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Assessment and Engagement Strategies for STEM

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by

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ABSTRACT

ASSESSMENT AND ENGAGEMENT STRATEGIES FOR STEM

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In this study, I looked at how does student engagement change when a certain assessment is announced prior to a unit. This study looks at what different assessment levels have been researched to accomplish and how to utilize that to our advantage. I researched how does student engagement change when STEM projects are introduced in a 5^{th} grade classroom. It is the role as educators to work towards providing our students with the opportunities to express their levels of knowledge and to show students what they have achieved. This study looks at what I found to be important about STEM projects and if projects changed student engagement in my classroom. I found that students' engagement levels were not impacted by assessment strategies, but more related to utilizing STEM projects.

Keywords: STEM, Engagement, Assessment Strategies

DEDICATION

To Kirsten for being the force that pushes me! To Grace for always being a shining light in my world.

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CHAPTER 1: INTRODUCTION

Problem Statement

In today's advancing, technological education world, teachers are being expected to provide more in-depth learning opportunities than ever before. Teachers are required to prepare students for rigorous state testing and for the real world. How do teachers prepare and get all this instruction in? Educators have to begin to figure out ways to implement more than one subject into our teaching. The phrase STEM started as SMET (Science, Mathematics, Engineering and Technology) in the 1990s but schools are just starting to realize its importance. STEM stands for Science, Technology, Engineering and Mathematics. It is important that teachers implement STEM in their classrooms. STEM can provide the students with what they need to be able to meet the demands of today's expanding world of jobs and opportunities.

It is important that teachers begin to understand the significance of what STEM can provide. Teachers can go from only covering one subject at a time to being able to implement multiple subjects in a matter of minutes. With this saved time teachers can really allow students to experiment and explore different aspects of their learning. STEM projects are rich in integrating math, science, engineering and technology together into a project that enhances all of these aspects at once. I move from doing experiments in science to implementing math, engineering and technology with it and it grows from a science project to a STEM project. STEM projects would have kids involved in hands-on learning, planning their engineering process, deep in conversation or work and so much

more. The purpose of this study is to explore what assessment strategies provide high engagement levels from my students.

Engagement is a word that is thrown out in conversation and class so easily but how easy is achieving a proficient engagement level. Student engagement refers to how interested our students are in their learning, are they curious about what they are learning, do they have a passion to continue and broaden on that learning and are they excited to be participating. For successful learning to take place students need to be actively engaged in their learning. What practices can solve the engagement problem? Kids are spending a majority of their free time utilizing technology and I think it is the teacher's job to learn how to utilize technology to meet the engagement needs of our students. Student engagement is digging deep into pedagogical knowledge, having a plan or visual of what is needed and being an active participant in classroom discussions, activities and experiments. It is the role of the teacher to provide all of these opportunities for all students simultaneously. Are educators up for the challenge?

Purpose and Research Questions

This study is designed to provide educators with the tools to successfully engage students throughout their STEM projects. I asked myself how does student engagement change when a certain assessment is announced prior to a unit. Would their engagement change if it was a test, compared to a poster project? I look at what research defines as student engagement, how to achieve it and how to recognize it. Throughout my research study I also look at how does student engagement change when STEM projects are introduced in a 5^{th} grade classroom. One of the biggest questions I ask myself is how do I tell if my students are truly engaged or if they are just programmed to do what they are

told. Throughout my study my definition of engagement changed drastically. I went from are they participating and doing the work all the way to my kids are smiling, laughing and fully participating. Engagement in education is defined in so many ways and everyone looks at the word differently. To me engagement in my classroom is when students have taken their education into their own hands by taking an interest and ownership of it and have explored deeply into their contexts and invested their time in exploration and consideration of the real world. I want to be able to show a correlation between assessment strategies and student engagement while utilizing STEM projects.

Assessment is a hot topic in not only my district but also the state of Nebraska. Educators are beginning to ask themselves how important rigorous state tests are to students' well-being and education process. The way I assess my students will continue to be a heavily researched topic. There are many types of assessments; for my study, I looked at three different ways of assessing my kids. I gave them a summative test for one project, they did a poster project at the end of another and a group project with peer grading at the end of the other one. I know that a majority of my students do not like taking tests and so I wanted to see if I could match that thinking with my data in my study and really see if there is a correlation between not being engaged when there is a test at the end and being more engaged because there is a different form of assessment that they find more important to their learning. Finding the kind of assessment that is most pertinent and most productive for my students is a challenge. It is educators job to continue to stay up to day with current issues in education and promote research-based learning. Project based learning (PBL) is beginning to become a hot topic again and be implemented in many districts. PBL looks at introducing learning that helps students gain

a deeper understanding of learning in real world contexts. My research looks at how does student engagement change when a certain assessment is announced prior to the unit.

Methods Overview

My action research looked at how does student engagement change when STEM projects are introduced and a certain assessment is announced prior to the unit beginning in a 5th grade classroom. I utilized student interviews to try to gain insight into their thoughts and ideas and whether or not they thought they were engaged and excited about learning. I collected my own thoughts and observations in my field notes notebook. I collected my thoughts and observations on numerous occasions. Students' work was collected and recorded to show me their understanding and utilized to show progress throughout the semester. I took advantage of pre/post surveys as well. I used these surveys to look at preconceived thoughts on topics as well as what they wanted to learn. By the end the post surveys showed me what they had learned as well as their post thoughts about our topics. This really gave me insight into how to successfully meet their needs during the lessons as well as what they really got out of the lesson.

Definition of Key Terms

STEM-Integrating and merging science, technology, engineering and mathematics into a lesson

Engagement-students are interested, curious, excited about their learning and have a passion to improve and broaden their understanding

Assessment Strategies-tools teachers use to find the level of proficiency of their students, involving multiple different types, including summative, formative, exit tickets, discussion questions, presenting findings and explaining to a partner

CHAPTER 2: LITERATURE REVIEW

Overview

My study looks at how assessment strategies can have an impact on engagement levels throughout my unit while implementing STEM projects. When researching I looked for keywords. I searched assessment strategies in education, active engagement in education, implementing and integrating STEM projects and formative assessment and summative assessment in education. I searched through Google Scholar and UNL Libraries Academic Search Premier. I found three major themes throughout the related literature: student engagement, assessment strategies and integrated STEM and increasing teacher knowledge. Throughout my research I found that the type of assessment strategy utilized can impact student engagement and the impact that STEM projects can have on education. There are many types of assessments that can be utilized. Research has found ways to maximize student engagement and how to advance STEM projects for the future. It is vital that teachers are comfortable enough to teach STEM to be able to move forward.

