The Effects of Inquiry Based Practices on Students Problem Solving Competence

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An Action Research Report
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The Effects of Inquiry Based Practices on Students Problem Solving Competence

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Abstract

This action research project looked at the impacts that family dynamics and family resources have on student achievement and self-advocacy. It then went a step further by showing how inquiry-based strategies can give students with little family resources the tools to self-advocate and become academically successful. A specific six-step inquiry process was taught and implemented amongst 28 rural fifth grade students. The researcher utilized observations, assessments, and compared completed student work to Minnesota Academic Standards throughout the project period. After the students learned and implemented inquiry practices, their self-advocacy and academic achievement increased showing that these practices can affect students in a positive manner. Inquiry based learning may allow students to build intrinsic value and help support core curriculum. Through the knowledge of how family dynamics affect students and the impact of inquiry strategies on student achievement, educators can successfully support a diverse set of learners.

*Keywords:* inquiry, problem solving, academic achievement
Many schools have begun moving from traditional settings to a focus on science, technology, engineering, and math, also known as STEM. STEM schools are often wonderful places where you will find inquisitive minds, active students, and elaborate projects dressing up the walls and halls. This innovative approach is embedded through teaching students how to think, solve problems, and work with their peers. It also incorporates the 21st century skills of critical thinking and problem solving, creativity and innovation, collaboration, and communication (Nadelson, 2016). On any given day in a STEM school, you may find kindergarten students engineering a new board game, second-grade students creating plant packages that can journey in a delivery truck, or even fifth-grade students collaborating to build a fully functioning robot. Open-ended STEM projects create a buzz that is palpable. Not only are students actively engaged in their projects, but educators are also learning new ways to tinker and teach. These cutting edge schools are becoming hubs of innovation and excitement and places that value challenge and delight in collaborative efforts.

The unique role I play in my STEM school setting has allowed me to be in classrooms teaching students from kindergarten through fifth grade engineering, science, and technology concepts. Interwoven into these open-ended and hands-on activities is also the reality that time is being taken away from direct instruction in mathematics and literacy. Project-based learning is a wonderful time for students to showcase their individual abilities, but some worry it can also breed engagement without purpose (Pollitt, Cohrssen, Church, & Wright, 2015). Many educators have expressed their opinion that open-ended activities replace time for worksheets or direct instruction and that this could hinder their ability to meet expectations on the Minnesota Comprehensive
Assessments (MCA). They worried about the amount of time that these activities take and they see student driven projects as just playtime. One educator noted that an engineering task where students were to build structures with cups, craft sticks, and cubes turned into “utter chaos and disruption when students began shouting and destroying their creations” (Anonymous personal communication, September 12, 2016).

While many educators have seen open-ended activities as an engaging playtime for students, they also recognized that a school is a place for learning and growth (Sezer, 2008). They measured students learning and growth through the use of the Minnesota Academic Standards. Previous staff development opportunities focused mainly on direct instruction strategies as a means to meeting these standards (Kaya & Kablan, 2013). Inquiry instruction and open-ended learning activities are a new concept in many districts. Though there is research to show the academic benefits to using inquiry-based and open-ended learning to support mathematics and literacy achievement, many educators have not looked at this research or dismissed it as something they did not take seriously (Andes & Claggett, 2011; Broussard, Cooley, & VanDerHeyden, 2006). Educators have found that they lack the proper training to be able to adequately teach inquiry-based lessons and therefore have not attempted to facilitate these unique learning opportunities within their classrooms for fear of failure (Sever & Guven, 2014).

As schools look to integrate STEM concepts within their buildings, their main focus should be to integrate the 21\textsuperscript{st}-century skills of critical thinking and problem solving, creativity and innovation, collaboration, and communication into their core academic content. Furthermore, I see the importance of allowing students to become self-sufficient and confident learners through the process of inquiry and problem solving.
My action research showed the importance of inquiry-based learning in building students’ confidence and increasing academic achievement. It also strove to show how important it is for students to feel connected to what they are learning.

The research for this project was performed at a rural Minnesota STEM school that focuses on engineering. The setting held a socially diverse population of students from rural, urban, and suburban settings. The population consisted of students from kindergarten through fifth grade and also offered a before and after school program for families. Thirty-two percent of the students within the school setting came from single parent or other non-traditional two-parent families and forty percent of the families fell into the category of low socioeconomic status. This particular school’s MCA scores were an average of fifteen points behind other elementary schools in the surrounding area and they were not meeting adequate yearly progress in reading and mathematics for their upper elementary students. Many of the students did not finish their MCA tests in the 2015-2016 school year, even though there was no time limit.

