	Santa Fe
Los Alamos High School	Los Alamos	Los Alamos
Mandela International Magnet School	Santa Fe	Santa Fe
Memorial Middle School	Las Vegas	San Miguel
Pecos High School	Pecos	San Miguel
Pecos Middle School	Pecos	San Miguel
Robertson High School	Las Vegas	San Miguel
Taos High School	Taos	Taos
The Academy for Technology and the Classics	Santa Fe	Santa Fe
Turquoise Trail Charter School	Turquoise Trail Charter	Santa Fe
Vista Grande High School	Rio Rancho	Sandoval
Wagon Mound Public School	Wagon Mound	Mora

Finding 6: At least fourteen schools have chosen online learning for the 2020-21 school year and have reached a 1:1 ratio of student to learning device.

Due to the nature of the COVID-19 virus, CDC guidelines recommend that everyone should wash their hands often, cover their mouth, clean and disinfect, and maintain a social distance of at least six feet from on another in order to help prevent the spread (How to Protect Yourself & Others. 2020). Within schools, reopening for the Fall 2020 semester meant that desks needed to be moved, everyone would need to wear a mask, and a greater amount of disinfecting supplies would be needed. Returning to in-person classes with the CDC guidelines was not feasible for all schools. In some cases, classrooms are not large enough to keep a social distance, and there was not enough money budgeted for the school year to supply all of the necessary personal protective equipment (PPE). Overall, the rising number of COVID cases in these students' communities meant it was much safer for education to continue remotely.

The three learning formats that emerged as a result of the pandemic are: in-person, online or distance, and hybrid learning. Of the schools our team received survey responses for, **fourteen utilized online or distance learning**, while the other two schools chose to utilize a hybrid learning format, where students were able to attend in-person school on assigned days and were online or distance for others.

Whether students were in the classroom or on the other side of a screen, educators turned to the use of various online platforms and Learning Management Systems (LMS). The role of a LMS is to provide students with a virtual learning experience while also aiding instructors in tasks such as recording attendance, keeping track of grades, uploading coursework, and creating lesson modules. With the knowledge from our sponsor that the PED acquired a subscription to the Canvas software that is often used on college campuses to support digital learning, we investigated if that was the only platform or LMS utilized by educators, and if not, which was the most popular. Below, Table 8 shows the rankings of the platforms and LMS used by respondents.

Table 8: *Ranked List of Learning Management Systems*

Ranking	Platform/LMS Name	Frequency
1 (most common)	Canvas	12
2	Google Meets	11
3	Google Classroom & Powerschool	10
4	Class Dojo, Google Suite, Jamboard, Microsoft Teams, Office 365, Zoom	2
5 (least common)	Bright Thinker, Discovery Education, Edgenuity, Envision, Eureka, GoGaurdian, Google, Google Hangouts, IXL, Kuta Software, Managebac, Math-aids, Nearpod, Open Access, Seesaw, Youtube	1

In order to further make this available education accessible and equitable for their students, districts also had to consider options for students who did not have devices or an internet connection at home. Of the educators who responded, **all answered that their school provided students with devices that they could bring home to complete their schoolwork**. With a 1:1 student to device ratio, these schools earn an excellent rating for the "Access to Technology for Students and Educators" component of our assessment framework in Appendix C.

However for some students, having a device made available to them for the school year did not mean they had the accessibility to use it. Districts have attempted to overcome the obstacle of students lacking internet access by offering paper packets filled with lessons and coursework and materials for hands-on learning to these students. Based on the survey responses we received, only **one school reported utilizing these packets and three reported providing hands-on learning kits** (Figure 7).

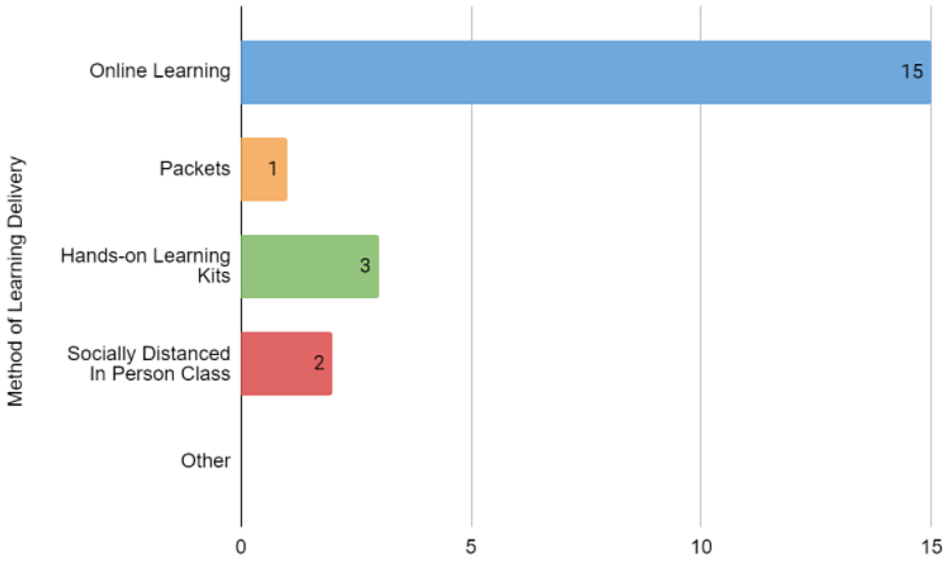


Figure 7: *Methods of Learning Delivery for the 2020-21 School Year*

Finding 7: As many schools of northern New Mexico have turned to online or distance learning, educators are struggling to ensure students are engaged as they adapt to new methods of course delivery.

