Arts-Based Data Visualization Project

Year 4 Evaluation Report

Synergy Evaluation Institute
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Executive 4-Year Summary

The Arts-Based Data Visualization Project (ABDVP) has been a successful program over the last four years. From the beginning of the project, the leadership and implementation teams have been an exceptional driving force. Under the direction of Dr. Joy Bertling, the teams have overseen the creation and full implementation of program materials, including a Summer Institute workshop with professional development (PD) materials for teachers, an external Curriculum Content Expert Panel, and an IRB-approved research agenda.

The Summer Institute was a highly rated and well-attended professional development week, which allowed for the successful establishment of a data visualization curriculum across middle-grade classrooms in the area. The Curriculum Content Expert Panel provided constructive feedback on the professional development materials, with the items progressively improving during the program and receiving a 100% exemplary rating during the final year. In addition, the program has produced six publications, with more manuscripts under review or planned.

Synergy concludes that ABDVP was a very well-run project. It has been organized, and the leadership and the implementation team have communicated and worked well together to continuously improve the program. All program participants rated the program extremely well, with few recommendations for improvement, and look forward to its direction and potential broader reach. In addition to this executive summary, data collection summaries are included for fall 2024 and spring 2025 evaluation processes.

Previous evaluation reports illustrate the following sections more in-depth. The reports can be reviewed here:

- Year 1 Summary
- Year 1 Pilot
- Year 2
- Year 3

Instrument Development

The Data Visualization Project developed several measures once the grant was funded on October 1, 2022. In consultation with NISER, the project had developed evaluation measures as well as research measures.

The measures specific to research are listed below:

- Research interview guide for the teachers
- Observation Protocol

The measures used for both research and evaluation were:

- Post reflective student survey
- Student drawing prompt (both pre and post)

The measure specific to evaluation was:

- Evaluation group interview for the teachers

Curriculum Content Expert Panel Summary

The Curriculum Content Expert Panel comprised art education professors and experts in the field of data visualization education, all of whom had extensive experience teaching data visualization in their respective fields. Four of these members had multiple national publications on the topic of data visualization, and two panel members serve as members of NAEA's Data Visualization Working Group.

The first meeting took place on January 11, 2022, and the second on February 15, 2022. The Curriculum Expert Panel reviewed the curriculum and provided recommendations to the team. The recommendations were incorporated into the implemented curriculum and were reviewed annually for further improvements.

The panel was also surveyed annually by Synergy. The survey requested the panels' ratings on the PD's progression of topics, content, instructional strategies, instructional resources, teacher resources, alignment of standards, and the PD overall. Respondents also had the opportunity to provide additional feedback for each in an open-ended question.

The following sections were rated on the scale below:

- Inadequate (1) = Falls far below standards to educate teachers about concepts and the PD would need to be significantly improved and/or redone to be brought up to acceptable levels.
- Needs Improvement (2) = Does not meet standards to educate teachers about the concepts, but with improvement, can be brought up to acceptable levels.
- Acceptable (3) = Meets standards to educate teachers about the concepts.
- Exemplary (4) = Exceeds standards to educate teachers about concepts.

During the second year, the experts rated three of the six components exemplary. One expert rated three components, the PD's content, instructional resources, and teacher resources, as "Acceptable," providing an 83% exemplary score. Lastly, all of the panel rated the PD's progression of topics, instructional resources, teacher resources, and the PD overall as exemplary in the final year. Only one panel member rated the alignment to standards, content, and instructional strategies as "acceptable" in this review.

Summer Institute Summary

ABDVP invited 10 participants to attend a week of PD for two summers, entitled The Data Visualization Summer Institute in Knoxville, TN. The goals for the participants at the conclusion of the week were as follows:

- Demonstrated a broader conceptualization of data visualization, to include arts-based data visualizations.
- Gained experience drawing upon knowledge and methods from multiple disciplines to address ecological and social issues through data visualization.
- Designed transdisciplinary data visualization curriculum that aligns to classroom goals and content standards.

Each day, participants completed a series of small-group and large-group discussions, as well as individual and group work. A sample of the topics covered is listed below:

- Monday: Single Statistics, Repetition, and Context
- Tuesday: Repetition and Comparisons, Processes to Make Sense of Data
- Wednesday: Proportion and Storytelling
- Thursday: Datasets, Time, and Metaphor
- Friday: Mapping, Multimedia, Contemporary Creative Strategies

Participants engaged with the facilitator's lectures and then used various datasets and the day's content to create presentations and/or create their own data visualizations as a group. The participants agreed to use the curriculum they designed with a class of students the following academic year.

The Summer Institute participants were emailed pre- and post-surveys to measure their attitudes toward STEAM, art education, and data visualizations, as well as their confidence in teaching data visualization to their students. In the post-survey, participants rated their satisfaction with the professional development and provided feedback on their favorite and least favorite aspects of it.

In the first year, the participants strongly agreed that the DVP Summer Institute was a good use of their time and rated the PD as "excellent." The participants strongly agreed or agreed with all the other satisfaction questions. The qualitative responses showed high levels of satisfaction as well as a few mentions of ways the PD could improve. Some participants suggested that the PD could offer additional examples as exemplars or could be more explicit in their expectations for the presentations. For the positively worded attitude and confidence variables, the participants indicated growth from before to after (meaning that their attitude or confidence for each item increased after attending the PD), and for the negatively worded items, the participants indicated a decline from before to after (meaning that their attitude decreased for the item after attending the PD). When Wilcoxon Tests were run on all the before and after variables, 16 variables were significant, meaning that the difference in means for the item from before to after cannot be attributed to chance, but instead is due to the participants' attendance at the PD.

In the following summer, during the second occurrence of the institute, participants strongly agreed that the DVP Summer Institute was a good use of their time and rated the PD as "excellent." The participants strongly agreed or agreed with all the other satisfaction questions. The qualitative responses showed high levels of satisfaction as well as a few mentions of ways the PD could improve. For the positively worded attitude and confidence variables, the participants indicated growth from before to after (meaning that their attitude or confidence for each item increased after attending the PD), and for the negatively worded items, the participants indicated a decline from before to after (meaning that their attitude decreased for the item after attending the PD).

Overall, the participants strongly agreed that the DVP Summer Institute was a good use of their time and rated the PD as "excellent." The participants strongly agreed or agreed with all the other satisfaction questions, including:

- Attending the DVP Summer Institute was a good use of my time
- I am excited to implement my own transdisciplinary curriculum about data visualizations and art in my classroom
- I feel confident in what I learned so I can implement my own transdisciplinary curriculum about data visualizations and art in my classroom
- The facilitators were knowledgeable about the content
- I have a greater understanding of data visualizations which includes arts-based data visualizations
- I feel comfortable using data visualizations to address ecological and social issues

The qualitative responses showed high levels of satisfaction as well as a few mentions of ways the PD could improve. Some participants suggested having an option to attend more of the Thursday sessions instead of only selecting one. They advised that so many of the sessions were

on appealing topics and would have liked more instructional time on them from facilitators. For the positively worded attitude and confidence variables, the participants indicated growth from before to after (meaning that their attitude or confidence for each item increased after attending the PD), and for the negatively worded items (reverse-coded for analysis and visualization), the participants indicated a decline from before to after (meaning that their attitude decreased for the item after attending the PD).