Student Engagement

Student engagement is not only concerned with gaining engagement from students but also working to move the disengaged to engaged. Harris (2008) conducted a phenomenographic study of student engagement. She interviewed 20 different teachers looking for connections and themes of what teachers were wanting and observing to gain engagement and justify if they were achieving it. Harris (2008) found three areas to look at for engagement and they include behavioral, emotional and cognitive. They are broken down into behavior being the participation, emotional is their attitudes and cognitive is

putting in their own investments. Throughout the study Harris (2008) found that six main themes came about. Those themes are:

- participating in classroom activities and following school rules
- being interested in and enjoying participation in what happens at school
- being motivated and confident in participation in what happens at a school
- being involved by thinking
- purposefully learning to reach life goals
- owning and valuing learning

Munns and Woodward (2006) study student engagement through a project called, Fair Go Project. In the project, they look at how student self-assessment can impact student engagement. There are strong theoretical and practical connections between student engagement and self-assessment (Munns & Woodward, 2006). Substantive student engagement should be the top priority for educators who are worried about improving student outcomes. To argue this Munns and Woodward (2006, p. 194) state that "for students to be substantively engaged, then it is necessary that there be a classroom philosophy of individual and collective student self-assessment." That is when students begin to really dig deep into their understanding of how they learn and what motivates them to learn they will begin to take responsibility for their learning. When students start to assess themselves and ways are found to help them navigate their learning there is a movement from responsibility being on the teacher to the student. In contrast to Harris (2008), Munns and Woodward (2006) found that student engagement should not be broken into the three categories of behavioral, emotional and cognitive but should instead include all three as one multi-dimensional piece.

Student Engagement is being transformed from concentrating not on the disengaged but looking at what needs to take place to get the engaged students where they are. Taylor and Parsons (2011) are both life-long educators as well as having interests in education research. In their study, they looked at what strategies and philosophies teachers are using to gauge and attain student engagement. Historically and largely, student engagement has looked at increasing achievement, positive behaviors and a sense of belonging so that students can be kept in school (Taylor & Parsons, 2011). Eventually student engagement was correlated with classroom management. It is recommended that teachers today have to utilize a curriculum that includes exploration, interaction, multimedia and other aspects of instruction to be able to meet the needs of today's technology literate students. (Taylor & Parsons, 2011) state that to be an effective teacher today, you need to be able to thoughtfully design learning tasks that include the following:

- The task requires and instills deep thinking.
- The task immerses students in disciplinary inquiry.
- The task is connected to the world outside the classroom.
- The task has intellectual rigor.

Hughes, Wu and West (2011) investigated classroom performance, goal practices and student behavioral engagement with just under 500 elementary kids in grades 2 to 5 who were academically at-risk. Engagement has been linked to relying on many aspects of the teaching day including; student-teacher relationship, acceptance, classroom practices and instructional practices (Hughes, Wu & West, 2011). Over time there has been an emphasis put on performance goals, which has decreased student engagement.

Taylor and Parsons (2011) agree that there is a correlation between student engagement and student behaviors.

Overall, research shows that to attain student engagement and to retain it, there has to be a level of understanding between both teacher and student. Behavioral, cognitive and emotional engagement pieces should all be considered when planning STEM projects. To successfully achieve student engagement, classroom management practices and strategies have to be implemented and followed. The way educators assess our students may also have an impact on their engagement levels as well.

Assessment Strategies

Assessment has been a hot topic in education for years. There are so many different types of assessment available for educators to gain insight into their students learning. Formative assessment deals with supporting learning during an unit and summative assessment is used to verify learning on a unit. With technology new ways are being found to assess students and new platforms to perform them on. With the changes being implemented there is always a need for new research.

Rick Stiggins is a founder and executive director of a training institute and Rick DuFour is an education author and a consultant of professional learning communities in districts. They have worked on maximizing the power of formative assessment in the classroom. Formative assessment can be used to identify understanding, what comes next, bring about intervention strategies, make improvements to teachers' instruction, help students to own their learning and build confidence, continue improvements across education and drive a school's transformation (Stiggins & DuFour, 2009). William, Lee, Harrison and Black (2004) studied six different schools and 24 total teachers to explore

and plan their approaches to formative assessment. The introduction of No Child Left Behind and high stakes testing makes the implementation of formative assessment a little difficult (William, et al.,2004). There has become a "widespread belief that teaching well is incompatible with raising test scores" (William, et al., 2004, p. 50). They concluded that improving formative assessment had a positive impact and had positive benefits in their study.

Karee Dunn and Sean Mulvenon looked through research on formative assessment and its impact on student performance. They both work for universities and were analyzing data to figure out how valid it is. Dunn and Mulvenon (2009) talked about the importance of formative assessment to improve practices of teachers and provide support for lower achieving students. They found that in contrast to previous research stating that there was a positive correlation between formative assessment and student improvement that there is a "dearth of empirical evidence identifying best practices related to formative assessment" (Dunn & Mulvenon, 2009, p.2). Throughout their research they found limitations, that they believed negatively impacted data.

Self-Assessments are becoming more and more common and heavily utilized. Bingham, Holbrook and Meyers are all assistant professors at a university dealing with early childhood education. Their research looked at how self-assessments can enhance learning and assessments in education. They believe that when students look at their learning and get to express their comfort level it helps them take ownership of their education. Educators are continuously trying to assess students as the year goes on. They look for ways to evaluate student learning. However, student self-assessment can sometimes be overlooked (Bingham, Holbrook & Meyers, 2010). They go on to talk

about how self-assessment practices can help elementary students' early development as critical and reflective thinkers (Bingham, Holbrook & Meyers, 2010).

Assessments are utilized at three different levels. Classroom assessments are those that take place at the classroom level and reflect on students, teachers and parents who are working together towards what is to come next in the learning process. Stiggins and DuFour state to have a balanced classroom educators' assessment needs to utilize formative to support learning and summative to verify it. The next level of assessment is school-level in which teams of teachers, principals and curriculum personnel work together to create assessments that reflect the districts visions and goals. The final level of assessment is institutional. At this level the school board, superintendent and legislators work together to make sure the school and district are meeting the state and national standards set forth to reassure students are meeting those requirements. As educators, we need to be a voice on all three levels. Stiggins and DuFour give four foundations for productive assessment:

1. Clear learning targets.
2. A commitment to standards-based instruction.
3. High-quality assessment.
4. Effective communication.