The sudden need to completely reformat the delivery and implementation of STEM education has led to many challenges for students and educators that had never previously been considered. While schools chose their learning formats for the 2020-21 school year based on the needs of the majority of students and educators, not everyone has shared the same experience. Through thematic coding, our team was able to produce an initial analysis of educators' responses to the "Successes and Challenges" section of our survey regarding their current experience with providing education during the pandemic. We found that there were eight themes that occurred across all of the responses:

1. Student Participation & Engagement,
2. Course Materials & Resources,
3. Mental & Emotional Wellbeing,
4. Hands-On Work,
5. Interaction with Others,
6. Responsibility & Organization,
7. Course Preparation & Implementation, and
8. Time for Instruction.

Our thematic framework (Appendix D) features the common phrases that we categorized to create each of the themes. After the completion of this framework, we then counted how frequently each of these themes occurred in order to determine which were the most common and should be considered first for future research. Figure 8 below shows the percentages of these occurrences, and that the three most common themes that were of concern to the educators who responded to our survey were **Student Participation & Engagement, Course Materials & Resources, and Hands-On Work**.

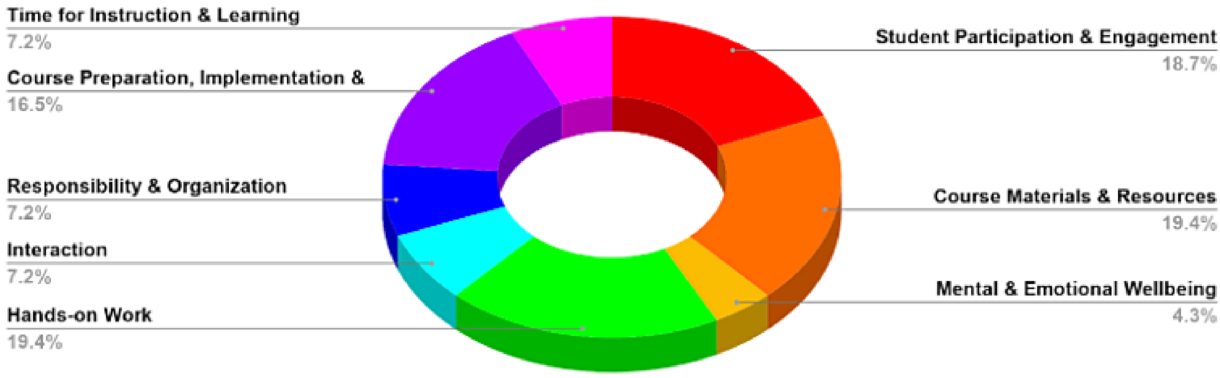


Figure 8: *Common Themes of Challenges Educators are Facing Produced Through Thematic Analysis*

When asked for their opinion on if the work being completed for STEM courses during the 2020-21 school year was comparable to that of previous years, s**ixty-two percent of educators who responded felt that it was not, while seventeen percent felt it was**. Among their responses, the most common theme mentioned was Hands-on Work. While some educators felt that students were learning more advanced topics by using items in their own home to conduct hands-on assignments and lab experiments, others found it limiting and difficult to find activities with materials that each student had. Here are a couple of quotes to demonstrate these findings:

"Yes they are covering Next Gen standards but using household products"
- 5th Grade Teacher

"Yes, except for labs, because we can only do virtual labs or assign labs that could be done with kitchen equipment. And we have to give choices for labs in case some supplies aren't available for some students. The most difficult challenge is finding kitchen labs and ensuring equity by providing choice…" **- High School Biology Teacher**

Regarding the specific challenges that they are facing, educators that responded to the survey shared a common concern for ensuring their students' engagement in their online lessons. Many mentioned that this uncertainty stems from not seeing students turn on their cameras and microphones, participate in class discussion, or take notes.

"Without students using their cameras, I do not know if they are actually listening or taking notes."
- Middle School Math Teacher

"I have a lot less instructional time, some of my students won't turn on their microphones and most won't turn on their cameras, decreased student participation and motivation." **- High School Math & Science Teacher**

As for challenges faced by their students, educators repeated their concern that **without hands-on work and access to course materials such as books and math tools, students are becoming overwhelmed.** Additionally, students living in rural areas "lack consistent internet service" and "tech devices" at home.

"Students cannot physically manipulate materials such as protractors, blocks, 3d shapes, algebra tiles, etc" **- Middle School Math Teacher**

"Screen exhaustion, overwhelmed/confused, limited platforms to ask for help, kinesthetic learners have nothing right now." **- High School Science Teacher**

Despite all of these challenges, the educators of northern New Mexico were still able to find a silver lining to their less than ideal situations and provide our team with some of the successes they had experienced with distance learning.

"Students are becoming more independent learners. They are taking more responsibility for their learning. Students are learning time management and organizational skills that they didn't need before." **- High School Biology Teacher**

"It's been easier to tie into a thematic lessons/cross curricular lessons. It's been easier to fit the lessons in because the kits we were using in person take way too much time to prepare and deliver." **- 2nd Grade Teacher**

"I am succeeding with making my teaching more student centered than ever and keeping better track of student data and more organized in my grading." **- High School Math & Science Teacher**

Based on these responses, our team drew the conclusion that educators are facing many difficulties when it comes to providing their students with an accessible, available, and equitable online education that keeps them engaged. For courses that require experiments, educators are doing their best to give students hands-on options that require materials they can find at home, however not all students may have kitchen materials available to them to use for purposes other than cooking. Additionally, some students with internet access may not have enough bandwidth to use their cameras or microphones to ask their teacher questions they may have during lectures.

5. RECOMMENDATIONS & CONCLUSION

In this chapter, we discuss our recommendations for the sponsor and future research based on our findings.