Pilot

ABDVP conducted two curriculum pilots during the spring of 2022. Two sites were selected and approved by Knox County Schools: one STEM and another Media Arts class at local middle schools. At each site, the students were given a link to a survey that asked them about their perceptions of data visualizations and art and their confidence in being able to create and use data visualizations. The students were asked to rate themselves on each survey question thinking about before the curriculum and now after the curriculum. Sixty-six surveys were collected from the students. They are split up by class, with 27 from the Media Arts Community (MAC) class, 25 from the Media Arts Storytelling (MAS) class, and 14 from the STEM Class.

The students showed growth on all of the questions. The highest percent change was evident in the perception question, "I know how to read a data visualization," and the confidence question, "I can use data to make my own data visualization." The lowest percent change was "I am interested in a STEM career when I grow up." 66% of the students thought that the curriculum was "excellent" or "pretty good."

Additionally, Synergy conducted interviews with the teacher at each site after implementing the curriculum. The teachers were asked to reflect on their experiences with the curriculum, including the successes and challenges they observed, and whether they had any feedback on how to improve it. The teachers discussed their experiences with the curriculum, and several themes emerged from their interviews. One of the teachers addressed high levels of student engagement with the material, and both teachers mentioned that they were very pleased with the UT researchers and implementers. They found them to be respectful of the teachers' space and loved their interactions with their students. Challenges mentioned by one of the teachers were a low level of student engagement. It was determined that this could have been due to the curriculum's timing, because it took place at the end of the school year, or due to a mismatch between the students' level of development and the curriculum.

Post-Implementation Data Collections

During the fall and early spring semesters, Synergy collected three types of data for ABDVP using the data collection method detailed below and in subsequent summaries:

- **Teacher Surveys**
    - Quantitative data: Evaluation-focused questions about the teacher's experience with the implementation of their curriculum and their thoughts on their experience with the program. Topics included for the evaluation were:
        - Overall thoughts on curriculum implementation
        - Ratings on program components
        - What went well and could have been improved on in implementation
- **Teacher Focus Groups/Interviews**
    - Qualitative data: questions designed to explore each teacher's experience after implementing their curriculum in the fall semester. Discussion topics covered included:
        - Student experiences when
            - First learning data visualization
            - Examining data closely
            - Creating data visualizations
        - Challenges and successes with these student experiences
        - How did they envision data visualization playing a role, if any, in their future curriculum
        - Overall feedback about their experience with the curriculum
- **Student Surveys**
    - Quantitative data: retrospective instruments designed to measure students' growth regarding their experience with the curriculum. Topics measured included students:
        - Data visualization attitudes
        - Data visualization confidence

Teacher Survey

After the first fall implementation in 2023, the teachers rated the implementation of their curriculum positively overall. Six of the seven said that "it went pretty good" and one as "excellent." 100% of the teachers indicated that they strongly agreed or agreed with all of the evaluation survey items with 100% strongly agreeing that attending the DVP Summer Institute was a good use of their time. For the open-ended questions, teachers overwhelmingly reported positive aspects of their implementation, with the majority indicating that the best part was the

level of student engagement or how interesting they found their students' discussions during the implementation. The survey included items that matched with the pre-survey, but project leadership indicated that this data wasn't required so the evaluator decided to report only the evaluation portion of the survey. 100% of the teachers indicated that they strongly agreed or agreed with all of the evaluation survey items with 100% strongly agreeing that attending the DVP Summer Institute was a good use of their time.

For the open-ended questions, the teachers overwhelmingly reported positive aspects to their implementation, with the majority of the teachers indicating that the best part of the implementation was the level of student engagement or how interesting they found their students' discussions during the implementation. See the representative quotes under each theme heading. Six of the seven teachers indicated that timing was an issue with their implementation. The teachers said that they found it difficult to fit the implementation within Knox County's curriculum during the fall semester. One teacher said they had an issue with the sequence of their lesson.

In the second fall implementation in 2024, Synergy sent surveys to the 24 teachers who completed their data visualization curriculum that semester. Fourteen teachers completed the surveys in December 2024. Overall, the teachers rated the implementation of their curriculum positively. Eight teachers said that "it went pretty good" and six as "excellent." 100% of the teachers indicated that they strongly agreed or agreed with all of the evaluation survey items with 100% strongly agreeing that attending the DVP Summer Institute was a good use of their time. See Figure 2 for this data visualization.

For the open-ended questions, the teachers overwhelmingly reported positive aspects to their implementation with the majority of the teachers indicating that the best part of the implementation was the level of student engagement or how interesting they found their students' discussions during the implementation.

Teacher Focus Groups and Interviews

The purpose of the individual or group interviews was to explore each teacher's experience after implementing their curriculum in the fall semester. After each interview and focus group, the audio was transcribed and checked for accuracy. The Synergy evaluator then coded and collapsed the codes into broader themes. The evaluator utilized open, descriptive, and In vivo coding techniques to explore themes within the data. (Saldana, 2012).

Following the initial implementation in fall 2023, STEM and Art Education teachers were interviewed or participated in focus groups organized by content area. The STEM teachers reported positive experiences with the project. They stated their curriculum decisions in a

detailed manner and indicated that their students were interested in and engaged with the lessons.

The STEM teachers planned to incorporate art and data lessons into their curriculum in the future, with some implementing them later that year, and others planning to use some form of data visualization lessons in every unit going forward. The largest theme was where the STEM teachers reflected on the program, either reporting that the program was the "best PD" they ever attended or giving some feedback that the leadership should consider for future programming. The STEM teachers also reflected on their successes and challenges over the fall. These could reference stories of the students engaging with the data, logistical issues related to the timing of the curriculum or having difficulties with their students' level of confidence in math. The STEM teachers also provided detailed descriptions of their curriculum with stories of their students examining data closely.

Overall, the art teachers also reported positive experiences with the program. The largest theme was where the art teachers told stories of stories of their students examining data closely. The art teachers also thought that the program was the "best PD" they ever attended and that engaging with teachers from the STEM disciplines added to their satisfaction with the program. The art teachers also reflected on their successes and challenges over the fall. These could reference stories of students excited about art, logistical issues related to the timing of the curriculum or having difficulties with the data being over their students' heads. In addition, the art teachers indicated that they are thinking about how to incorporate arts-based data visualization lessons in their future curriculum.

Following the second fall implementation in 2024, Synergy conducted interviews and focus groups in December 2024 and January 2025 with 12 participants from the fall implementation. STEM and art teachers participated in the same focus groups, rather than being separated by content area. This elicited more in-depth conversations about the teachers' implementation experiences. Notably, several participants stated that implementing the curriculum and seeing students' positive experiences brought joy back into their teaching. Both content areas provided feedback on aspects that went well and areas where they would make adjustments when they conducted the curriculum again. These conversations evolved into both STEM and art teachers sharing best practices and recommendations from their respective content areas with each other to inform subsequent implementations of the curriculum. All teachers stated they were planning to repeat it in their curriculum with some changes, and one school noted they were planning for it to become part of the normal curriculum.

In their discussions, a majority of the teachers advised that they utilized data visualization as a method to aid in student learning about concepts they were behind in or had not been introduced to yet. This was due to the challenges of some students not knowing math concepts, were

developmentally behind in other ways, etc. Through these processes, they confirmed that relevant data, such as their school or other self-selected data, were key to keeping students engaged and moving forward. The teachers stated that after some rocky beginnings, the experience opened new possibilities for their students, including those who were timid about changing or trying new ways to experience data, such as feeling unconfident as an artist and working with art.

When discussing a situation where students examined data closely, three themes were predominant in their conversations. Notably, students' understanding of data's potential use and impact on community and world issues. Students' experience and comprehension with storytelling and data were positively impacted. Students experienced the process of working through material decisions and designs to determine what information they wanted to convey to their audiences. Lastly, teachers discussed the challenges of managing the materials, especially if they were moving from classroom to classroom.