The study was done during the first four weeks of the school year in September. The study was performed in a fifth-grade classroom with 28 students who had minimal exposure to project-based learning. The study focused on direct instruction of a specific six-step inquiry and problem-solving process followed by implementation of a “Genius Hour” for students to create a project of their choosing. The goal of the study was to see whether students were able to solve problems and find solutions independently. This research was conducted in hopes that educators will see increased academic achievement in literacy and mathematics through the use of inquiry based strategies. The driving
question in this Action Research Project was: What are the effects of inquiry-based practices on students’ problem-solving competence?

**Review of Literature**

This literature review highlights the effects of inquiry-based learning and the implementation of the 21st century skills of critical thinking and problem solving, creativity and innovation, collaboration, and communication.

Many factors impact elementary students’ problem-solving skills and academic achievement. Research shows that children from families of low socioeconomic status are at a higher risk of not achieving in school (Rydell, 2010). Socioeconomic status is the total measure of an individual’s work experience, economic status, and social position in relation to others. Single parent families, or families with children being raised by an extended family member or in a foster home, typically represent a majority of the low socioeconomic demographic (Milne & Plourde, 2006; Sang Min, Kushner, & Seong Ho, 2007). The Common Core State Standards were a pledge that 45 states made to the Federal Government agreeing that they would create and use the same standards in all schools for English language arts and mathematics from kindergarten through the end of high school (Konstantopoulos & Chung, 2011). They were designed to help ensure that students who were not academically achieving were getting an education to help them succeed. These new standards provide more rigorous academics for students and require teachers to be more involved in the educational process (Neuman & Roskos, 2013). Though Minnesota is not currently required to use the Common Core State Standards, many schools in states where it is not required are modeling their settings upon these

With the influence of the Common Core State Standards and the fact that many students are coming from non-traditional families of low socioeconomic status, educators see a shift in the landscape of education (Burks et al, 2015). Many educators are employing innovative methods to increase problem-solving and self-efficacy skills in their classrooms to meet the needs of diverse learners and satisfy the higher expectations of schools within the United States. These skills are proving to enhance academic achievement for all students (Sezer, 2008; Snyders, 2014). This literature review focuses on the impact of socioeconomic status, family dynamics, and available family resources on children’s problem-solving skills. It will further show the impact these factors have on mathematics and literacy achievement. It will then explain how inquiry-based learning aims to provide children with the problem-solving skills to meet more demanding academics in and out of school.

Many schools are seeing an increase in families who fall into the category of low socioeconomic status and the traditional two-parent family is no longer the dominant family make-up in many areas (Milne et al., 2006). Family changes in structure, relationships, and mobility are escalating the gap between children from traditional two-parent families and children from single-parent or stepparent families. Many times these families have limited resources such as education, time, money, and employment. When children lack time on education at home, do not have money for school supplies, or are limited in their interactions with their caregivers, they fall into the category of low socioeconomic status (Stull, 2013; Sun & Li, 2011).
Studies have found that family structure and socioeconomic status are linked and directly affect academic achievement (Gennetian, 2005). Statistics from the National Center for Education looked at the mathematics and reading achievement of 2,156 high school sophomores from single-parent families and discovered that these students scored 20 points lower than the national average. This low academic achievement led to higher levels of incompletion of schooling, poor quality of schoolwork, and poor social-emotional development (Milne et al., 2006). Another study concluded that children ages three through eight from families with incomes less than one-half of the poverty line scored between six and thirteen points lower than their more affluent peers on multiple standardized tests (Sang Min et al., 2007).