Recommendation #1: The Public Education Department (PED) & Northern New Mexico STEAM Coalition should apply the STEM Education assessment framework across all schools within the northern counties

We recommend that the Northern New Mexico STEAM Coalition use this STEM Education assessment framework we developed to assess schools and school districts. The framework serves to establish a baseline picture of accessible, available, and equitable STEM education. Implementation of the framework will provide a flexible evaluative system with components encompassing student experience, technology accommodations, course offerings, educators, and education adaptability (pertaining to the current COVID-19 pandemic). This will allow evaluations to be precise in which areas schools can improve upon and which school practices produce the best results holistically. Additionally, the qualitative aspect of the assessment framework allows for an evaluation on factors that do not have assignable metrics or numbers. By taking these components into account, a complete understanding of the accessibility, availability, and equity of STEM education can be reached. Lastly, we understand that there are many factors to take account for when understanding the accessibility, availability and equity of STEM education. We encourage that other components that may also be relevant to education in New Mexico be added and less relevant components be removed as deemed appropriate by evaluators.

Recommendation #2: The Northern New Mexico STEAM Coalition, experts in STEM Fields, and K-12 educators should work together to develop ways to provide students with innovative lessons in STEM education.

From our research and discussions with our sponsor, our team has identified that there is a need for innovative ideas for teaching STEM topics to the students of northern New Mexico. In order to accomplish this, we recommend that the NNMSC teams up with various STEM experts and K-12 educators to create a collaborative network of those who are passionate about STEM topics and can be used to improve students' interest in both their STEM education and STEM careers. Below describes how this can be beneficial to all parties:

- ***NNMSC*** - The goal of the NNMSC is to support STEM education and workforce development. Through this collaboration, the NNMSC would accomplish such by integrating the knowledge STEM experts have from their career with the knowledge on how to provide an education that the K-12 educators have. By providing these two parties with a space to collaborate, the NNMSC will be able to better chart improvement in students' engagement and progress in STEM courses.
- ***Experts in STEM fields*** - For those who currently hold a bachelor's degree or have multiple years experience in a field in or related to science, technology, engineering, or math that want to help to educate the next generation in their field, this collaboration could allow them to pass on knowledge they have gained through the years. There is the potential for these experts to assist in the creation of hands-on learning activities that can be completed by students at home, be utilized as guest speakers, and even be inspired to pursue an alternative teaching license so that they may teach their own classes while taking online courses in education.
- ***K-12 educators*** - Based on the results of our Distance Learning Survey, it is apparent that these educators are struggling to keep students engaged without the use of hands on lab equipment. This collaboration could assist these educators in development in both their STEM and educator skills through the NNMSC's STEAM hub resources and the knowledge of the STEM experts, reducing the stress they are currently facing.

Recommendation #3: The Northern New Mexico STEAM Coalition should continue to run the Distance Learning Survey we developed with improvements.

Throughout our Distance Learning Survey, we were able to gain a basic understanding of how sixteen different schools are adapting to new learning formats as the pandemic continues to prevent educators and students from going back to in-person learning. As this is an ongoing issue affecting the accessibility, availability, and equity of STEM education, we recommend that the NNMSC continues to run the Distance Learning survey used in this report with a few alterations.

Potential alterations to this survey include:

- ***Further Outreach of Educators*** - This survey was sent to head administrators of all of the schools we found contact information for online, meaning that some schools were excluded. As a result, we only received responses from sixteen different schools out of over one hundred and fifty within the seven northern counties. With contact information for administrators and educators of all the schools and various educator associations such as the New Mexico Council of Teachers in Mathematics and the New Mexico Science Teachers Association, the NNMSC can obtain more responses from a larger population.
- ***Clarify or Alter Phrasing of Questions*** - For some of the questions asked in the survey such as those inquiring about how much time students spend on synchronous and asynchronous learning online, educators' responses led our team to believe that these questions were very easily misinterpreted. By looking at the responses our team received, the Coalition should be able to pinpoint which of these questions need to be clarified or altered in order to collect helpful information.
- ***Add a Link to a STEAM Hub Page Highlighting Findings*** - When asked if there was anything else they would like to add in order to help our project, one administrator requested that we keep them updated with any findings as they were willing to learn from other schools. In order to provide educators who respond to the survey with these findings, we have sent them a copy of this report and a link to our website at the conclusion of this project. To take this a step further, the Coalition should provide this information on their own website along with their suggestions and recommendations. For example, next to findings regarding educators' challenges with engaging their students, links to various resources on how to create lessons in hands-on learning at home and develop an attractive course website can accompany this information.

Recommendation #4: The Northern New Mexico STEAM Coalition should sponsor another team from WPI to conduct research similar to what we have accomplished with the Higher Education Department (HED) STEM education data