The teachers' conversations were then guided to discuss their students' actual data visualizations and the successes and challenges experienced during that process. They all agreed that this was the best, but most challenging part of the process. The students were engaged, but so thoroughly in-depth in the process that the teachers advised that better planning sessions will be necessary in the next iteration. Students experienced successes in academics, such as finally passing a fractions quiz after working with the data visualization, and collaboration and communication skills.

Student Survey

In the fall of 2023, the survey was completed by 141 Art and STEM students. Ten of the respondents were art students and 131 were STEM. The students responded to questions asking them to select their level of agreement in the Data Visualization Attitudes section, confidence level in the Data Visualization Confidence section, and additional feedback in comment fields. Nonparametric statistical tests were conducted to investigate the differences between each group's pre- and post-program responses. Overall, statistically significant differences were found in most items, along with several items demonstrating 40-48% increases. The item " I know how to read a data visualization" reported the highest increases among all groups, followed by "I can use data visualizations to solve community problems, " "I think that data visualizations and art go together," "I can use data to make my own data visualization," and "I can use data in data visualizations to solve social problems in my community." Finally, 65% of the students reported that the program was pretty good or excellent.

After the most recent implementation in fall of 2024, the survey was offered in English, Spanish, and as a bilingual version of both. It was completed by 276 Art and STEM students. The evaluator

was not able to identify whether ten students were Art or STEM due to missing or incorrect ID numbers, in addition to the 133 of the respondents that were art students and 133 that were STEM. The ten students were not included in content-specific analyses, only the overall analyses. The students responded to questions asking them to select their level of agreement in the Data Visualization Attitudes section, confidence level in the Data Visualization Confidence section, and additional feedback in the comment fields. Using an alpha level of .05, dependent-samples t tests were conducted to evaluate whether the differences between each group's pre- and post-program responses. Overall, statistically significant differences were found in a majority of items. Finally, 49% of the students reported that the program was pretty good or excellent. The following section illustrates the results in aggregate for the overall, art, and STEM groups. The figures note statistically significant results, and formal APA tables of the results are included in the Appendices of this report.

Student comments regarding their favorite parts, how art and data visualization go together, and the usefulness of data visualization.

- *I enjoyed weaving my data visualization. You can make interesting shapes that way.*
- *I enjoyed getting the options with data and making decisions about to draw. I like being able to make the choices for myself.*
- *One of my favorite insights about data visualization and art is how they intersect to tell compelling stories. I learned that data visualization goes beyond simply presenting numbers; it can evoke emotions and provoke thought when paired with artistic design.*
- *My favorite thing that I learned about data visualization and art was how we could use data to make art so we can be creative. Also we can use data for many things for art.*
- *We used a lot of different materials that made our pieces an art form. And we still communicated a message.*

Evaluation Summary

Performance Measures

Performance Measure 2A

By May 2025, 80% of Cohort 2 teachers will have effectively designed data visualization curriculum based upon a review using the Arts-Based Data Visualization Curriculum Checklist.

Cohort 2 teachers' data visualization curriculum was assessed using the Arts-Based Data Visualization Curriculum Checklist. Teachers were scored on two primary criteria, "Students

Reading Socially and/or Ecologically Relevant Arts-Based Data Visualizations" and "Students **Creating** a Socially and/or Ecologically Relevant Arts-Based Data Visualization," with a total of 50 possible points for five sub-criteria, "View an arts-based data visualization (5 points)," "Describe, analyze, interpret, or evaluate an arts-based data visualization (10 points)," "Communicating a statistic or trend(s) or pattern(s) associated with a data set (15 points)," "Communicating data-based ideas related to a socially or ecologically relevant data set (10 points)," and "Using cultural practices of storytelling to communicate data or ideas about data (10 points)." The twenty-five participating teachers achieved a score above 35, the benchmark for qualifying as "effectively designing data visualization curriculum." Therefore, ABDVP has met this metric with a ratio of 25/26, or 96%.

Performance Measure 2B

By May 2025, 80% of Cohort 2 teachers will have effectively implemented data visualization curriculum based upon an observation using the Arts-Based Data Visualization Curriculum Implementation Checklist.

Cohort 2 teachers' implementation of the data visualization curriculum was assessed using the Arts-Based Data Visualization Curriculum Implementation Checklist. Teachers were scored on two primary criteria, "Students Reading Socially and/or Ecologically Relevant Arts-Based Data Visualizations" and "Students Creating a Socially and/or Ecologically Relevant Arts-Based Data Visualization," with a total of 50 possible points for five sub-criteria, "View an arts-based data visualization (5 points)," "Describe, analyze, interpret, or evaluate an arts-based data visualization (10 points)," "Communicating a statistic or trend(s) or pattern(s) associated with a data set (15 points)," "Communicating data-based ideas related to a socially or ecologically relevant data set (10 points)," and "Using cultural practices of storytelling to communicate data or ideas about data (10 points)." Of the 26 Cohort 2 PD participants, 2 participants switched teaching positions prior to the PD implementation phase that excluded them from participation. (These positions were not STEAM positions and thus did not meet our inclusion criteria.) Of the remaining 24 participants, only 18 teachers participated in implementing data visualization curricula. 17 of these 18 teachers achieved a score above 35, the benchmark for qualifying as "effectively implementing data visualization curriculum." Therefore, ABDVP has not met this metric with a ratio of 17/24, or 71%.

Performance Measure 3A

By June 2025, 80% of students (of Cohort 2 teachers) have confidence (mean confidence ratings of 3 or higher) that they can read a data visualization based on a post-student survey administered during the 2024-2025 SY.

The survey was offered in English, Spanish, and as a bilingual version. It was completed by 266 Art and STEM students, 133 were art students, and 133 were STEM. The students responded to

the item "I know how to read a data visualization" in the Data Visualization Attitudes measure. The measure was scored on a Likert-type scale from "1" to "5," with "1" being "Strongly Disagree" and "5" being "Strongly Agree" respectively. Out of the 266 student respondents, 255 ranked their level of agreement at a "3" or higher. Therefore, ABDVP has met this metric with a ratio of 255/266, or 96%.

Performance Measure 3B

By June 2025, 80% of students (of Cohort 2 teachers) have confidence (mean confidence ratings of 3 or higher) that they can use data to make their own data visualization based on a post-student survey administered during the 2024-2025 SY.

The survey was offered in English, Spanish, and bilingual versions. It was completed by 266 Art and STEM students, 133 were art students, and 133 were STEM. The students responded to the item "I can use data to make my own data visualizations" in the Data Visualization Confidence measure. The measure was scored on a Likert-type scale from "1" to "5," with "1" being "No Confidence" and "5" being "Very Confident" respectively. Out of the 266 student respondents, 258 responded, and 219 of those ranked their level of agreement at a "3" or higher. Therefore, ABDVP has met this metric with a ratio of 219/258, or 85%.

Performance Measure 3C

By June 2025, 90% of students (of Cohort 2 teachers) create a data representation that communicates a socially/ecologically relevant data point or set and achieve related standards based upon a review of student data visualizations using the Arts-Based Data Visualization Social and Ecological Relevance & Standards Alignment Checklist.

The Arts-Based Data Visualization Social and Ecological Relevance & Standards Alignment Checklist was used to assess students' data visualizations and determine if the relevant academic standards identified by their teacher were met, as well as if there was evidence of social and ecological engagement. Students needed to achieve a score of 7 or above to demonstrate competence in these areas. Of the 173 students who consented, 172 provided evidence of Social or Ecological Relevance or Relevant Standards Achieved. ABDVP has met this metric with a ratio of 172/173, or 99%.