One study broke down family structure and found that 27% of American children were in one-parent households, of this group 38% lived with a divorced parent. They also noted that 35% of children resided with a parent who had never been married but had multiple partners coming in and out of the household and 4% did not live with either parent but were rather shuffled between extended family members (Shaff, Wolfinger, Kowaleski-Jones, and Smith, 2008). When families are disrupted or have a sudden change, it has shown to contribute to declines in academic achievement (Stull, 2013). Disruptions can include residential mobility, loss of income and lack of time spent with children due to extra demands on families. All of these changes cause instability, and this instability affects children’s cognitive and social-emotional health. Family instability can be further defined as anything that “compromises children’s trust in security and imposes emotional stress” (Amato, Patterson, and Beattie, 2015, p. 543).
Promoting behaviors that increase school readiness skills early can reduce the stress that children from disadvantaged families may face due to lack of resources (Konstantopulous et al., 2011). These behaviors include time-spent reading, working on early literacy skills, providing adequate educational materials, time for play, and providing social interactions with peers. Research has connected the amount of time families devote to these behaviors with the quantity of schooling the parents have completed. The less schooling the parents had, the less time they devoted to their own children’s school readiness skills (Kingston, Huang, Calzada, Dawson-McClure, & Brotman, 2013). One researcher stated, “Parents transmit their educational experiences to children through time spent in school-related involvement” (Zheng et al., 2015, p. 207). If a parent did not have a positive school experience, they may not find value in investing time or money in resources such as educational games or books. Lack of investment will affect children’s ability to make meaningful academic achievements in school (Chyi and Ozturk, 2013; Shaff et al., 2008).

There are other resources families of low socioeconomic status lack. As mentioned above, these families have lower levels of wealth and, therefore, limited access to educational resources, but they may also fail to nurture the cultural resources their children need (Rydell, 2010). Cultural resources are resources that the family or child values in their life and can be activities such as museum visits, other types of community outings, or participation in sports and social activities. These cultural resources prepare children for school by offering collaboration and social growth with peers (Sun et al., 2011; Wagmiller et al., 2010). When children go to school without these experiences, it can cause higher levels of stress and can affect academic
achievement (Marks, 2006). Parents’ financial, physical, and motivational ability to invest time, money, enriching cultural experiences and educational opportunities ultimately affect children’s academic achievement (Roble, Jewell, & Kanotra, 2012). Such is the case of a group of 2,000 10-year-old boys from Sweden. Their negative behaviors were shown to escalate two percent over the course of a year when faced with traumatic life events such as poverty and isolation. The lack of familial resources did not allow them to experience the cultural resources that may have improved their negative behaviors (Zheng et al., 2015).

Though there are a myriad of factors that affect the lack of problem-solving skills in children, a family’s dynamics and socioeconomic status are two factors that are changing at a very high and fast rate (Amato et al., 2015). Many researchers are pointing to inquiry-based strategies versus teaching traditional skills to enhance problem-solving and increase academic achievement (Kaya & Kablan, 2013). Traditional learning skills include rehearsal, elaboration, time management, organization, and study environment. Inquiry-based strategies include integrating critical thinking and problem-solving, creativity and innovation, collaboration, and communication in the classroom. These strategies offer more opportunities for open-ended activities, such as project-based learning that require children to think critically and collaborate (Pollitt et al., 2015). Famed philosopher John Dewey knew the importance of inquiry-based learning as his philosophy supported collaboration and critical thinking through the process of problem solving. Dewey stated that problem-solving and collaboration techniques allow children to grow into successful members of society (Guccione, 2011). Inquiry-based practices improve content knowledge, enthusiasm, and confidence in learners. Educators are now
creating community centered classrooms that focus more on the student process of learning and less on the teacher imparting their knowledge on students (Sanger, 2007).

Though increased content knowledge, enthusiasm, and confidence are important, growth is the goal of any sound intervention (Kaya & Kablan, 2013). One research study looked at the math topic of fact fluency in two fifth-grade classrooms. The researchers worked with a control group and a treatment group. Though both groups made gains in numeracy strategies and knowledge, the treatment group outperformed the control group by 4 points in the area of problem-solving. They also found that the treatment group, who used inquiry-based practices, provided more evidence of content knowledge and precise explanation for the work they completed (Broussard et al., 2006). Gu, Chen, Zhu, & Lin (2015) implemented inquiry-based strategies with preschool students. They allowed the students to explore basic mathematics concepts through the inquiry practices of collaboration and problem solving. At the end of the study, the percentage of students who could count objects increased from 31% to 50%. When given a numeracy assessment, student achievement increased from 37% to 50%, and when assessed on rote counting, student achievement increased from 48% to 57%.