Computer-based assessment is something that is being utilized more and more as schools are transforming to a more technology basis. Computer-based assessment has it pros and cons. A recurring theme over assessments is the critical role of feedback. Shute and Rahimi (2017) have reviewed computer-based assessment for learning in elementary and secondary education to gain insights into how educators can utilize these assessment

types to maximize student outcomes. Computer-based assessment has given educators the opportunity to provide instantaneous feedback that would normally take educators a lot of time. Teaching is making a shift from a teacher-centered education to a more student-centered aspect. Students have to become more responsible for their education and have to take control of their learning to make it worthwhile. Research is saying educators need to move forward to personalized learning (Shute & Rahimi, 2017). With educations advances in computer and technology, computer-based assessment is becoming more and more adaptive and can be utilized online. There has been talk over the last couple years of moving to a more computer based education where teachers teach in front of a computer to students in front of a computer. This would lead to no face-to-face interactions, which can be detrimental to student learning. Teachers are provided more opportunities for informal assessment when teachers are face-to-face with students rather than just online learning.

Game-based assessment is something new to a lot of educators. With the way technology is advancing and our districts are looking to integrate technology it is in the foreseeable future. Shute and Rahimi (2017) believe that video games can be utilized as a channel for assessment. Game-based assessment can utilize real life context activities that interest our technology-advanced students. When there is a focus put on engagement and providing students opportunities to show us what they know, game-based assessment is starting to find itself at the top of that list. Shute and Rahimi state, “video games can be used as a vehicle for assessment, p. 13.”

Whatever assessment is utilized, feedback is pivotal to making it applicable. Both formative and summative assessments have their pros and cons but it is how educators

utilize those pros and cons that make the difference. There are so many types of assessments that can be utilized to gain a better understanding of student learning and each researcher believes they have figured out the best assessment to utilize but in the end, they all agreed that feedback is very pivotal. Researching is always important so that educators stay-up-to date to expand their knowledge as educators.

Integrated STEM and Increasing Teacher Knowledge

In today's technological world it is important to stay up-to-date on the trends and what is taking place educationally with technology. Being able to be comfortable implementing and utilizing technology is important. An article I read talked about how having the access to technology is an important first step in the digital conversion of schools' systems (McKnight, Omalley, Ruzic, Horsley, Franey & Bassett, 2016). McKnight et al. talk about how to make this conversion successful. They discuss how to not fully focus on technology itself and how to really dig deep into how it can enable us to teach and learn. Technology is a great source and tool to use to make tasks easier to accomplish or finish.

Professional development takes an important role in districts to try to continue teachers learning and knowledge of the classroom. McKnight et al. (2016) found that schools with successful technology initiatives had a change in how teachers teach the curriculum and that changes in teaching practices appeared to be speeded up or inevitable. This use of technology including: accessing advanced learning resources and content, igniting cognitive processes that enhance learning is transforming learning routines (McKnight et al., 2016).

One of the biggest problems found when looking at teaching STEM is teachers just don't have the confidence to be able to implement STEM in their own classrooms. Teachers do not have the confidence to teach STEM because they may only be confident in teaching one subject or may not even feel comfortable enough in one subject to effectively implement STEM into their classroom. In a study done by Nadelson, et al. (2013), the researchers' intents were to instill increases in confidence, knowledge and efficacy for teaching STEM. The study assessed different surveys looking at gender, ethnicity and education to assess teachers' comfort levels and knowledge levels. Their study sent out the surveys pre-and post-professional development. The actual professional development was three days. The results supported the idea for developing and providing concentrated short-term continuing education to teachers to increase their capacity to teach STEM concepts effectively and increase their knowledge and confidence (Nadelson, et al., 2013).

A big takeaway from researching is how important teacher knowledge and willingness to learn is pivotal in expanding STEM projects. Many school districts are eager to implement STEM projects but aren't willing to give their teachers the professional development time to effectively learn how to implement STEM projects. To truly be STEM educators there needs to be a move past misconceptions and into a thinking of solving problems that draw on concepts and procedures from mathematics and science while incorporating the team work and design methodology of engineering and using appropriate technology (English, 2016). Lastly, integrated STEM-based activities lend themselves to learning opportunities for students and meet their current needs and are also able to extend those needs (English, 2016).

The whole idea of integrating STEM into your classroom can be a daunting task that may scare some educators away. Shernoff, Sinha, Bressler and Ginsburg (2017) look at identifying challenges and needs of promoting integrated STEM projects to help guide educators, how to foster integrated STEM projects and the supports needed to overcome the challenges. Shernoff et al. talk about what teachers reported they wanted to see before they were comfortable implementing STEM projects. Those teachers wanted more integrated STEM training; to see examples of effective lessons, talk with out-of-district teachers and more time for teacher collaboration. Shernoff et al. found that pre-service teaching and how educators are preparing not only current teachers but also teachers in training to be prepared is important. Shernoff et al. talks about different ideas to improve the pre-service education. The ideas mentioned include: integrated multidisciplinary approaches, observing effective STEM lessons, more classroom experience, a good teaching mentor and more rigorous science/math training. These ideas also provide insight into how districts can improve in-service education by: more integrated STEM training, creating a supportive community, requiring follow-up after trainings, reviewing and using emerging technologies and discipline-specific training. These professional development sessions need to include math, science and engineering teachers together as well including constructivist, inquiry-based and project-based pedagogy. With all of these aspects educators can properly and successfully prepare teachers to feel comfortable implementing STEM projects into their classrooms.

Summary

Students' achievement and engagement levels can be impacted by assessment strategies. Research points out how to attain student engagement by and how to keep it

and also talks about different assessment strategies and how effective they can be but educators need to look further into how those or what assessment strategies can effectively promote student engagement. With STEM projects becoming a bigger picture in education, educators need to learn how we can utilize them with the assessment and engagement strategies to have one smooth, fluid education.

CHAPTER 3: METHODS

Overview

In this action research study, I analyzed data from multiple sources, looking for changes in student engagement when STEM projects are introduced and a certain assessment is announced prior to a unit. Throughout the study I utilized STEM projects to see the overall outcome on assessments and engagement levels. I collected four different types of data. First, I started with student interviews to get students' personal views. I also kept my own personal teacher journal to record thoughts. I also utilized pre-and post-surveys. Last, I collected and took photographs of student work.

Context of the Study

School profile.