Performance Measure 3D

By June 2025, 80% of students (of Cohort 2 teachers) create a data representation that shows competencies based upon a review using the Student Arts-Based Data Visualization Checklist.

The Student Arts-Based Data Visualization Checklist assessed students on communicating a statistic, trend(s), or pattern(s) associated with a data set (4 points), data-based ideas related to a

socially or ecologically relevant data set (3 points), and how they use cultural practices of storytelling to communicate data or ideas about data (3 points), for a total of 10 possible points. Of the 105 students who consented, 74 met or exceeded a score of 7 to qualify as "showing competencies." ABDVP has met this metric with a ratio of 168/170, or 97%.

Performance Measure 4A

By September 30, 2025, 1 project website will have been created with all ABDVP curricular and PD materials, a technical report and infographic, and links to any published scholarly articles associated with the project.

The ABDVP created a project website introducing the project with pages for curriculum, professional development, and research. All ABDVP curricular and instructional materials were linked on the curriculum page. All ABDVP professional development materials were linked on the professional development page. The research page contained references with links to all published articles associated with the project, a link to the NAEA Webcast in which ABDVP had presented, a link to the ABDVP final technical report, and an infographic image. ABDVP has met or exceeded this metric.

Performance Measure 4B

By September 30, 2025, the project team will present project findings at 9 national conference presentations.

ABDVP team members presented 14 conference presentations associated with the project at national conferences. These conferences included the American Educational Research Association (AERA), the National Art Education Association (NAEA), the National Council of Teachers of Mathematics (NCTM), and the Symposium on Data Science and Statistics. With 5 more presentations than the 9 set in this outcome measure for a total of 14, ABDVP exceeded this metric.

Performance Measure 4C

By September 30, 2025, the project team will present findings at 4 local or state meetings or conferences.

ABDVP team members presented 5 presentations associated with the project at local or state meetings or conferences. These meetings included the conferences of the Tennessee Art Education Association (TAEA) and local school districts' professional development meetings. With 1 more presentation than the 4 set in this outcome measure for a total of 5, ABDVP exceeded this metric.

Performance Measure 4D

By September 30, 2025, the project team will have written 7 scholarly manuscripts.

This performance measure is ongoing and will be addressed during the approved no-cost extension period from 10/1/25 – 12/31/25. This data will be shared in our final report.

Performance Measure 4E

By September 30, 2025, the project team will write 1 technical report and 1 infographic of project findings and disseminate them to 10 partners.

ABDVP wrote 1 technical report and 1 infographic of project findings. This report and infographic were disseminated to all 10 project partners. Thus, ABDVP met this metric: 10 partners.

Performance Measure 4F

By September 30, 2025, 5 partners will have shared links to the ABDVP website with their staff or members (e.g., email, online newsletter, social media, blog, or website) and documented their dissemination method.

ABDVP recently shared the link to the ABDVP website with all 10 partners (and many other stakeholders). So far, 5 partners have already shared the link to this ABDVP website with staff or members and documented this dissemination by notifying ABDVP team members. These partners include Union County Public Schools, Maryville City Schools, the East Tennessee STEM Hub, the National Art Education Association's Data Visualization Interest Group, and the Tennessee Council of Visual and Performing Arts Supervisors. Thus, ABDVP has met this metric: 5 partners shared the website.

Performance Measure 4G

By September 30, 2025, we will conduct 1 summer camp week session or family session will have been conducted with a museum partner.

ABDVP conducted 2, two-day summer workshops for youth at the Knoxville Museum of Art, an ABDVP partner. Thus, ABDVP met this metric.

Fall 2024 Post-Implementation Data Collection

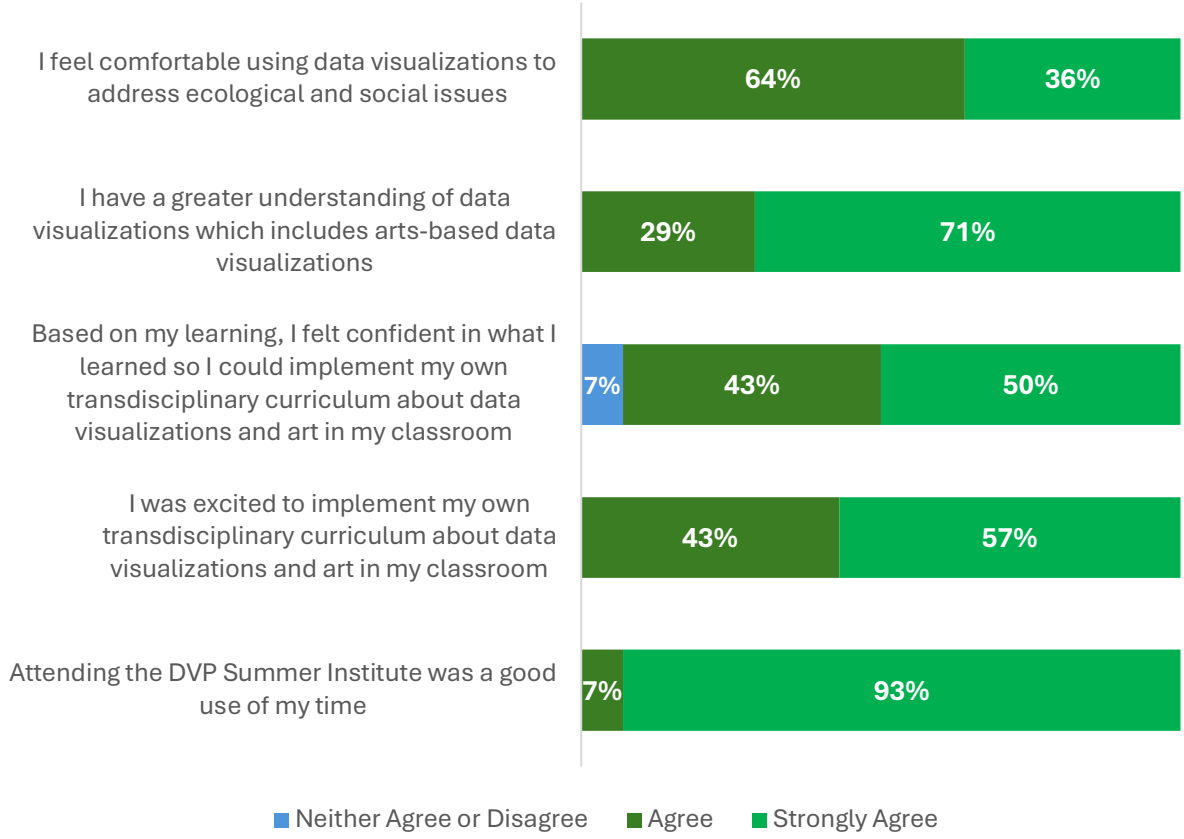
Teacher Survey

After the fall implementation, Synergy Evaluation Institute sent surveys to the 24 teachers that completed their curriculum in the fall of 2024. Fourteen teachers completed the surveys in December 2024. Overall, the teachers rated the implementation of their curriculum positively. Eight teachers said that "it went pretty good" and six as "excellent." See Figure 1 for this data visualization. 100% of the teachers indicated that they strongly agreed or agreed with all of the evaluation survey items, with 100% strongly agreeing that attending the DVP Summer Institute was a good use of their time. See Figure 2 for this data visualization.