In another study, researchers set aside a time for 16 seven and eight-year-olds who were not making academic achievement to write and read using a web-based literacy program that was unique to them. The students used the 21st century skills of critical thinking, creativity, and collaboration in their work. By the end of the year, the students had consistently been immersed in many different ways to read, write, problem solve, and think. Each student grew at least one reading level and 50% of the students scored above academic expectations (Andes et al., 2011). Further research has found that students who
actively used inquiry-based practices reported higher levels of academic self-efficacy; they were able to resolve conflicts at a higher rate, were less afraid to take risks, and were more likely to continue trying different ways to be successful when they failed (Gu et al., 2015). One study that measured collaboration and problem-solving practices in a third-grade classroom found that 31 students who were engaged in inquiry methods outperformed the 28 students who engaged in only traditional teaching practices by 2 points. The researchers concluded that these skills might allow students who do not have adequate adult support to have the tools to problem solve and be successful with academics (Sahin, Ayar, & Adiguzel, 2014).

In summary, the literature that was reviewed showed that students from low socioeconomic backgrounds living in non-traditional families often lack the resources necessary to be academically successful (Andes et al., 2011). The research revealed that socioeconomic status and family structure only touch the surface of the problem and that the resources families provide for students such as time, income, educational tools, and cultural opportunities significantly affect whether they will be academically successful or not (Marks, 2006; Sang et al., 2007; Shaff et al., 2008). When inquiry-based strategies appeared in classroom settings, students showed greater academic achievement in multiple areas of study (Sun et al., 2011).

This literature review is important, as educators are seeing students who require more attention in and out of school (Konstantopoulos, 2011). Inquiry-based strategies are one way that they can ensure students have the proper tools to be successful in situations where help is not readily available (Milne et al., 2006). One gap in the research was that the studies did not focus on academic achievement in typical two parent families. The
following action research project looked to find what are the effects of inquiry-based practices on students’ problem-solving competence?

**Methodology**

To study the effects of inquiry based practices on student achievement, various research methods were used. Each student was given a pre-assessment prior to the first week of direct instruction and the subsequent three weeks of project based learning and data collection. After one week of direct instruction and a three-week project were completed the students were given a post-assessment. The pre and post assessments consisted of the same set of questions with the exception of a set of questions in the post assessment that related to their feelings and knowledge of the inquiry strategy they were taught, also known as The Tatanka Toolbox (see Appendix A). Because many teachers feel students are asking too many questions related to previously taught content, the pre and post assessment both consisted of each student being asked their feelings and their actions when faced with a problem in the school setting (see Appendix B). Both assessments were conducted via a digital test in the school’s computer lab. Each student was instructed to take the test independently. To respect the confidentiality of others, the use of privacy shields was employed so students could not see the computer screen of the person next to them.

During the first week of the Action Research Project, students were introduced to the six stages of The Tatanka Toolbox Inquiry Strategy. Each stage was introduced, modeled, practiced, and then assessed the following day. The six stages of The Tatanka Toolbox Inquiry Model included, linking prior knowledge to a topic, inquiring about a topic, exploring a topic, making connections with a topic, imparting knowledge of a
topic, and metacognition in relation to work completed. To model, practice, and assess the mastery of each stage, thinking maps were utilized. To ensure integrity of the model, each stage was modeled using the topic of ramps.

On Monday of the first week students were taught how to link their prior knowledge to the topic of ramps. They then completed a circle map with the researcher to list what they already knew about ramps. The students then completed a bubble map with the researcher to list adjectives related to describe ramps. On Tuesday of the first week, students were first asked to come up with a topic of their choosing and create both a circle map and a bubble map to explain what they already knew about their specific topic. This assessment was collected and analyzed to check for understanding of the linking stage of The Tatanka Toolbox. Once this was completed, students were taught about stage two of The Tatanka Toolbox. They learned how to make predictions and ask questions about the topic of ramps. They completed a flow map with me to sequence events that might happen if they were to build a ramp.

On Wednesday of the first week, students began by coming up with a topic of their own and then creating a flow map to sequence a series of events related to their topic. This assessment was collected and analyzed to check for understanding of the inquiry stage of The Tatanka Toolbox. After the assessment, I taught about the exploring stage of The Tatanka Toolbox. The day culminated with the students listing places they could find information related to the topic of ramps.

On Thursday of the first week students started the day by researching sources of information, such as, the library, the internet, or their peers. This assessment was collected and analyzed to check for understanding of the exploration stage of The
Tatanka Toolbox. I then taught the making stage of The Tatanka Toolbox and students completed a double bubble map with the instructor comparing what they knew about the topic of ramps with what they had learned through research on the topic of ramps.