I teach at High Plains Community Schools, which is comprised of the towns: Polk has a population of 315, Clarks has a population of 354 and Hordville has a population of 146, for a total of 815. Right now, our configuration is as follows: PreK-6 in Clarks and 7-12 in Polk. We have a manufacturing company in town that provides some jobs to patrons of our district. The other industry that comprises work for most of our patrons is farming. Beyond those two, a majority of the other jobs for parents would be out of town in neighboring towns.

We have an enrollment of 225 PK-12. Of those 225, 35% are on free/reduced lunch, we don't have enough ELLs to provide any data and we have 32 non-white students (30 are Hispanic). We are continuing to see more and more Hispanic families move into the district and see that population rising. We have fewer students than we did

10 years ago but have seen our numbers stay consistent with past years now. We have a high graduation rate as a district.

We have, for the most part, stayed ahead of the state averages on the state tests. Our concerns over the past couple years and emphasis has been on improving reading scores and have noticed from our last year's data that I have improved upon our reading scores but are now declining in math. Our male populations have scored better than our female populations from our last data sets. When we revisit our goals, I think we will be putting a bigger emphasis on math and hopefully keep up our reading scores.

High Plains is a great district to work for. The community supports education and students are given the opportunities to participate in education outside our classrooms, which has brought up engagement. The administration and community encourages STEM by providing money to gain access to the tools needed to implement STEM.

School and community STEM views.

My administration pushes for STEM implementation in our district. We currently have a designated technology teacher whose job is to provide teachers with resources and tools to implement technology in their classrooms. I have utilized her but feel like others have not. Our school has provided us the opportunity to share our classroom ideas and technology at professional development days but it hasn't been utilized successfully yet. We currently do not have any after school programs to help promote the STEM initiative. I think it is something that could definitely benefit our students but because of having three different communities of kids to bus back to their hometowns, it could be a difficult project to accomplish. We have reasonable funds for purchasing resources to be utilized for STEM implementation but available resources are still a complication.

Our community is very involved and we host community coffees throughout the year to show what we are doing in our schools. Members of the community always want to know what we are doing and are excited about the direction we are going. We have a manufacturing company in Clarks that could provide many great opportunities to our kids and hopefully will be ready to co-op with us. All of the communities are very big on agriculture and so a majority of students get to see agriculture operations, which are heavy STEM topics. I am very excited about the direction our district and communities are headed.

Participants

This study was based in my rural classroom. Seven of my twenty fifth-graders participated with me in this research study. The reason these seven kids were chosen to participate in my study is because they were the seven that got their parent permission forms back to me. These students were both male and female and ranged in academic levels. My role was a facilitator and observer. From this study, I was hoping to gain insight into how I can improve my practice.

Data Collection

I collected four different types of data over the semester of research. There were three STEM projects that we worked on and completed. Each STEM project took about two weeks to finish. I utilized student interviews as well as collecting and/or student work was photographed. Student interview questions are referenced in Appendix A. I kept a teacher journal of my field notes which is also referenced in (Appendix A). In the journal, I wrote down observations as well as ideas on improvements weekly during the research study. Each week I wrote about a page and a half of my observations. The last

form of data collected was pre/post surveys, which were utilized to look at students' prior knowledge and students' post thoughts on comfort levels, what students learned and how students can apply it in their lives. Pre-and post-surveys are referenced in (Appendix B). Surveys were utilized to gauge prior knowledge and post knowledge to understand students learning throughout the unit.

STEM projects were utilized during my study to see how they impacted student engagement levels. I told students what summative assessment strategies would be utilized for each unit in the beginning to gauge whether or not that would change a students' engagement level throughout the project. I utilized three STEM projects with a different end assessment strategy. I chose the three assessment strategies and told students in the pre-project talk, what would be the ending assessment. For the first project, students were asked to create a poster of their understandings of food webs and food chains. This was an individual project. The second unit students were notified in pre-project talk that they would be given a multiple-choice test at the conclusion of the unit. The last unit, students were notified that they would have a group project at the conclusion of the unit. Each of these assessment strategies was used to gauge which kind of pre-understood assessment would bring about the highest engagement level.
I gauged engagement levels, using a rubric as a guideline (International Center for Leadership in Education, 2015).

Student interviews.

Student interviews were conducted with seven students from a range of academic levels. The students were interviewed individually three times over the course of the research study. Students were interviewed before the first STEM project. They were also

then interviewed in the middle of the research study. Finally, students were interviewed at the end of the research study. Each student was interviewed for about three to ten minutes. The purpose for collecting data from student interviews was to gauge students' knowledge of STEM projects, engagement and assessment strategies. Interviews were also used to gauge students' prior and post understandings of those categories. Interview questions can be referenced in Appendix A.

Teacher journal.

I kept a teacher journal for field notes along the course of the research study. I reflected in my teacher journal each week that we partook in STEM projects or were collecting data for the study. I wrote a page to a page and a half for each week collected. Each week's reflection took about half an hour to write. The purpose I kept a teacher journal was to reflect on what I saw as an observer and researcher in the study. I could use first hand observations to solidify the collection of data for my study. The prompts I utilized while reflecting can be found in Appendix A.

Pre/Post surveys.

Pre-and post-surveys were administered to all twenty of my students but only the seven participating in my research study were utilized for data collection. The pre-and post-surveys were administered on Google Forms for each of the three units utilized during the research, amounting to six total surveys. The pre-survey was administered before the start of the unit and the post survey was administered after the conclusion of each unit. The purpose I collected and utilized pre-and post-surveys were to find out students' prior knowledge, attitudes towards school and engagement and to better

understand each students' learning style and level. The pre-and post-surveys are found in Appendix B in the order they were administered.

Collection and/or photographs of student work.

The last form of data that was utilized during my research was the collection of student work. I collected and/or took photographs of the seven students participating in the research. The students' work was collected during the unit, as well as pictures taken, including the final projects. If I want actively engaged students I need to immerse them in activity rich curriculum where students get to show their knowledge and skills. The purpose of including student work was to show kids participating in activities and being able to express their knowledge and skills. Each STEM project took about two weeks in duration. The reason I collected student work was so I could look at the level of engagement and learning that was taking place with each student. I took pictures of students' final projects so I could gauge what they learned over the unit and compare it to the pre-surveys to understand what learning took place. Collection of students' work can be seen in the findings section of this work.