For the open-ended questions, the teachers overwhelming reported positive aspects to their implementation with the majority of the teachers indicating that the best part of the implementation was the level of student engagement or how interesting they found their student's discussions during the implementation.

Figure 1: Overall thoughts on curriculum implementation

Figure 2: Teachers' ratings of program components

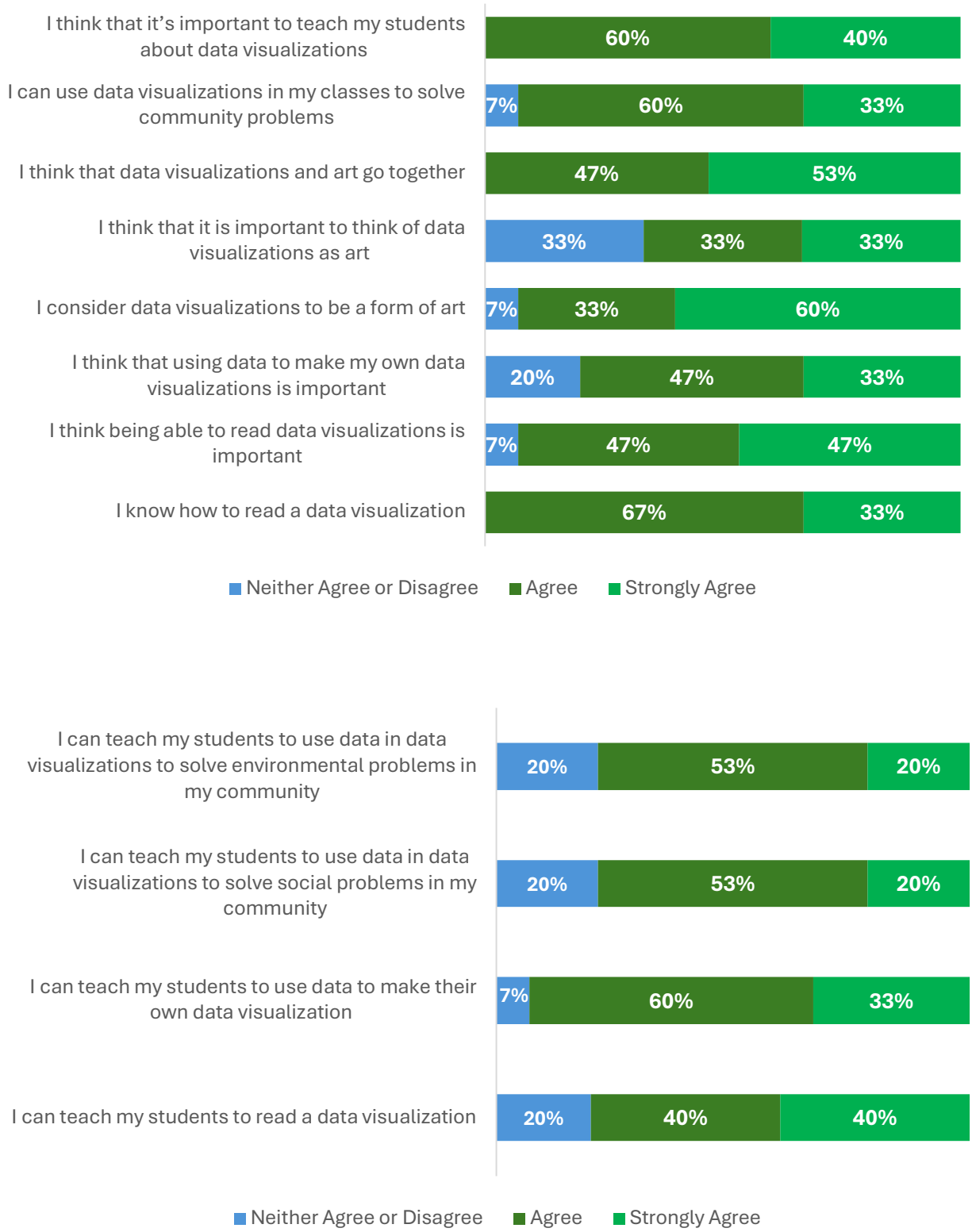


Art Education Attitudes

Figure 3: Teachers' ratings of their Art Education Attitudes

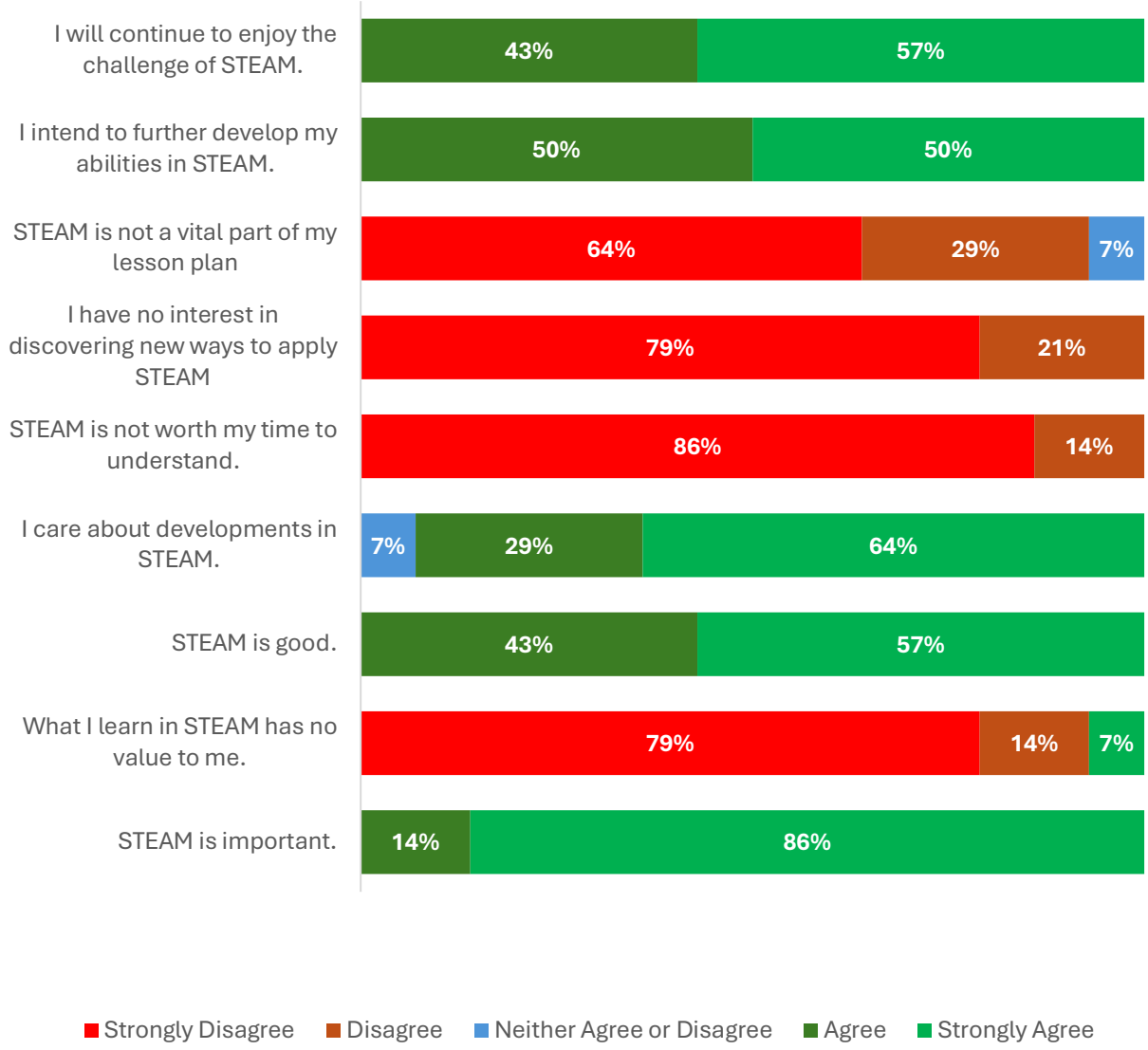
Data Visualization Attitudes

Figure 4: Teachers' ratings of their Data Visualization Attitudes



Data Visualization Attitudes

Figure 5: Teachers' ratings of their STEAM Attitudes



What Teachers Liked about the Implementation

Students Were Engaged

- *The kids were excited to apply what they have learned in other classes in this class. They loved coming up with visual ways of showing their knowledge of how to convert decimals to percentages and back.*
- *It was a hands on way for students to understand and see the data in our environment.*
- *I enjoyed seeing the engagement that it brought to the classroom and ways that the students analyzed the data making meaningful connections.*
- *I enjoyed seeing the students' creativity, especially when given the opportunity to choose their own materials. I feel like students had a much better understanding of the concept as soon as they made it. They had a hard time making connections without spending a good amount of time on their own piece.*

Return of the Joy of Teaching

- *Implementing this curriculum brought back to me, the joy of teaching. The current Math curriculum is incredibly limiting and stifling. Giving students the opportunity to explore topics, data, and make choices on what story to tell and how was incredibly fun to watch.*
- *The students enjoyed it, and it was a lot of fun to teach!*

What Teachers Think Could Have Made the Implementation Better

Timing of the Curriculum

- *More time than my once a week 45 minute blocks. I hated to cut them short while they were creating.*
- *Not having the time broken up so much.*
- *Breaking tasks up into more manageable chunks.*
- *More time would have made it much better.*

Data Issues

- *I gave my students a little too much choice for their first project. The data was either hard to nail down and/or the topic was delicate. Despite this presenting a challenge with timing, many quality conversations about data sourcing and use were had.*

- *I wish going in the kids understood reading data better. I feel like I will start earlier with my elementary students, but my middle school students had a lot of trouble with graphs. I feel like maybe their math/science teachers don't focus on it because of the state standards and tests.*
- *I still do not feel 100% comfortable finding data sets to use. I need to practice this skill... I know it will get easier to find and clean data for student use, the more I practice.*
- *If the students had more experience with data or if they had seen art based data.*

Materials and Curriculum

- *Having more materials, and having a larger class. I believe the class was to small and they were not able to bounce ideas off each other as much as I would have liked.*
- *I wish I could have been more closely connected to the age level that I taught (elementary). It would have been nice to be able to share lessons and maybe even observe others teaching in action.*
- *I believe each time, I implement it, it will become better. For my students, I will focus on reading the graphs and answering "What" questions first, rather than having "What" mixed in with math questions. Then, I will focus on how to determine which math operation to use for the math questions. To implement this change, I will need to add in more time.*
- *I think if I had more student examples (or examples more accessible to students) to show upfront then students may have understood a bit sooner. Students had trouble connecting to the examples I showed from professional artists. I made some examples that I showed, and those did help a bit more.*