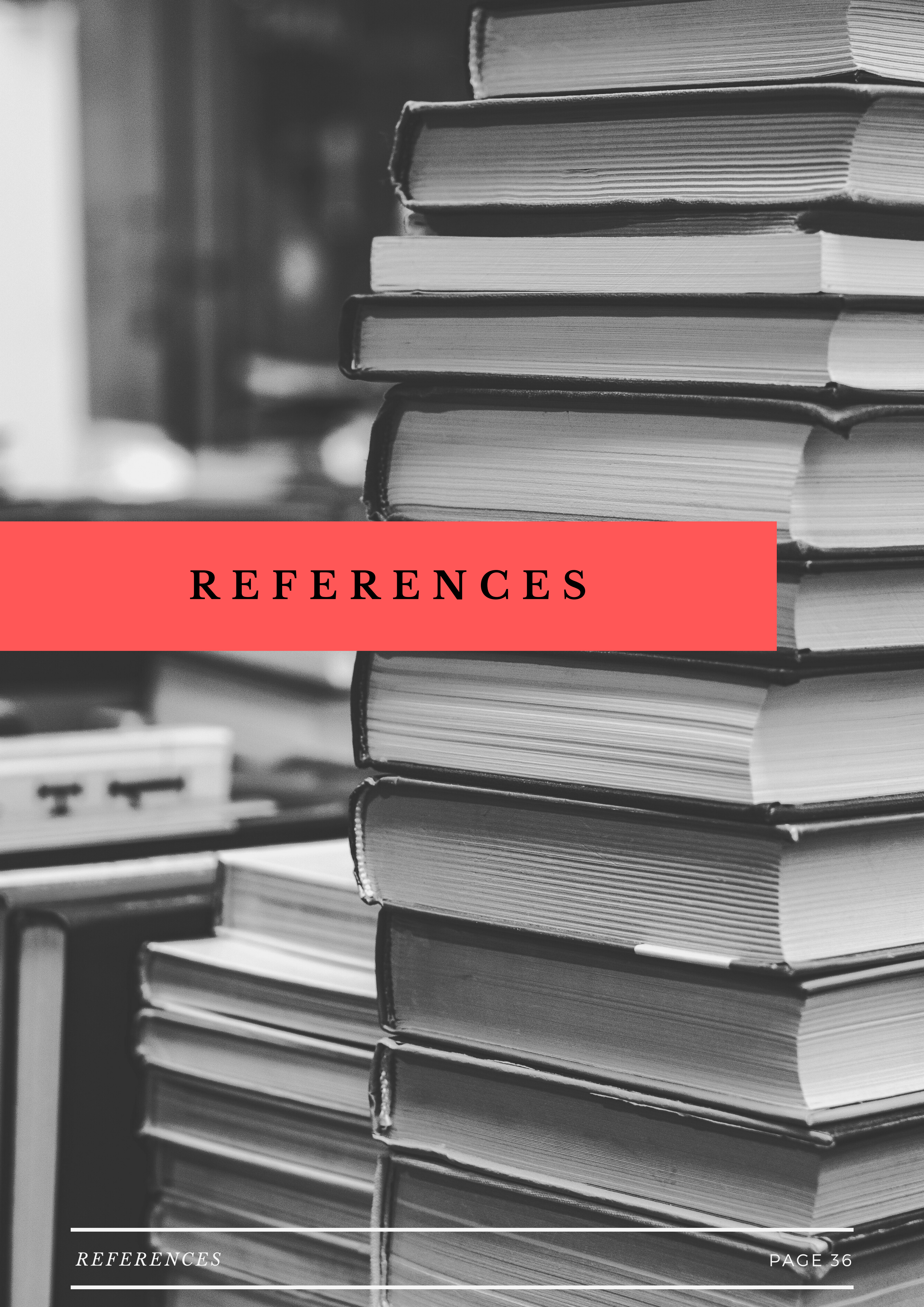
We had originally planned to include higher education in our analyses for this project by use of data sourced from the Higher Education Department (HED). However, the HED deemed our request for data to be burdensome and were unable to deliver the requested data within the timeframe that it would have been useful to us. Despite this, we did receive some of the data in the final week of the project and have compiled it to be handed off to the Northern New Mexico STEAM Coalition for analysis. The majority of the remaining data, especially data regarding specific courses, requires a memorandum of understanding (MOU) before it can be handed off, and we recommend that the NNMSC plan on writing and submitting this MOU. We suggest that the most useful analyses to be done with HED data are considerations of what core STEM courses students most often take in the first semester of their freshman years, proficiency and credit earning rates in STEM courses, investigations into what barriers exist to an accessible, available, and equitable higher education, and comparisons between these data sets that also include geographical data to highlight regional or demographic trends.

Recommendation #5: The Northern New Mexico STEAM Coalition should sponsor another team from WPI to study informal education's impact on students' interest in STEM in northern New Mexico and initiate the survey our team created.

For future projects, we recommend that the NNMSC sponsors another team of students from WPI to investigate informal STEM education in the northern New Mexico region. Through our research, we have found that informal education enables students to become aware of, learn about, and get interested in STEM subjects. This will broaden the scope of the project to include all of the region's educational resources. Potential areas of research include what organizations sponsor or manage programs in the region, how programs are working with local students to benefit local communities, how programs have been forced to adapt in the midst of the COVID-19 national pandemic, and how they are impacting program participants. To that end, we highly recommend the utilization of the survey our team created. We were unable to send out this survey due to time constraints and the hiatus STEM programs were on because of the national pandemic.

Conclusion

This project examined the current state of STEM education in northern New Mexico in terms of accessibility, availability, and equity. We developed a framework to assess the fundamental components of an accessible, available, and equitable STEM education, analyzed STEM education data from the PED, and performed a thematic analysis of responses from a survey regarding distance learning adaptations. Our findings show that the northern region of New Mexico is confronted with a multitude of challenges including, relatively poor math and science proficiencies, inequitable course offerings, low educator diversity, and adaptations to a distance learning format. These issues are affecting student demographics disproportionately. While our investigation on education in northern New Mexico was informative, areas such as informal education and secondary education would complete this picture of STEM education. There is also potential in the framework for highlighting aspects of education that the numbers cannot. Amidst the COVID-19 pandemic, it has become apparent that there are an ever-growing number of factors that go into facilitating successful education practices. With these growing factors, education organizations can only benefit from the utilization of qualitative and quantitative data to discover insights that can be implemented into improving the accessibility, availability, and equity of STEM education in northern New Mexico and beyond. In the future, the Northern New Mexico STEAM Coalition should continue to analyze the impact of COVID-19 and the accessibility, availability, and equity of STEM education in northern New Mexico through using our framework, collecting data from the HED, and sending out more surveys. Our project has created a baseline understanding of the current state of STEM education in northern New Mexico that can be expanded on in the future to create a more accessible, available, and equitable education for the students in the region.