Data Analysis

My study was an action research qualitative study that took place in my classroom. I looked for themes across data sources. I looked for connections throughout my data and other research data. I utilized four types of data including: student interviews, teacher journal, pre/post surveys and student work collection and/or photographs.

Student interviews.

Student interviews were analyzed for qualitative research. The purpose of the student interviews was to find themes and connections throughout the data to be analyzed. The interviews were conducted in the beginning, middle and end of the study to find correlations and themes determining prior knowledge, ideas and comfortability. These themes and connections were then analyzed to look at how did student engagement change when assessments were announced prior to a unit. The themes and connections were also analyzed to look at how did student engagement change when STEM projects were introduced in a 5th grade classroom.

Teacher journal.

My teacher journal was utilized to analyze my findings qualitatively to find themes and connections. I wrote in my teacher journal weekly so that I could utilize my observations to be able to see connections and themes throughout my study. The themes and connections I was looking for were utilized to determine if there was a change in student engagement when STEM projects were introduced in my 5th grade classroom. I was also looking to find correlations or a change in student engagement when an assessment was announced prior to a unit. These themes and connections were analyzed qualitatively.

Pre/Post surveys.

Pre/post surveys were utilized in my study to look for growth in student responses from prior knowledge to post knowledge. I was looking to find data on how does student engagement change when an assessment is announced prior to a unit. I utilized the data to determine if the changes showed growth in student comfortability, knowledge and ideas.

I was also looking for descriptive statistics on how does student engagement change when STEM projects are introduced in my 5th grade classroom. Both of these questions were analyzed through the answers on the pre/post surveys and utilized to show descriptive statistics.

Collection and/or photographs of student work.

The collection of student work and/or photographs of the student work were utilized to analyze if I was providing activity rich projects that were actively engaging students. The data I collected from the collection and/or photographs of student work were utilized to determine if kids were comfortable in showing their knowledge and skills on certain topics. Student engagement was the primary focus of this study and the collection of student work helped accomplish the task of improving myself in my profession through the use of an action research study. I utilized the student work to see if there was a change in student engagement with the introduction of STEM projects in my 5th grade classroom.

Summary

My action research involved seven students and myself as I looked at how assessment strategies impacted engagement levels in STEM projects. These students were interviewed, provided their student work and worked on pre/post surveys to show what they knew and learned. I also looked through my field notes collected for observations and determining how to improve my teacher to meet my students' needs.

CHAPTER 4: FINDINGS

Overview

This study looked at how does student engagement change when an assessment is announced prior to a unit. I also looked to see how does student engagement change when STEM projects are introduced in a 5th grade classroom. Students in this study are given pseudo names to protect their identities. The goal of this study was to determine what change assessments had on student engagement. First, student engagement was more impacted by the utilization of STEM projects than any assessment strategy. Second, students became better at participating in groups and working together. Third, I learned the impact STEM projects can have on my students. Finally, I learned what assessment strategies best promote student engagement. Four types of data were utilized to gain knowledge about student understanding. These included student interviews, keeping a teacher journal, the collection and/or photographs of student work, and pre/post surveys.

Typical Unit Outline

I utilized three STEM project units throughout out research study. We did a unit on food chains/webs, forces and motion and the final was engineering. Each unit took about two weeks to complete, and we spent about an hour a day working on our projects. A typical day when working on our STEM projects was conversations and questions about what we were looking at. Students got to talk about what they already knew in the beginning of the unit and what they thought they would learn. We always started with whole group discussions about the topics, what problems may arise, solutions we may find, what we already know, what we want to know and any questions they might have. Days two through nine would consist of students working alone and in groups with

activities dealing with the unit. Students were provided materials to explore and test our ideas, plans and outcomes. Materials ranged from data collection sheets, to launch pads and the use of the three-dimensional printer. I had two roles during the research study. My first role was being the teacher/facilitator. “It has become easier to be an observer and facilitator with the implementation of STEM projects.”

Each unit included activities to help guide us to our final STEM project. The first unit on ecosystems and the transfer of energy involved an activity game where students were divided up into three groups: grasshoppers, lizards and hawks. Each student was given a cup that had a line to measure how much food they had to collect. I laid out a bunch of beans all over the floor to represent the food. The grasshoppers were allowed to go first and then lizards were allowed to go. Finally, the hawks were released. The hawks could only eat lizards though. We attempted this activity with different numbers of each group to try to signify supply and demand too. We had an activity discussion following the activity where we talked about our data and observations the students made watching and participating in the activity. The final activity was the construction of a food web poster reflecting a biome that they drew. Each student drew a biome name and there were duplicates in the class. The rubric for this project is included in Appendix C. The other two units were very similar in structure just dealing with different topics.

The forces and motion unit had a summative test at the end to gauge students’ knowledge. Students were told before the unit that they would have a multiple-choice test at the end of the unit. An activity in our unit that students took a part in dealt with launching wood cars to test speed. The purpose of collecting photographs for this activity was to show kids immersed in activities that allow them to show their knowledge and

skills. The engineering unit had a peer review assessment at the end of the group project. Students were grouped into groups of two to do this unit and then each student got to peer review a group project. Students were asked to research with their partner and design their balloon powered car. Students were told that the axles, wheels and car itself had to be printed on the three-dimensional printer but they could add modifications as they saw fit from there. Throughout the units, there was one recurring theme and that was that kids were engaged in the STEM projects and were excited for learning. During this unit, my teacher journal included four entries referring to student engagement and excitement.

- "Kids are becoming more independent."
- Students have begun to utilize internet sources and/or peers."
- "The kids are excited about the project and can't wait to get started."
- "I am surprised by how little they are coming to ask me what to do."

Figure 1. Wooden car in engineering unit.

Student Engagement

Throughout this study, I focused on student engagement and how that can be changed by assessment strategies and STEM projects. Student engagement was positively changed by the implementation of STEM projects. I stated in my teacher journal that, "kids were beginning to become more and more comfortable exploring and learning to figure out problems without my help"! Students started to ask me fewer questions and were engaging with each other in discussion and observations. When Lydia was asked what she does when she is struggling with a problem on her pre-survey, she answered, "I would ask the teacher." When Lydia was asked the same question on her post-survey, she answered, "I would go over it again until I understood it." Figures 2 and 3 show a couple of my students' food web/chain projects. These figures show what students learned throughout the unit and gave them the opportunity to express their knowledge and skill on the topic of the transfer of energy in ecosystems.