On Friday of the first week I asked the students to create a double bubble map comparing and contrasting what they knew about a topic of their choice with what they wanted to learn through the process of research. Students were allowed to use digital devices and books within the classroom to conduct their research. This assessment was collected and analyzed to check for understanding of the making stage of The Tatanka Toolbox. Following the assessment, students were taught about the impart process of The Tatanka Toolbox. They were asked to fill in a brace map with me to list the specific jobs needed to build a ramp. They were then taught the metacognate process of The Tatanka Toolbox and asked to complete a tree map and a multi-flow map to help them imagine ways to improve a ramp. The students were then asked to reflect on a past project and create their own brace, tree, and multi-flow maps to check for understanding of the metacognate stage of The Tatanka Toolbox. This assessment was collected and analyzed to check for understanding of the final two stages of The Tatanka Toolbox, impart and metacognate (see Appendix C).

The remaining three weeks of data collection consisted of students working on a project based learning activity of their choice. The first day of the remaining three weeks I provided the following instructions to the students: “You will be completing a project of your choice. You have access to the computer lab, media center, and your classroom resources. Resources related to The Tatanka Toolbox will be available in the back of the classroom each day. You will have one hour each day to work. You may begin.”
Following these instructions data was collected regarding whether the students worked with support or independently, the number and type of resources the students utilized to complete their project, and if The Tatanka Toolbox was utilized.

A tally sheet was used to track how many times each student approached the me to ask a question each day. The results were then tabulated to study trends related to students over the entire three-week period of the project based learning activity. This tally sheet was necessary to see whether students were moving from assisted learning to more self-directed learning over time. A table was also utilized to mark what resources each student used for each day the students worked on their project. This information was used to show whether the students used resources related to The Tatanka Toolbox, resources they found on their own, or resources provided by me to learn more about their topic of choice. Student observations were taken each day and I noted whether the students were working with or without support and whether the support was from the an adult or from a peer. I collected each work sample along with the thinking maps and student plans at the end of the three-week working period. The number and types of thinking maps used were collected to find trends in the stages of The Tatanka Toolbox that were used. They also helped to note what parts of The Tatanka Toolbox were more effective in the project based learning activity.

Finally, each project was compared to the Minnesota State Standards to determine whether the student’s projects contained strands in the areas of literacy or mathematics. This information was used to support the findings in the literature review that inquiry-based strategies support and enhance academic proficiency.
In the next section, the data was analyzed and the results were studied. The use of The Tatanka Toolbox allowed students to have a specific problem solving strategy to solve problems. They were also able to integrate Minnesota State Standards in literacy and mathematics through the process of project based learning. Through the use of written assessments, observations, and physical evidence, I will show whether the implementation of a “Genius Hour” benefitted 5th grade students.

**Analysis of Data**

The students started with a pre-assessment, which contained two categories of questions. The first category asked questions related to students’ feelings when faced with a problem and the second category asked questions related to how students solve problems. The pre-assessment showed that 71% of the student group had negative feelings when facing a problem. Despite the high number of students who had negative feelings toward facing a problem, 28% of the student group had positive feelings about completing projects at school. On a scale of one through five, where one indicated they dislike school projects and five indicated they love school projects, 20 out of 28 students rated themselves a four or five, showing they like or love school projects. Out of this group, 18 of the 28 stated that they would not be likely to use a new problem solving strategy if they were taught one. Of the 28 students in the class, 15 referenced needing adult support in the form of a teacher or a parent. Only seven students made reference to specific problem solving strategies or inquiry-based practices in their pre-assessment responses (see Figure 1).
Figure 1. Student self-reporting on whether they use problem solving strategies and adult support for problem solving.

The data on my pre-assessment indicated that while students may enjoy project based learning while at school, they are relying heavily on adult support to complete their work.

After the first week of direct instruction on The Tatanka Toolbox, the students were given instructions to complete a project related to a topic that was of interest to them. The Tatanka Toolbox thinking maps were placed in multiple locations in the classroom as well as in the media center and the computer lab. During their working time students were not given explicit instructions or direct answers to questions they had. When students asked questions the researcher responded by paraphrasing what the student said or re-questioning. At the end of the three-week working time all thinking maps related to The Tatanka Toolbox were collected along with the projects. Of the 28 students in the class, 27 students utilized thinking maps related to the linking stage of The Tatanka Toolbox, 16 students used thinking maps related to the inquiring stage of The Tatanka Toolbox, 18 students used thinking maps related to the exploring stage of The Tatanka Toolbox, 23 students used maps related to the making stage, and four students used maps that related to the impart and metacognition stages (see Figure 2).
The categories of The Tatanka Toolbox utilized by the 28 students in the class.