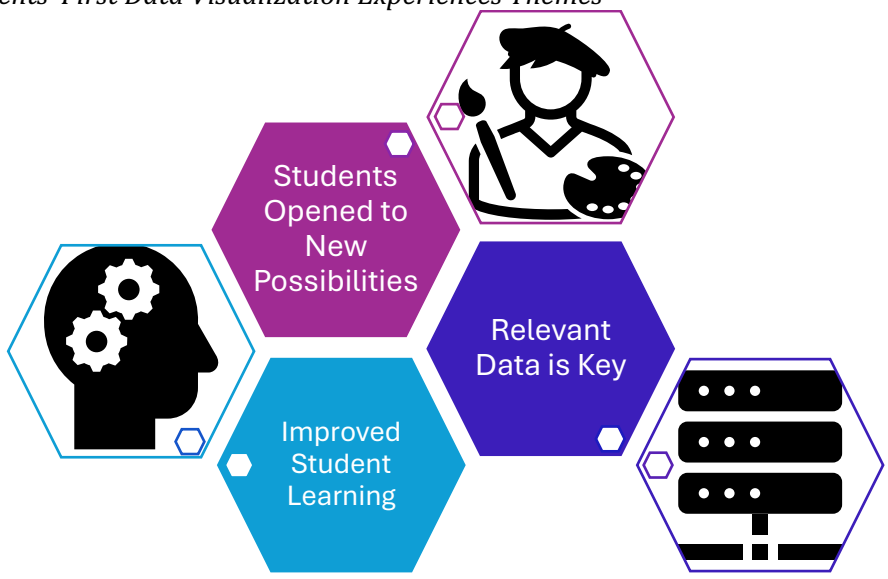
Teacher Focus Group and Interviews

In December and January, twelve teachers were interviewed or attended a focus group. The purpose of the individual or group interviews was to explore each teacher's experience after implementing their curriculum in the fall semester. After each interview and focus group, the audio was transcribed and checked for accuracy. The Synergy evaluator then coded and collapsed the codes into broader themes. The evaluator utilized open, descriptive, and In vivo coding techniques to explore themes within the data. (Saldana, 2012). All of the quotes provided for each theme were edited for readability.

Students' First Data Visualization Experience

The teachers discussed a multitude of different experiences as they introduced data visualization to their students, but the coding process identified several common themes. A majority of the teachers advised that they utilized data visualization as a method to aid in student learning about concepts they were behind in or had not been introduced to yet. This was due to the challenges of some students not knowing math concepts, were developmentally behind in other ways, etc. Through these processes, they confirmed that relevant data, such as their school or other self-selected data, were key to keeping students engaged and moving forward. The teachers stated that after some rocky beginnings, the experience opened new possibilities for their students, including those who were timid about changing or trying new ways to experience data, such as feeling unconfident as an artist and working with art. The following section presents the themes and quotes from teachers regarding their students' initial experiences with data visualization.

Figure 6: Students' First Data Visualization Experiences Themes



Improved Student Learning

- *I had to start at the very beginning because they didn't know what kind of graphs there were…We started a month back to get them a foundation so then I could start, after they made a couple graphs on their own, and then I had them do a practice visualization, and they, at first, weren't sure what was going on… I was in the beginning wondering if it was going to be too much for these kids, but it really helped them understand graphs better. I was shocked about how well they did and some of the pieces that they made, I was blown away, really, because It did everything that I wanted it to do for them and more.*
- *So my students actually used a survey that we had sent out at the beginning of the year based on needs and wants for club time, which is our and after school clubs, because we did get a grant that we could put some clubs together and possibly sponsor some biggest struggle was they don't know fractions.*
- *We selected this group of students to try this integration with is because we noticed a pattern trend in their data that anytime there were data tables or any kind of visualization, a graph, a bar graph, a line graph, a data table, instructional chart, anything like that, for any kind of standardized questioning, the kids typically missed it, and we realized we sat down and we're talking through some of those things with the kids that a lot of them were not even able to articulate steps that they would take to be able to understand the data, or how where to begin to look.*
- *Once we had the systems in place, how much easier it was for kids to be able to address this higher order thinking with data analysis, which has been a stumbling block in several places, especially our fifth grade classes, and how that would apply not only to science, but it also was supporting students in math, but then it also began to make us start to focus in a little bit deeper with ELA cross connections too, simply because we were talking so much about the details of things and how details can support larger messages, which is what our kids spend a bulk of their time doing fourth and fifth grade and all of their ELA lessons.*