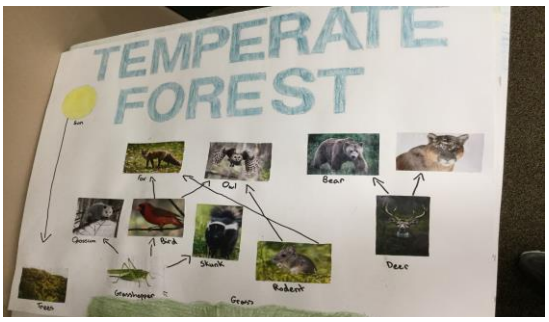

Figure 3. Student's food web poster for Temperate Forest biome.

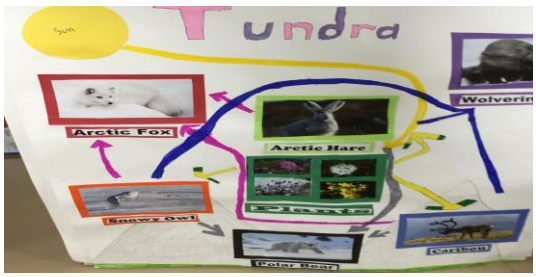

Figure 2. Students' food web poster for Tundra biome.

Students have access to Chromebooks, which are laptops, as we are 1-1 and they began to utilize research as well instead of asking me questions. “Students are more engaged because of being more comfortable, being able to explore and have taken an interest in their learning.” When asked whether he would like to do a STEM project or take a test to see student knowledge, Blake responded saying, “project, because I get to do something with the learning but in a fun way!” Students interviewed all looked at STEM in the same aspect. They were all excited about what we were going to be doing during the research and many talked about how they saw STEM projects being utilized. They talked about being excited, Paige stated, “tests put a lot of pressure on us, but STEM projects give us a different view of learning where we get to witness first hand and be able to work in our own words!”

A recurring theme in my data is that STEM projects provided students with hands on activities that kept them alert and engaged. In one post-survey asking students if they would rather read from a book or do activities, Paige answered, “I would rather do activities because they are easier to enjoy!” During one period of work on our last STEM project I noted in my teacher journal that, “in the entire hour, not one kid came and asked me a question.” They were all immersed in their research and designing of their balloon powered three-dimensional cars. Students were more engaged in their three STEM projects than with the regular work we were doing and this research came at a time in the school year where students are starting to really get stressed about testing season and are looking forward to getting out for the summer. These activities provided them the education they needed and the engagement they wanted to be able to be continuing to learn to finish the school year.

Assessment Strategies

The goal of my study was to see how does student engagement change when an assessment is announced prior to a unit. Throughout the research, I determined that students' engagement levels were not impacted by assessment strategies but rather, they were changed by the implementation of STEM projects. Whether students were told they would have a poster project, a summative test or a group, peer-reviewed project, their actual engagement levels throughout the units did not differ from each other. When Calvin was told on his pre-survey that there would be a multiple-choice test at the end of the unit and was asked how much work will you put into the lessons, he responded by saying, "I will put in as much as usual."

When interviewing students, I got many different views on assessment strategies and their understandings of assessment. We talked about what assessment entailed and discussed what assessments they knew of. In one of the interviews, Calvin talked about this topic saying, "I would rather just take a test because it is what I am used to." By the end of the research that same topic was brought up again and his view had changed to wanting to do group projects because you can have two views working together to get a better outcome. Lydia talked about how she would rather take a test because she believed she would get better feedback from a test and she was more comfortable with it. I honestly was taken aback by these comments. Both kids' views definitely changed by the end of the research, with both stating at the end, projects were better because projects reflected learning and personal views. "Students began to dig into their designs and research knowing their assessment was peer review on their balloon-powered car."

I stated in my journal how, “students were engaged in their learning throughout all three units and determined that from my data I could state that assessment strategies did not change students’ engagement levels when utilizing STEM projects.” I talked about how, “students were excited about the upcoming activities when we were discussing at the beginning of each unit.” In my journal entries for the start of each unit I stated that, “students’ engagement levels were not changed by the assessment strategies.”

Feedback has a huge impact on the success of assessment strategies. One of the questions I asked in the student interviews was: What kind of feedback is most important to you? From this question, students’ ideas of feedback changed from the first interview to the last. They understood a lot more about feedback and what that can entail. In my first interviews, Cameron said in response to feedback, “I want to know the number I missed.” From the same question, Calvin said, “I just want to know I got a good grade.” In the end students’ views changed into more in-depth answers. Paige answered saying, “feedback that I can learn from and see what to do differently next time to make it look more interesting and to better understand how to improve. Feedback was a vital aspect of assessment during my study and students were wanting to utilize the feedback to improve in the future. Students were excited about poster projects and group work projects. Assessment strategies did not change student engagement.

Group Work

One of the STEM project units that we partook in looked at engineering and building a balloon powered car that would be three-dimensional printed. I have a 3-D printer in my classroom that allows us to print three-dimensional figures that are fairly strong and durable. The big factor in this unit was that kids had to work in groups of two.

Figure 5. Students' balloon-powered cars.

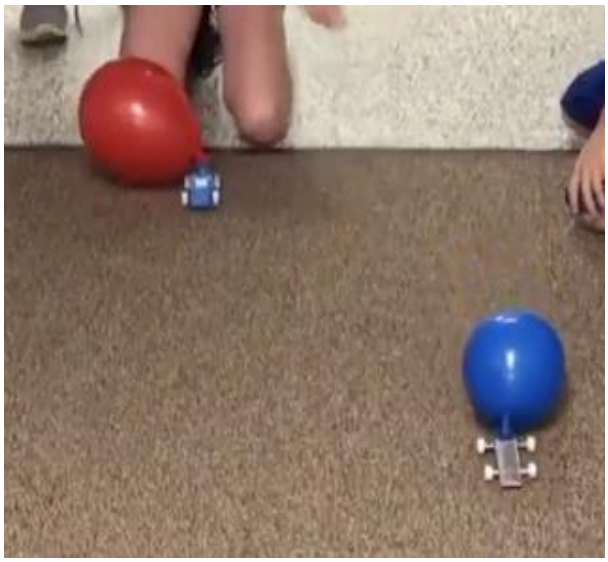

Figure 4. Student balloon-powered car.