The data in this chart indicates that most students used The Tatanka Toolbox to inquire, explore, and research their topic. It also shows that they used this inquiry tool to make connections with their information to complete their projects. The data also shows that they did not spend much time sharing their final project information with their peers or reflecting on the process of their work once they were finished. Beyond the use of the thinking maps provided, the number of questions that students asked of the researcher each day was also recorded. As hoped for, the number of questions each day decreased as the three-week period went on. Though there were more questions during the first half of the project, many of these were related to obtaining materials and tools (see Figure 3). As a class, students asked questions of an adult an average of 42 times per day in week one. This number dropped to an average of 20 questions per day asked in week two and an average of 5.4 questions per day in week three (see Figure 4). The data shows that the number of questions asked of the researcher decreased over the three-week working period.
Figure 3. Total number of questions asked of the researcher by members of the class on each given day during their independent work time.

Figure 4. Average number of questions asked by the whole class per week.
There were 88 thinking maps that were used over this same period and this shows that students were advocating for themselves and problem solving on their own as their working time went on. In the end, 16 out of the 28 students were able complete their project using inquiry strategies and peer support only (see Figure 5).

![Pie Chart](image)

**Figure 5.** The percentage of students who completed their projects with/without adult support.

The students used various resources when starting their projects and when working to complete their presentations. The direct instruction included a lesson on where to find resources and perform research. The students who utilized thinking maps related to the making stage of The Tatanka Toolbox talked about the resources they used. They shared that much of the work they completed involved problem solving through the use of the Internet. Some students also found books in the media center and many asked questions of their peers. Google was the most prevalent resource used. Students also asked many questions of each other and worked together during the project (see Figure 6).
After the three-week working period ended, each of the student projects were evaluated and compared to literacy and mathematics Minnesota Academic Standards to see whether there was evidence of student mastery in either of these areas. Of the 28 students, ten met literacy standards in their final projects, while eight met mathematics standards, seven met both literacy and math standards, and three students did not meet any standards (see Table 1). Of these projects, seven students met both literacy and mathematics standards. Though direct instruction was not provided on literacy or mathematics standards, this project based learning opportunity allowed for students to naturally read and comprehend information, write informational works that conveyed comprehension, calculate whole and parts of numbers, create and manipulate three-dimensional objects, and present their findings in written and verbal formats.

*Figure 6.* Resources used to problem solve and complete project.
Table 1. Students who met Minnesota Academic Standards in literacy and mathematics.

<table>
<thead>
<tr>
<th>Category</th>
<th>Literacy Standard</th>
<th>Math Standard</th>
<th>Both Standards</th>
<th>No Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Students Who Met</td>
<td>10</td>
<td>8</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

The literacy and mathematics standards are broken down into multiple categories, or strands. These include comprehension, fluency, phonics, and writing for literacy, and number and operation, algebra, data analysis, and geometry for mathematics. Literacy strands were more prevalent in students’ projects than mathematics strands. This could be due to the fact that many students produced displays and gave oral presentations where literacy practices were necessary. Of the students who did show evidence of mathematics strands in their final projects, number and operation was the only area that more students met the strand versus not meeting. This could be a result of the basic operations such as addition and subtraction of whole numbers this strand contains. Algebra, data analysis, and geometry are more specific disciplines and many students’ projects did not require these operations (see Figure 8). Further research may help to clarify whether the students already had mastery of the standards and applied their knowledge to their projects, or whether the project helped them to gain mastery of Minnesota Academic Standards.
The final task the students completed was a post assessment. The post assessment contained the same questions as the pre-assessment. The number of students who referenced needing adult support decreased from the pre-assessment to the post assessment by 29%, the number of students who referenced self advocacy as a problem solving technique increased by 29% on the post assessment, and the number of students who made reference to a specific inquiry strategy increased by 61% on the post assessment (see Figure 9).
Figure 9. Comparison of student self-advocacy in pre and post assessment.