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APPENDICES

Appendix A - Distance Learning Survey Distribution Email

From: WPI STEM Education IQP Team
Sent: 11/11/2020, 11/12/2020
To: Educators of all schools within the scope of our project
Subject: Survey of Educators Who Teach Science, Technology, Engineering, and Math Subjects

Dear Educator,

We are a team of students from Worcester Polytechnic Institute (WPI) in Massachusetts assisting with area research to support the strengthening of STEM (Science, Technology, Engineering, and Math) education in northern New Mexico. Our team is working on behalf of a growing coalition of local organizations and STEM advocates facilitated by the Community Learning Network (CLN) and in support of development of the free online resource portal www.nmsteamhub.com.

In the process of this research, we have identified a need for information that comes directly from the educators who are teaching in the current pandemic. We are reaching out to request the participation of your school's STEM faculty in a brief 10-15 minute survey. This survey focuses on the learning format your school is currently utilizing, the status of STEM coursework, what challenges and successes students and educators are facing with the current learning format, which processes are being used to distribute and facilitate lessons for remote or distanced students, and if these lessons are comparable to the work that students would normally be doing in school. This information will assist us in informing our sponsor how they can better help the northern New Mexico education community during these uncertain times.
The link to the survey can be found below for your consideration.
Survey Link: https://forms.gle/aoggShKeFP6NTf697

We ask that you forward this survey to administrators, teachers, tutors, mentors, educational support staff or any other faculty staff members who teach courses or cover topics related to science, math, technology/computer science, or engineering. If you feel that any other faculty or staff members would be able to offer particularly valuable insights, we welcome their input as well. We ask that responses be submitted within the next two weeks to allow time for data compilation and analysis.

Participation in the survey is completely voluntary and all responses will be kept confidential. No personally identifiable information will be associated with responses in any reports of these data. The WPI Institutional Review Board (IRB) has approved this survey. Should you have any questions or comments, please feel free to contact us at gr-sf20-stemed@wpi.edu. At the conclusion of our project, our complete findings will be posted to a website we are currently developing to showcase the current state of STEM learning in Northern New Mexico as schools are adapting and responding to the current pandemic. A link to this website will be provided to you at the conclusion of this project.

Thank you so much for your time and cooperation.
Best,
The STEM Education Team - gr-sf20-stemed@wpi.edu
Cady Diehl, Management Information Systems 2022
James Marlow, Chemical Engineering 2022
Ben Tetreault, Mechanical and Manufacturing Engineering 2022
Madelyn Uryase, Civil Engineering 2022

Appendix B - Distance Learning Survey Questions

Survey Statement: For the purpose of this survey, the WPI STEM Education IQP Group is interested in gathering information specifically on courses offered by schools in northern New Mexico with lessons in science, technology, engineering, and/or mathematics.

Section 1: Distance Learning Survey

What school do you represent?

What is your job/role at the school?

- Teacher (**move to Section 2**)
- Principal/Administrator (**move to Section 3**)
- Learning Coach or Educational Support Staff (**move to Section 4**)
- Tutor/Mentor/Volunteer (**move to Section 4**)

Section 2: Teacher

Check all grade levels you teach: Pre-K, K, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

What STEM courses/lessons do you teach?

If there are any, what STEM programs, clubs, or activities do you facilitate at your school? (i.e. Math Club, Computer Science Club, Social Media Club, Robotics Team) (**move to Section 5**)

Section 3: Principal/Administrator

Check all grade levels of your school: Pre-K, K, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

If there are any, what STEM programs, clubs, or activities do you facilitate at your school? (i.e. Math Club, Computer Science Club, Social Media Club, Robotics Team) (**move to Section 5**)

Section 4: Learning Coach/Educational Support Staff or Tutor/Mentor/Volunteer

Check all grade levels you serve: Pre-K, K, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

What STEM courses/lessons do you work with students on?If there are any, what STEM programs, clubs, or activities do you facilitate at your school? (i.e. Math Club, Computer Science Club, Social Media Club, Robotics Team) (**move to Section 5**)

Section 5: 2020-2021 School Learning Format

What type of learning format is your school currently utilizing for the 2020-21 school year?

- In-Person (move to Section 6)
- Remote or Distance Learning (move to Section 7)
- Hybrid (Combination of In-Person and Remote Learning) (**move to Section 8**)

Section 6: In-Person Learning

Are all students issued devices such as a tablet or Chromebook that they may bring home to complete schoolwork?

- Yes, they are all provided devices
- No, only certain grade levels/student groups are issued devices
- No, the school's devices are only meant for work in the classroom
- No, the school does not have such devices

Are all of the STEM courses/lesson topics that were taught prior to the pandemic continuing to be taught at your school this semester?

- Yes
- No

List any STEM courses/lesson topics currently offered in-person: _________________________

If any STEM courses/lesson topics were REMOVED please list them here:_________________

Please check off some of the reasons for the removal of these courses (**move to Section 9**)

- Lack of student interest
- Minimum number of students required to run the course(s) not met
- Not enough/lack of funding to run the course(s)
- Lack of instructor(s) to run the course(s)
- Instructor was needed to teach other course(s)
- Inability for students/instructors to access technology needed for the course(s) (internet, computers, software, etc.)
- Inability for students/instructors to access other materials needed for the course(s) (laboratory equipment, textbooks, etc.)
- To make way for the creation of new courses
- Inability to for students to keep a social distance in the classroom while participating in the course(s)
- To create more time for lessons in other subjects
- Other: (explain)

Section 7: Remote or Distance Learning

Are all students issued devices such as a tablet or Chromebook that they may bring home to complete schoolwork?