Throughout the first seven months of the school year, we had group work and assignments but I never really felt like I was getting work out of the whole group. This project really brought out the group work in kids and created better teamwork students. Students learned that to accomplish the task set out for them they had to work together and share ideas. In the post-survey Sarah stated that, “I tried harder knowing that the project was peer-reviewed and I felt that I was engaged throughout the unit.” In interviews, students talked about group work and how they could do better on projects when in groups because different views were heard and ideas. From these different views and ideas, they found out that they could accomplish a greater outcome. “Students are taking ownership and responsibilities in their group seriously.” Throughout the study and particularly the unit on engineering I noticed and wrote in my journal how “students are starting to discuss amongst themselves more frequently and problem solving with each other instead of giving up and coming to me with questions”. I also discussed how, “students made a transformation from trying to work individually to utilizing each other and working together for a truly greater outcome.”

Some of the students began to become aware of other students’ talents and abilities in different aspects of the engineering process as well as the whole education process. Calvin said, “I would like to do group projects because they allow me to work together with a partner and come up with the best plan possible.” He came to the understanding that all kids think differently and that things he might not think about are discussed because of his partner. At one point during our engineering unit Blake talked about how confident he was in his car and its abilities. He stated that, “no one had a chance to beat him and his partners’ design because it was flawless.” We had a discussion

about how we can always improve prototypes but I liked his confidence in his design. Overall, students took very well to group work and figuring out how to maximize their outcomes. Students were committed to working together and improved tremendously in that area of group work. Learning to help guide each other and support each other was an important trait they figured out throughout the study.

What I Have Learned

Students taught me a lot about my teaching and the way I approach education. I know from this research study that next year, STEM projects need to be a larger part of the students' education both in my classroom and across my district. The implementation of STEM projects in my research study took my students from going through the motions in a unit to being actively engaged and excited about their learning. One of the big concepts I learned was that the assessment strategy was not as important as the activities and the process of the STEM project. All seven students in my study noted on their surveys how they would rather do activities during a unit. Rachel responded saying, "I would rather do activities because they are more fun than writing. Paige responded to that same question stating, "I would rather do activities because they are more fun and interesting." I noted in my journal that, "students' engagement levels were not impacted by assessment strategies but were greatly influenced by utilization and implementation of STEM projects."

The way students worked in groups and utilized each other's strengths led me to truly believe that my students can get a lot of positive interaction and learning through more group work projects. I found that it is very important for students to be able to share

along their learning process and be able to talk and discuss with each other about problems and work on problem-solving skills.

Students began to take ownership of their education and learning. They began to want to do better and strived to improve. They were no longer just trying to get by and had more positive attitudes. This was brought about because of the implementation of the STEM projects. I saw very positive attitudes and evidence of the STEM projects working to improve student engagement levels. These projects gave my students the chance to talk about their education, their learning and their ideas. It gave them the freedom to explore and the time to work out problems. “Kids have started to watch YouTube videos and research websites instead of coming to me with questions.” I believe students became better problem-solvers not just because they became more persistent but they also learned to utilize many different resources instead of just resorting to asking me questions all the time. I actually found I had a lot more time to just discuss and learn about what students were thinking and their ideas because I wasn’t having to answer a lot of questions.

Conclusion

In my study, I found that STEM projects positively changed student engagement levels. I was looking at how assessment strategies impacted them and came to the conclusion that it didn’t rely on those strategies but were greatly impacted by the implementation of STEM projects. I also found that students did very well in groups and really learned how to utilize each other and work with each other for a greater educational outcome and learning. I learned the great impact STEM projects can have on the education of our students and the importance of teaching and instructing other peers on this topic. My research proved that STEM projects had a greater outcome on

engagement levels than the assessment strategies I implemented. From my data, I found out how these STEM projects can change student group work, attitudes and willingness to learn. They became more excited about their learning and were actively ready to learn and explore. My research questions looked at how does student engagement change when a certain assessment is announced prior to a unit. I also looked at how does student engagement change when STEM projects are introduced in a 5th grade classroom. From my data, I can point out that the actual assessment strategy did not have a noticeable change on my students' engagement levels. My students were more actively impacted by the implementation of STEM projects.

CHAPTER 5: DISCUSSION AND CONCLUSIONS

Overview

Students were positively impacted by the implementation of STEM projects. They had a greater attitude toward education and were more actively engaged in their learning because of the utilization of STEM projects. Students learned how to effectively work together and be able to discuss each other's ideas and concerns and come to a conclusion. They began to see how group work can help them academically. All of these put together showed that there was not a noticeable difference in students' engagement levels because of assessment strategies but were more influenced by the implementation of STEM projects.

Discussion

My study focused on how student engagement changed when a certain assessment was announced prior to a unit and when STEM projects are introduced in a 5th grade classroom. From my research, I learned that the assessment strategies did not have as much of a noticeable change on student engagement levels as the actual implementation of the STEM projects. Harris (2008) talked about three aspects that could lead to student engagement: behavioral, emotional and cognitive. In my study, I found that to achieve engagement I met those three aspects. My students were actively engaged and participating which is behavioral, their attitudes were very positive which is emotional and they were taking ownership of their learning or were investing their own time into the projects which is cognitive. Munns and Woodward (2006) stated that all three of these aspects must all be met and be in one multidimensional piece. Taylor and Parson (2011) summed up student engagement very clearly when they stated that teachers today

have to utilize a curriculum that includes exploration, interaction, multimedia and other aspects of instruction to be able to meet the needs of today's technology literate students. With the implementation of STEM projects, I was able to gain that student engagement that research has explained.

There is a vast number of different ways educators can assess students to find their learning. Stiggins and DuFour (2009) talk about three levels of assessments and planning assessments. Those levels start in ones' own classroom, moving to a district level and the final is at the state and federal level. Stiggins and DuFour (2009) go on to talk about how formative is geared toward supporting learning and summative is geared towards verifying it. I utilized summative assessment on my forces and motion unit, and both formative and summative in my other two units. The formative was in our post discussion from the activities and the summative was in our final projects. Both of these aspects need to be a part of every unit. Stiggins and DuFour (2009) gave four practices to productive assessment. Those practices included effective communication with clear learning goals, standards-based instruction and high-quality assessment. STEM projects are a great way to meet these aspects and be very productive. Feedback was an over recurring theme from researchers as well as in my own study. Students understood that to really get as much as they could out of their learning they needed productive, time efficient feedback.

Having the confidence to teach and implement STEM projects is the first and maybe most difficult step. Teachers don't like to teach when they are uncomfortable with their teaching knowledge on a subject. Having the time and resources to be comfortable teaching STEM projects is something I am striving to accomplish. Nadelson and et al.