This data points to students utilizing some form of inquiry process throughout their project based learning time. Students were also asked the same series of questions on the post assessment as on the pre assessment. These questions related to their feelings and actions when solving a problem. Sixteen students felt negative when faced with a problem on the pre-assessment and then felt positive when asked the same question on the post assessment. Twelve students went from feeling negative about school projects to feeling positive about completing school projects and eight students changed their minds and stated they would use inquiry strategies in the future. This shift in student thinking may be due to the inquiry tools that were provided during the course of the project to support their need to solve problems.

**Action Plan**

My action research project points to the benefits of inquiry based practices. The results showed that students, when given choices, could still meet academic standards in multiple areas. Teaching students how to think and solve problems will allow them to complete schoolwork or projects when a teacher or a family member is not readily
available. Many students were apprehensive when given an open-ended project.
Offering them tools, such as the thinking maps utilized in this project, not only helped the students to feel more comfortable it offered a way to generate new ideas and solutions to problems. This project seemed to create a safe environment for students to collaborate and communicate. As students worked they talked with their peers about the thinking maps they were filling out, they shared ideas and asked questions about how to complete their projects, and they offered help and support to each other to complete their projects.
Because each student was working on an individual project, there was not a right way to complete his or her work. This seemed to allow for the students to be more open to talking about their successes and their failures, which may have been the reason most students were successful in completing their projects while meetings Minnesota Academic Standards in literacy and mathematics. Offering different ways to complete work such as project-based learning could lead to more in depth content knowledge for previously taught material.

The use of a specific inquiry strategy further assisted students in advocating for themselves and completing their work. The shifts in attitude throughout the project showed that allowing students choice in their schoolwork might lead to enhanced student engagement. Allowing time for peer support and collaboration also helped to build student confidence in their problem solving skills.

The use of The Tatanka Toolbox could be an excellent strategy for students who are new to project based learning opportunities. It clearly lays out a framework for completing a project and collecting each student's thoughts. The more students use and become comfortable with what the purpose of each piece of this tool is used for, the more
in depth their thinking will be. By embedding thinking maps into this framework, it further helped to support student learning and solidify the concepts that were taught in the direct teaching portion of the project. Another potential benefit to this model was evident in the post assessment results. Many of the students made reference to either The Tatanka Toolbox or another inquiry strategy they have been taught. If students continue to talk about inquiry-based strategies and share their thoughts while collaborating with their peers, these ideas will be practiced on a more regular basis and may become habit. This could lead to more attempts at independent problem solving for students who may struggle in different content areas.

One area that was not quantified was student confidence. In future studies, I would add a section to my pre and post assessment to see how confident students were with academic work. One example I did see related to student confidence was evident as the students shared their work with their peers. They were able to articulate the topic of their choice very clearly, showed accuracy and poise in their presentations, and were visibly happy while presenting their work. Though there was not a specific question related to confidence on the post-test, many students still shared that they felt confident about completing school projects.

Inquiry based learning strategies and the 21st century skills of critical thinking and problem solving, creativity and innovation, collaboration, and communication are being implemented in the school setting where I performed this project. Continued practice with these skills will ensure that when students leave this elementary setting after fifth-grade they will have problem solving strategies that they can take with them. I plan to incorporate my action research project into staff development throughout the
upcoming school year. Furthermore, I will offer support by going into classrooms to facilitate co-teaching strategies to implement and embed The Tatanka Toolbox through the use of the thinking maps I have created. This strategy will allow for inquiry based strategies and The Tatanka Toolbox to become a theme and mindset that students will use from kindergarten through fifth grade in the years to come.

My action research project began with the question of what are the affects of inquiry-based practices on student’s problem solving competence? I believe that through the use of a specific inquiry process students can become more confident learners who do not rely on constant outside support to succeed. Another effect that inquiry-based practices may have is the building of intrinsic motivation. Project based learning opportunities and problem-solving strategies may allow students to feel more confident in their abilities through decreased criticism and increased collaboration. At the start of my project, students seemed to rely on adults when faced with a problem. By the end of my project, many students had either made reference to, or showed evidence of self-reliance to solving problems. Inquiry-based practices could be a strategy educators could implement to support and enhance their direct instruction to enhance curriculum and academic knowledge.
References


Pollitt, R., Cohrssen, C., Church, A., & Wright, S. (2015). Thirty-one is a lot! Assessing
four-year-old children's number knowledge during an open-ended activity.