- Yes, they are all provided devices
- No, only certain grade levels/student groups are issued devices
- No, the school's devices are only meant for work in the classroom
- No, the school does not have such devices

What is the current structure of distance learning delivery and facilitation for STEM courses?

- Packets delivered to the student at home or picked up by families
- Online Learning
- Hands-on Learning Kits
- Other ______________

If packets are used: What is the frequency at which the learning packets are delivered to students?

- Every 1-2 days
- Every 3-4 days
- Every 5-6 days
- Once per week
- Other: _______

If packets are used: Who is responsible for determining and developing the content for STEM learning packets and how are they approved?

What platforms and learning management systems (LMS) are being used to support online distanced learning? (i.e. Canvas, PowerSchool, Zoom, Google Hangouts)

How many hours a day on average are students engaged in synchronous learning for STEM courses facilitated by a teacher online?

- 0-2 hrs
- 3-5 hrs
- 6-8 hrs
- 8+ hrs

How many hours a day are students engaged in self paced online learning of their STEM courses?

- 0-2 hrs
- 3-5 hrs
- 6-8 hrs
- 8+ hrs

Who is responsible for determining and developing the content for online STEM learning and how is it approved?

How is student work returned to be assessed? (Checkboxes)

- Mail in
- Online Upload
- School Drop Off
- Handed to teacher in-person
- Pick-Up Other: ____

Are all of the STEM courses/lesson topics that were taught prior to the pandemic continuing to be taught at your school this semester?

- Yes
- No

List any STEM courses/lesson topics currently offered through distanced learning (packet/online/other)

If any STEM courses/lesson topics were removed from the 20-21 course offerings, please list them here

Please check off some of the reasons for the removal of these courses (**move to Section 9**)
- Lack of student interest
- Minimum number of students required to run the course(s) not met
- Not enough/lack of funding to run the course(s)
- Lack of instructor(s) to run the course(s)
- Instructor was needed to teach other course(s)
- Inability to for students/instructors to access technology needed for the course(s) (internet, computers, software, etc.)
- Inability to for students/instructors to access other materials needed for the course(s) (laboratory equipment, textbooks, etc.)
- Lack of instructor training to create an online platform for their course(s)
- To make way for the creation of new courses
- To create more time for lessons in other subjects
- Other: (explain)

Section 8: Hybrid Learning

Are all students issued devices such as a tablet or Chromebook that they may bring home to complete schoolwork?
- Yes, they are all provided devices
- No, only certain grade levels/student groups are issued devices
- No, the school's devices are only meant for work in the classroom
- No, the school does not have such devices

What is the current structure of hybrid learning delivery and facilitation for STEM courses?
- Packets delivered to the student at home or picked up by families
- Online Learning
- Socially distanced in-person class
- Other

If packets are used: What is the frequency at which the learning packets are delivered to students?
- Every 1-2 days
- Every 3-4 days
- Every 5-6 days
- Once per week
- Other: _______

If packets are used: Who is responsible for determining and developing the content for STEM learning packets and how are they approved?

What platforms and learning management systems (LMS) are being used to support online distanced learning? (i.e. Canvas, PowerSchool, Zoom, Google Hangouts)

Who is responsible for determining and developing the content for online STEM learning and how is it approved?

How many hours a day are students engaged learning online in hybrid STEM courses?
- 0-2 hrs
- 3-5 hrs
- 6-8 hrs
- 8+ hrs

How many hours a day are students engaged learning offline in hybrid STEM courses?

- 0-2 hrs
- 3-5 hrs
- 6-8 hrs
- 8+ hrs

How is student work returned to be assessed? (Checkboxes)

- Mail in
- Online Upload
- School Drop Off
- Handed to teacher in-person
- Pick-Up
- Other: ____

Who is responsible for determining and developing the content for hybrid STEM learning and how is it approved?

Are all of the STEM courses/lesson topics that were taught prior to the pandemic continuing to be taught at your school this semester?

- Yes
- No

List any STEM courses/lesson topics currently offered in a hybrid model

If any STEM courses/lesson topics were removed from the 20-21 course offerings, please list them here

Please check off some of the reasons for the removal of these courses (**move to Section 9**)

- Lack of student interest
- Minimum number of students required to run the course(s) not met
- Not enough/lack of funding to run the course(s)
- Lack of instructor(s) to run the course(s)
- Instructor was needed to teach other course(s)
- Inability to for students/instructors to access technology needed for the course(s) (internet, computers, software, etc.)
- Inability to for students/instructors to access other materials needed for the course(s) (laboratory equipment, textbooks, etc.)
- Lack of instructor training to create an online platform for their course(s)To make way for the creation of new courses
- Inability to for students to keep a social distance in the classroom while participating in the course(s)
- To create more time for lessons in other subjects
- Other: (explain)

Section 9: Successes and Challenges

In your opinion, is the current work for STEM courses whether they are in person, online, or hybrid, comparable to the work that students would normally be doing in school? Why or why not?

Please list 1-2 specific challenges that instructors of STEM courses/lessons are currently facing with the current model of teaching.

Please list 1-2 specific challenges that students taking STEM courses/lessons are currently facing with the chosen learning format.

Please list 1-2 specific successes that instructors of STEM courses/lessons are currently facing with the current model of teaching.