(2013) talked about how developing and providing concentrated short-term continuing education to teachers to increase their capacity to teach STEM concepts effectively and increase their knowledge and confidence was important. With this step teachers will begin to have the confidence to teach and implement STEM projects which will create productive life-long learners.

Conclusions

I learned how important STEM project implementation can be in my classroom. I know what I need to do for next year and the years to follow. It is very important that I continue to learn new ways of implementing and utilizing STEM projects to help my students in their educational lives. The implementation of the three STEM projects in my classroom brought out high engagement levels from students and created an atmosphere of problem-solving and actively engaged learning. Next year, I will be working to implement as many STEM projects as I can into my teaching and curriculum.

It is my responsibility to help out others in my district to become more comfortable implementing STEM projects into their curriculum. My plan is to try to get into classrooms in my building each once a month to be able to work with their students and help them to build their knowledge in implementing STEM projects. I will try to be participating in continuing education through conferences to be able to share with teachers in my district. I will also be trying to present at conferences on my knowledge to be able to help other teachers in the state and area. This research study gave me the knowledge I need to know how to move forward as an educator and be able to expand my teacher knowledge. I will be able to utilize my research study in the years to come to

improve my teacher strategies and ideas and be able to implement my findings. My goal is to share my study with the peers in my district as well as district administration.

Limitations

This action research took place in a rural setting. I had a mixture of different academic levels that reflected the learning groups in my classroom. I looked at three months of instruction and three units. With more time and more units, more data can be looked at and utilized. Teachers in an urban setting may find my research non-applicable. Nebraska state testing put a limit on the amount of time I had allotted to work on my research and study as well. The assessment strategies I utilized were limited to the number of units I taught and so not all strategies were researched and studied.

Future Research

With more time, I would have definitely looked at many other types of assessments that I could utilize. I think future research that would best supplement my research would be looking at a span of grade levels in both rural and urban settings. It would be interesting to see the match up of data taken in both settings and be able to look at how to improve each setting's education. I think studying and researching for a longer amount of time would open up the doors for numerous different assessment strategies to really find the one that most appropriately benefits students.

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APPENDIX A: Interview Questions/Journal Prompts

Teacher Journal Prompts

1. How does each of the incidents I wrote about relate to my research question?
2. What changes have I seen in my students this week?
3. What surprised me this week, related to my assessment strategies for engagement?
4. What went really well this week, related to my assessment strategies for engagement?
5. What challenges did I encounter this week related to my research? What did I do to address these challenges?
6. What did I learn this week that will inform my teaching and/or journaling next week?
7. Tensions I felt this week between my roles as teacher & researcher?

Student Interview Questions

1. We use “STEM” to talk about science, technology, engineering and math. What does it look like to you when we do STEM activities during class?
2. If I tell you, your peers will be grading your project, do you try harder than if I told you just I would be looking at it?
3. Do you like the STEM activities more or less than other activities we do? Why?
4. How good in STEM are you?
5. When working a word problem, do you think you know the meaning of most of the vocabulary words in each problem?

6. Compared to other school subjects, how good are you at STEM?
7. What kind of feedback is most important to you?
8. How good are you at learning new things in STEM?
9. What does it look like when you justify your answers on a homework assignment?
10. What are the benefits of justifying your answers on your homework assignments, if any?
11. Thinking about when I review your projects or a peer, which do you find more beneficial to you?
12. Did you enjoy working word problems before this school year?
13. Has your attitude about working word problems changed during your 5th grade year?
14. Do you think you would be more engaged in lessons if you had a test or project at the end of a unit?
15. What kind of assessment do you think is most effective? Why?
16. Is there anything you want to know from me?

APPENDIX B: Pre/Post Surveys

Pre-Survey Food Chain

Questions Gauging Curiosity

1. Name

2. Are you interested in learning more about the food chain and transfer of energy in an ecosystem?

    Yes

    No

    Maybe

3. What do you know about the transfer of energy in ecosystems?

4. Do you enjoy learning new things in class?

    Yes

    No

    Maybe

5. Do you try hard to do well in school?

    Yes

    No

    Maybe

6. Would you rather read from a book or do activities?

7. When you are in class does your mind wander or do you focus solely on the class activities?

8. When I am struggling with a problem, what do I do?

Give Up

Ask Teacher

Go over it again until you understand it

9. When learning new information, I try to put ideas into my own words?

Yes

No

Sometimes

10. When learning things for school, I try to see how they fit together with other things I already know.

Always

Often

Sometimes

Rarely

Never

11. I try to understand how the things I learn in school fit together with each other.

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

Post-Survey Food Chain

1. Name
2. Did you learn more about the food chain and transfer of energy in an ecosystem?

Yes

No

Maybe

3. What do you know about the transfer of energy in ecosystems?
4. Do you try hard to do well in school?

Yes

No

Maybe

5. Would you rather read from a book or do activities?
6. When do activities did your mind wander or did you focus solely on the class activities?
7. When I am struggling with a problem, what do I do?

Give Up

Ask Teacher

Go over it again until you understand it

8. When learning new information, I try to put ideas into my own words?

Yes

No

Sometimes

9. When learning things for school, I try to see how they fit together with other things I already know.

Always

Often

Sometimes

Rarely

Never

10. I try to understand how the things I learn in school fit together with each other.

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

Each unit had a pre-and post-survey with it. Each one had the same kinds of questions, just different wording depending on the STEM Project.

APPENDIX C: Rubrics

3D BALLOON POWERED CAR RUBRIC

Name_____ **Score**_____	**Excellent** **20**	**Good** **10**	**Lacking** **5**	**Missing** **0**
Content The content of the model covers our objective!				
Composition The entire model is 3-Dimensional (not flat). The model is constructed student/s solely and was not a bought kit.				
Realism All components of the model are realistic in appearance as much as possible with regard to shape and the objective.				
Effectiveness Did the design perform how it should of? Did it move straight?				
Appearance Did they make an effort to put any design into it?				

Rubric Food Chain Poster

Food Chain/Web Poster	Points Possible	Points Given
Biome Displayed	5	
Food Chain-5 Links Included	20	
Food Chain Links-Arrows Point Right Direction	5	
Title-With Name of Biome	5	
Name on Back	5	
Questions Answered	10	
Rubric Turned In	10	
Points	60	

Food Chain Questions

1. How are food chains and food webs alike?

2. How are they different?

3. How is a diagram of a food web more helpful than a written description of the same information?

4. If all the green plants were removed from the community, how might the flow of energy be affected? Explain your answer.