Relevant Data is Key

- *I was doing it with fourth and fifth graders, and we had just completed a food drive for our community, and we do this good neighbors food drive every year. And so I took the, you know, the numbers per class, who, which classes, collected how much, how many canned food items or whatever, and I put that all in a graph for them to use for the project…I said, why was it important for us to count and know how many? You know? Why? Why do we collect the data? And I had, you know, two 4th grade classes and two 5th grade classes, and none of them said so we could find out who had the pizza party. And I was like, I'm so proud of you guys. They all said, you know, so we know how much we're donating, maybe next year we could try to collect more.*
- *And then we talked about they were really interested in the XXXXXXXXX data. Like, really interested in that sparked their interest. They even went home and talked about it. They were like "My dad and I talked about this…" and they were all on board with that…And so they were like*

little sponges. They just really were into what we were talking about, because I tried to make it as relevant as possible. Once they had the vocabulary, then they were good to go.

- *I really believe in student choice. And it was one of those moments where, like, what I want to do and what I should do and what I can do kind of got and I was, they were like, well, we want to do this, and we want to do that. And I was like, okay, 30-minute research. But like, we gotta limit it. And so, then they started. We did, like a brain map, and we had all these topics.*
- *I kind of went the self-choice route, kind of like what XXXX did with some limitations, of course, to some of them, most of my kids did pretty good ones that weren't out there, but there were one, one group of kids did domestic violence, and they really went to town on it.*

Students Opened to New Possibilities

- *It was a bigger picture. And then I showed them the data in like three different ways. So we looked at a bar graph, we looked at a pie chart, and we looked at another one that was like a bubble thing with the data. And fifth grade collected the as a grade level, they collected, collected the absolute most, and fourth grade collected the least amount of cans, although everyone was kind of pretty close, you know. But looking at it in different ways. They had different perceptions of it.*
- *But once they were explaining that a visual and were shown some examples of what they look like, from what we learned over the summer, and just some I pulled off the internet that caught a lot of their attention. And then that's where it turned that challenge into a success, to where they started saying, oh, I think I can create that, or that's cool. When do we get to start?*
- *They were honor students, but a few of them were able to get more creative and do it more in an artistic way, but most of them still were trying to do it in like, bar graphing mode and things like that.*

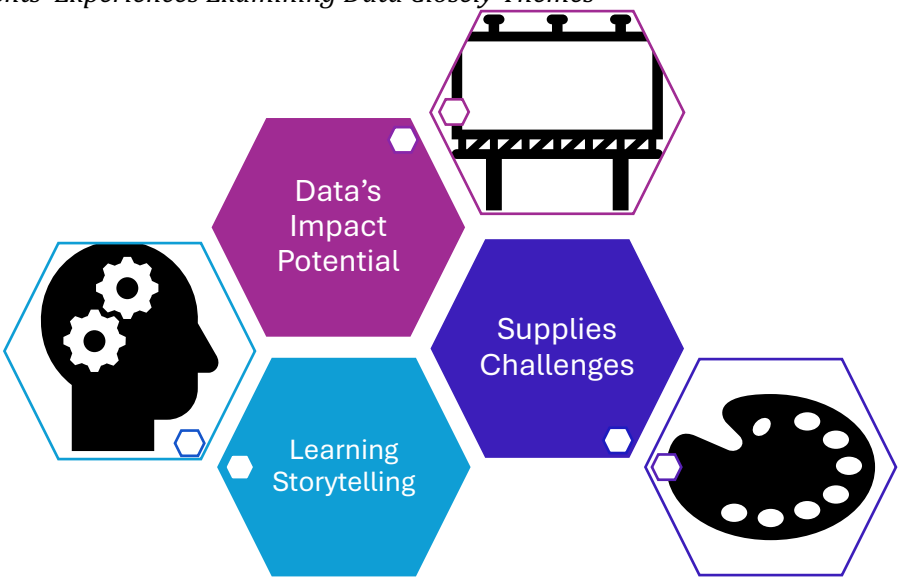
They all thought they could not do it when we first started talking about this, and we're really intimidated by just the title alone, so they were really proud of themselves at the end, but the beginning was a little tricky.

Students' Experiences Examining Data Closely

When discussing a situation where students examined data closely, three themes were predominant in their conversations. Notably, students' understanding of data's potential use and impact on community and world issues. From understanding how endangered a species is to problem-solving school attendance issues, teachers stated that one of their biggest successes was

students grasping these ideas in-depth. Additionally, students' experience and comprehension with storytelling and data were positively impacted. Students experienced the process of working through material decisions and designs to determine what information they wanted to convey to their audiences. Lastly, teachers discussed the challenges of managing the materials, especially if they were moving from classroom to classroom. The following section presents the themes and quotes from teachers regarding their students' experiences of engaging with data closely.

Figure 7: Students' Experiences Examining Data Closely Themes



Data's Impact Potential

- *One of my students chose to do red pandas because he loves red pandas, and he didn't realize how close they are to being extinct. And he had a really emotional moment where he realized that if he were to have grandkids, they may not get to see a red panda. I think that that was, like, it was really an eye opening moment for everybody, that data could be that impactful.*
- *There was a lot of data about how the numbers of Native Americans and the numbers of Buffalo and things like that were impacted by colonization, and it was and about the Trail of Tears and other relocation situations and the kids, especially with the buffalo, for some reason, the kids really were impacted by that, and most of the groups wanted to do that set of data and showing how the number of buffalo dropped significantly in the first half of the 19th century and that they were just really shocked by that.*
- *Do you see a pattern here? Do you see, how can we make a difference? How can we make a change and giving them a vested interest? So, of course, we do other things, you know, with other examples as well, but that, I feel like, has been very… It's very eye-opening for them.*

- *(Regarding school attendance) And so they started bringing in all these different data points to try and, like, justify, which was kind of neat, you know, kids got on the weather mapping, you know, and seeing if it was just because it was rainy or just because it was too cold. And they really enjoyed getting in there and trying to like it was like a puzzle for them to solve. Why in the world is this happening?*
- *(Regarding potential school club) And the sixth graders were so excited to see, like, it did something, just like when we looked at the club data, it did something, they actually got to see that there's a whole lot of people that want this cooking club to happen. But we also looked at like, why haven't we had a cooking club as well? Like, there's, you know, 90 people that want to sign up for a cooking club. Yeah, but we don't have one. And the kids were like, well, that's just wrong, you know? And so we had to break it down some and think about it like a little bit more. Like, what? What else would we need for a cooking club? We need a teacher sponsor. We need a kitchen area.*

Learning Storytelling

- *We had to set that up first so that they realized, they started to realize that every piece of artwork does have a message behind it, and the message could be a little bit different for everybody, but you have to be able to use some of the details in the art to be able to piece together that message, And then the same thing that we transferred to when we started to look at some different science data that that they were responsible for, we had to do the same sort of thing so they could tell us the numbers and the headings of what the graphs were and what the x and y axis was labeled, and all those things, but then telling them, getting them to think about, well, then what story is that data telling you that took a little bit, that took a little bit of practice, and that was just repeated exposure and practicing it so that they got used to that idea, that that was commonplace, that everything did have a story or a message.*
- *So, kind of bringing in that really hard, like, critical thinking piece, and then then I show them an unsuccessful data visualization and how it's confusing. And I'm just like, okay, what do you see here? And they're like, we don't know. I'm like, exactly. So, yeah, so then we kind of look at one that's more successful, and then some more that are successful, and then we start to, like, go into what we're doing. And I also created an example for the data set that they are using, just so they can see something that makes sense for their data.*
- *And the kids kind of were like, Oh, I don't understand what this is and, and what that is and, and so we had some good conversations about, I think you used the jewels because you thought the jewels were pretty and, you know, not necessarily because they matched and, and making your project fit their supplies, rather than making the supplies fit your project. So, they ended up with something kind of wonky. And I mean, if we're being like, being honest, not very good. But I think at the end, they, like, figured out that that was not the best way to go, and, and, and privately, I had a good conversation with them about respecting the data. And so, I think at the end, they, like, figured it out, but that was kind of hard for me, as current math teacher, former art teacher, not to*

like. Why are you doing that? Like it does. It's not telling a story. What stories are you telling? And I just kind of had to walk away a couple of times, like, you know, they've got to do this on their own.