Is there anything else you would like to add regarding the current adaptations in STEM learning that your school is utilizing during the pandemic that you feel would be helpful or informative? If so, please respond here:

Appendix C - Accessibility, Availability, and Equity Framework

STEAM Learning Accessibility, Availability, & Equity Component	Description	Excellent (above average)	Good (average)	Poor (below average)
Integration of Social and Cultural Awareness	*Accessible, available, and equitable STEAM education considers a variety of perspectives to build awareness of social, ethnic, and cultural sensitivities in order to foster awareness, sensitivity, and empathy in educational environments*	Lessons introduce multiple social and cultural perspectives in association with STEAM topics, projects, and relevant real-world applications. They also work to supplement the understanding of how to become an informed citizen.	Lessons may introduce some social and cultural perspectives in association with STEAM topics, projects, and real-world applications. Lessons attempt to supplement the understanding of how to become an informed citizen.	Lessons fail to introduce multiple social and cultural perspectives in association with STEAM topics, projects, and relevant real-world applications. Lessons do not supplement the understanding of how to become an informed citizen.
Accessibility for Students of Diverse Backgrounds	*Accessible, available, and equitable STEAM education includes students of diverse identities including their: ethnicity, race, socioeconomic status, gender, exceptionalities, language, religion, sexual orientation, and geographical area.*	All students have the opportunity to take any class which interests them offered at their school regardless of their identity. Students are provided with an inclusive and welcoming learning environment.	Efforts are being made to make STEAM courses inclusive of all identities, but some are placed at a disadvantage. Underrepresentation of these backgrounds leads to demotivation to pursue STEAM.	Students are prevented from taking some courses, either directly or indirectly, due to their identities. Some are clearly underrepresented in STEAM courses.
Access to Technology for Students and Educators	*Accessible, available, and equitable STEAM education gives students and educators the ability to access computers, laptops, tablets, the internet, and other technology needed to run the course.*	There is a 1:1 student to device ratio. Technology is frequently used to supplement STEAM learning. There is internet access in the school, and hotspots are provided to students and educators who do not have wireless internet connections in their homes.	Some students are provided devices but the school does not have a 1:1 ratio. Most students and educators have access to the internet. Technology may be used to supplement learning occasionally, but there is still a major dependence on physical copies.	Students and educators do not have access to technology and/or are not provided technology by the school. Access to the internet is very limited. Technology is not implemented in coursework or teaching.

Appendix C - Accessibility, Availability, and Equity Framework

STEAM Learning Accessibility, Availability, & Equity Component	Description	Excellent (above average)	Good (average)	Poor (below average)
Considerations in Accessibility of Technology	*Accessible, available, and equitable STEAM education meets accessibility considerations (large legend keyboards, formatting for screen readers, alternative human interface devices)*	All students who have accessibility considerations have their needs met quickly, efficiently, and discreetly.	There are methods in place to *accommodate* students that require accessibility considerations with technology, but the process of implementing them is convoluted and infrequently used.	Technology contains little to no accessibility considerations. Student needs are not met.
Quality of Student and Educator Technology	*Accessible, available, and equitable STEAM education includes functioning and adequate internet access and bandwidth, technology speed and age, ease of use, provided software (LMS and assessments)*	Technology is up-to-date and high-functioning. Wifi is high-speed and connection is reliable. LMS are easy for students and educators to navigate.	Technology can function but is not up-to-date. Internet access is relatively constant, but bandwidth is minimal and heavy use causes major slow-downs.	Technology for STEAM courses is very outdated, broken, or unreliable, Wifi is extremely slow and connection is unreliable. LMS are difficult for students and educators to navigate
Accessibility to varied STEAM curriculum and course selections	*Accessible, available, and equitable STEAM education provides students with a variety of course offerings that go beyond required science, technology, engineering, and mathematics*	STEAM courses of various achievement levels are offered including remedial, AP, IB, and Dual Enrollment as well as STEM electives. Courses also go beyond school requirements by exercising critical thinking, problem solving, and collaborative skills.	State standardized STEAM courses are available as well as some STEAM electives. Students have some choice in what STEAM courses they take. Some AP, IB, and Dual Enrollment classes are offered.	The only STEAM courses offered include those required by state standards. Students provided with little to no choice in what STEAM courses they take. Little to no remedial, AP, IB, or Dual Enrollment classes offered.
Availability of Teaching Support	*Accessible, available, and equitable STEAM education supplements students' education in the classroom by providing them tutors, academic advisors, and the counselors they need to succeed*	School actively encourages students to attend tutoring provided outside class. Each student has an involved and active counselor/academic advisor that has time for all their students.	Some additional help outside of class is available if students search for it. Each student is assigned a counselor/academic advisor, but may be shared among too many students.	Little to no tutoring or educational coaching is offered to students outside of the classroom. Minimal involvement from counselor/academic advisor if even assigned.

Appendix C - Accessibility, Availability, and Equity Framework

STEAM Learning Accessibility, Availability, & Equity Component	Description	Excellent (above average)	Good (average)	Poor (below average)
Student and Educator Access to Course Materials	*Accessible, available, and equitable STEAM education provides students and educators with access to learning materials including labs, textbooks, white boards, etc.*	Learning materials provided are up-to-date, in good condition, and there are enough in all classrooms to accommodate the number of students and educators. Supplemental materials are provided to meet the needs of students that require an accommodation.	Educators are equipped to deliver standard curricula, but resources for projects, labs, etc. are very limited. Most but not all classrooms are provided learning materials for each student.	Any materials needed to run STEAM courses are extremely limited in supply, damaged, outdated, or nonexistent limiting access for students and/or educators.
Access to Educators	*Accessible, available, and equitable STEAM education means that all teaching positions are staffed with educators with the appropriate license and content knowledge.*	Few to no vacancies in STEAM teaching positions which allows teachers to go above and beyond in delivering their curricula.	Some teaching positions are left unfilled. However, this does not cause a significant excess in the amount of work expected from each educator.	The majority of teaching positions are left unfilled causing overworked faculty and increased difficulty in delivering a high-quality education as a result.
Diversity of Educators	*Accessible, available, and equitable STEAM education includes teachers of diverse ethnicity, race, socioeconomic status, gender, exceptionalities, language, religion, sexual orientation, and geographical area.*	There is a diverse pool of faculty and staff.	The faculty is somewhat diverse, but shows a bias towards the most prominent ethnicity in the local area.	There is little to no diversity among the educators.
Instruction by Qualified Educators	*Accessible, available, and equitable STEAM education accounts for students learning best with non-standard educational practices and requires qualified and prepared educators to make this possible.*	Little to no educators are working with alternative teaching licenses, and there are frequent opportunities for teacher professional development provided.	Smaller population of STEAM educators are working with alternative teaching licenses.Some opportunities for teacher professional development are provided.	Most STEAM educators are working with alternative teaching licenses, and little to no teacher professional development is provided.