Appendix A
The Tatanka Toolbox
Appendix B
Pre and Post Assessment Questions

<table>
<thead>
<tr>
<th>Pre-Assessment Questions</th>
<th>Post Assessment Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do you feel when you can’t solve a problem?</td>
<td>How did you feel when you couldn’t solve a problem during your project?</td>
</tr>
<tr>
<td>□ Happy</td>
<td>□ Happy</td>
</tr>
<tr>
<td>□ Sad</td>
<td>□ Sad</td>
</tr>
<tr>
<td>□ Angry</td>
<td>□ Angry</td>
</tr>
<tr>
<td>□ Fine</td>
<td>□ Fine</td>
</tr>
<tr>
<td>□ Frustrated</td>
<td>□ Frustrated</td>
</tr>
<tr>
<td>What do you do when you can’t solve a problem?</td>
<td>What did you do when you couldn’t solve a problem during your project?</td>
</tr>
<tr>
<td>What two things would help you to best solve a problem?</td>
<td>What things helped you to be successful with your project?</td>
</tr>
<tr>
<td>□ Teacher Support</td>
<td>□ Teacher Support</td>
</tr>
<tr>
<td>□ Help From a Friend</td>
<td>□ Help From a Friend</td>
</tr>
<tr>
<td>□ The Internet</td>
<td>□ The Internet</td>
</tr>
<tr>
<td>□ The Media Center</td>
<td>□ The Media Center</td>
</tr>
<tr>
<td>□ A Parent</td>
<td>□ A Parent</td>
</tr>
<tr>
<td>□ Yourself</td>
<td>□ Yourself</td>
</tr>
<tr>
<td>□ Nothing</td>
<td>□ Nothing</td>
</tr>
<tr>
<td>What kinds of strategies have you learned at school that could help you solve a problem?</td>
<td>What kinds of strategies have you learned at school that could help you solve a problem and how do they help you?</td>
</tr>
<tr>
<td>If you were taught a new strategy to solve problems how likely would you be to use it?</td>
<td>How likely will you be to use The Tatanka Toolbox?</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>I would not</td>
<td>I would not</td>
</tr>
<tr>
<td>Absolutely</td>
<td>Absolutely</td>
</tr>
<tr>
<td>Why or why not?</td>
<td>Why or why not?</td>
</tr>
<tr>
<td>Please explain the steps you would take to complete a school project.</td>
<td>Please explain what steps you will take in the future to complete a school project.</td>
</tr>
<tr>
<td>On scale of 1-5 how do you feel about completing projects at school?</td>
<td>On a scale of 1-5 how do you feel about completing projects at school now?</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Not Confident</td>
<td>Not Confident</td>
</tr>
<tr>
<td>Very Confident</td>
<td>Very Confident</td>
</tr>
</tbody>
</table>
Appendix C
Thinking Maps Related to The Tatanka Toolbox

Link - Use this circle map to link your prior knowledge to your topic. What do you already know about it?

What do I know about: __________________________

Fill in this Bubble Map to describe what you know about your topic.

(Your Topic or idea)
Use this Flow Map to sequence events that might happen if you take a certain action.

**Event:**

---

**Inquire**

**Explore**

Places or sources I can use to research and find information on my topic:

1. 

2. 

3. 

4. 

5. 

6.
Use this Tree Map to categorize your main ideas and details from the information in the research you found.

(Topic)

(Main Idea 1)  (Main Idea 2)  (Main Idea 3)

Use this Double Bubble Map to compare what you already knew with what you learned from your research.

Topic:

What did I know?

(Similarities)

What did I learn?

(Differences)

(Differences)
Take what you already knew and what you have learned and explain your new connections to your topic. Tell how you will share your new connections to solve your problem.

Use this Brane Map to explain the parts of your project and who will be responsible for each part.

(Job and Person
Responsible for Job)

(Job and Person
Responsible for Job)

(Job and Person
Responsible for Job)

(Job and Person
Responsible for Job)

(Job and Person
Responsible for Job)

(Job and Person
Responsible for Job)
INQUIRY PRACTICES EFFECT ON PROBLEM SOLVING

Fill out the Multi-Flow Map to reflect on your results and improve if necessary.

(Cause: Because I did this...) (Effect: This is what happened)

(Briefly explain what you did in this box.)

Think of what worked and what did not work in your project. Fill in the Tree Map and reflect on what you needed to be successful.

(What was your project/assignment)

- Worked
- Did not work