Appendix C - Accessibility, Availability, and Equity Framework

STEAM Learning Accessibility, Availability, & Equity Component	Description	Excellent (above average)	Good (average)	Poor (below average)
Post-Secondary Degree Pathways ***Higher Education Specific***	*Accessible, available, and equitable STEAM education prepares students to enter post-secondary curricula without need for preparatory or remedial courses.*	Majority of students are graduating at/above expected STEAM proficiencies. Very few students have to take remedial/prep courses, most start with standard curricula, some bring transfer credit.	Some students are graduating at expected proficiencies in STEAM subjects. Some students still need remedial courses, but some start with standard curricula.	Majority of students are graduating below expected STEAM proficiencies. Majority of students have to take remedial courses when starting post-secondary education.
Adaptations for Distance Learning ***COVID-19 Specific***	*Accessible, available, and equitable STEAM education strives to offer the same quality of education when adapted for distance learning as when in more traditional formats by the effective use of tools like learning management systems (Canvas, Edmodo, Google Classroom, etc.) and virtual meeting systems (Zoom, Google Hangouts, Skype, etc.)*	Adaptations for distance learning meet the needs of the entire student population regardless of their identity. This includes providing all students with: • Devices and hotspots • Optional lesson and work packets delivered to their homes or picked up from the school • Hands-on learning kits	Adaptations for distance learning meet some but not all of the needs of the student population regardless of their identity. This includes providing students with: • Devices for those with internet access who do not currently have one at home • Lesson and work packets to those without internet connection	Adaptations for distance learning do not meet the needs of the student and educator population at all: • Devices and hotspots are not provided • Limited lesson and work packets provided to students in need
Availability and Integration of Learning Support ***COVID-19 Specific***	*Accessible, available, and equitable STEAM education is cognisant of the challenges students and educators are facing in the pandemic and allows flexibility in course and assignment delivery to account for complications in distance learning, as well as available student and staff support personnel and resources.*	Curricula have been reformed to accommodate the challenges of distance learning, and students and educators have been provided with additional resources to ease the transition to and implementation of distance learning. Increased availability of counseling services are added for both educators and students.	Curricula have not been altered to accommodate for distance learning, but course delivery has been reworked to better assist students in distance learning. Additional student and educator counseling resources have been added, but are insufficient to meet demand or are not widely advertised.	The pacing of course delivery has not been altered to reflect distance learning challenges, but students are expected to continue learning the same as they previously were despite this. No programs or personnel have been implemented to assist students with distance learning challenges or general COVID-19 stresses and issues.

Appendix D - Thematic Coding Results from Survey Responses

Student Participation & Engagement	Course Materials & Resources	Mental & Emotional Wellbeing	Hands-on Work
Engagement	Household Products	Out of Touch	Hands On Activity
Completion of Work	Classroom Materials	Overwhelmed	Hands On Approach
Class Attendance	Kitchen Equipment	Fatigue	Lab(s)
Motivation	Supplies	Burnout	Experiment
Listening	Online Materials	Exhaustion	Hands on Application
Taking Notes	Information	Confused	Hands-On Learning
Turn on (Camera, Microphone)	Books	Mental Health	Kinestheic Learners
Logging in/on	Computer		Physical
Discussion	Device		Hands-On Work
Course Completion	Internet		Projects
Focus	Online Access		
Participation	Items		
Fun	Notebooks		
Home Distractions	Technology		
Social Media	Online Platform (i.e. Google Classroom)		
Gaming	Support		
	Materials		

Interaction With Others	Responsibility & Organization	Course Preparation, Implementation	Time for Instruction
One on One	Time Management	Instruction	Pace
Working Together	Organization	Video (Lecture)	Hour(s)
Close Proximity	Keep Track	Feedback	Day(s)
Group Focused	Independent	Content	Time
Interactive	Organization	Create Lectures/Slides	Week
Face to Face	Self-advocacy	Planning	
Personal Contact		Assignments	
In-Person Teaching		Lessons	
Working With Peers		Synchronous	
		Asynchronous	
		Training	
		Note Writing (instructor)	
		Curriculum?	
		Remote Learning	

	Work Comparable?	Challenges (Instructors)	Challenges (Students)	Successes	TOTAL	%
Student Participation & Engagement	3	10	4	9	26	18.7
Course Materials & Resources	4	8	9	6	27	19.4
Mental & Emotional Wellbeing	1	3	2	0	6	4.3
Hands-on Work	9	9	9	0	27	19.4
Interaction	3	1	5	1	10	7.2
Responsibility & Organization	0	2	2	6	10	7.2
Course Preparation & Implementation	7	8	3	5	23	16.5
Time for Instruction	5	2	1	2	10	7.2
TOTAL	32	43	35	29	139	100%