- *But then when they went to do it on their own…There was a disconnect between because I was like, Okay, this one that really connect with the bubbles these circles. There's no number on it. It's just color colored circles. How do you know who collected the most? They're like, Oh, because the size, you know? So I was trying to help them with scale and when they when they were making their art, thinking about some certain parts of your artwork being bigger and certain being smaller to represent the numbers. I wonder if they had, like, a planning sheet where they spent more time actually planning out their idea they might catch some of those errors, you know? And we didn't do that part.*

Supplies Challenges

- *When I go into these classrooms, I have to, like, completely set up, and then completely tear down and clean up on my way out. And also, like, there's so many things, like, if the teacher's smart board doesn't work, or, like, you know, the teachers pull their kids to yell at them in front of the other kids about homework during my lesson, or, you know, like when they get mad about everything not being cleaned up. Like there's just so many things that, like, constrain my time with them, specifically, that make it hard.*
- *It's kind of similar to what XXXXXXXXXX was saying the cart thing, because when I started, I was kind of on a cart because it was, yeah, that, so I get that part. And also, I was sure sharing the library with the librarians. My actual problem-based learning class that was in there, and so it's kind of like it was two classrooms in the one. So, I would have to split my space, so it'd be my 25 kids, another 25 kids over there. They so much of their best friend, you gotta drag them back over here, like, hey, you need you need to come and focus. And then the counseling offices. Offices are in there too. So, you see emotional breakdown kids coming in there, and other kids will get everybody else's business. So, I probably said probably a challenge, not too much as we wind, I mean, progressed on, but that became a challenge.*
- *A lot of my data was pretty qualitative, which can get a little confusing, and also the fact that I am new to this, so in collecting their own data, it was a good idea, but there's a lot of things that I didn't account for. For example, being on a cart. I can't assign seating. So, when the teachers move the kids around, their group moves around. So, like, if I assigned one group a specific chicken nugget, now, all of a sudden, everybody's. Everywhere, and nobody knows what chicken nugget they had, and I can't move them. And so that got really frustrating, because now they have data and it's just like, well, what chicken nugget was that about? We don't know…*
- *I limited the materials. Originally I was going to be more free with the materials, but when I decided to do groups of four instead of originally, I thought I was going to do pairs, and when I decided to*

do it in groups of four, I limited the materials more, which worked out, because I'm letting them use, like, more 3d stuff in other projects.

> *I see 300 and like 70 some kids, and because I see everybody kindergarten through fifth, I don't have a lot of room to store projects that are in progress. They either have to complete it in that one class period, or it ends up getting stored somewhere, and then it gets touched or, you know, squished or something with another student, another student's work.*

Students' Experiences Creating Data Visualizations

The teachers' conversations were then guided to discuss their students' actual data visualizations and the successes and challenges experienced during that process. They all agreed that this was the best, but most challenging part of the process. The students were engaged, but so thoroughly in-depth in the process that the teachers advised that better planning sessions will be necessary in the next iteration. Students experienced successes in academics, such as finally passing a fractions quiz after working with the data visualization, and collaboration and communication skills. The following section presents the themes and quotes from teachers regarding their students' experiences of engaging with data closely.

Figure 8: Students' Experiences Creating Data Visualizations Themes

Academic and Collaboration Successes

- *That was the amazing part of the project…we were able to start asking more questions about, well, if this was, if this was built, what was the purpose of the lid, or if this was built, what was the purpose of the base? And the kids really had to think and dig a little bit deeper down in there.*
- *I had it displayed on the smart board so they could see each other and their builds. And I kind of was like a bird's eye view, and was sort of over the project and kind of traveling around so they could see on the build what they were making. Some of them chose to build collaboratively together. Some of them chose to kind of separate and build their own. Some of them use blocks and built their name in front of their projects that they made. Some of them made like little squares on the ground like this is mine. Stay out of my space. I actually, out of seven classes that I did this with, I only had one student in all seven classes who was destructive in any kind of way to any other students work, and he's one of our high flyer behavior students anyway, so that kind of tracks…it was very collaborative, and it was a lot of peer to peer communication, which was really like nice to see, because I didn't lead that they led that. They started that.*
- *It can be difficult to get them have academic to have academic communication. They struggle with vocabulary, usage of accurate academic vocabulary. So they were using the terms air quality, they were pointing to the data and using the word moderate, they were sharing with each other ideas about how, while it makes sense, we can represent air as clouds, because clouds are in the sky.*
- *Having to have that math broken down over and over and over, one of the math teachers actually told me that they finally passed their fractions quiz.*
- *And I'm like, this is how it relates to that and the connection. I mean, having them make that connection backwards with starting with the math and then making it backwards into art, they're like, "Oh!" When I teach them things like ratio and stuff like that and art, they see how it's in art, and it's broken down into our aim pictures, and that's how it relates.*
- *There were natural leaders that emerged. There were natural artists that emerged, and they just kind of like found their own little groove.*
- *I found so much joy in watching them work together as a team, and seeing what came out of their conversations, even if they had, like, hiccups or errors or whatever, like, I feel they were so into it. You know, they were really excited about it.*

Planning Challenges

- *They really wanted to go all out, like, have moving parts and, like, all this stuff.*
- *We had one kid that really wanted to build an entire school bus, like that worked and could be rolled across my classroom, and when they first thought about it, it seemed like a very feasible idea, until they started like figuring out that they'd have to put all the things in the school bus to represent it, because they were doing like their question was, like, modes of transportation, you know, how would you get home from these activities and our, most of our kids would need a bus ride home or they would walk.*

- *But then when it came to representing the actual data itself, they were stuck on a person as a person, but we a person driving a robot, and that somehow equals your parent driving you home. You know it was, it was interesting, like seeing you have to kind of come to this middle ground where we're not building robots, but we all start building 500 people, because that's how many people took the survey.*
- *they hadn't planned enough in advance to realize they had 13 classes, but they didn't have 13 colors.*
- *It was just like thinking outside the box and trying to think in a new way was probably the hardest thing for my kids.*
- *Like all of the kids in each of those groups really had a lot of really good ideas, and they had trouble just consolidating it down and agreeing on what to work do together as a group, whereas my lower kiddos, who needed a lot more support, they understood the data, but they didn't understand how to represent it in a way that other people would be able to understand or that would make sense to other people. That's when they finally decided, like how they would show it. It was a struggle for them to be able to explain why they had chosen to do things that way.*

Teachers' Curriculum and Data Visualization Future Plans

As the conversations ended, the teachers were asked how, or if, data visualization factored into their future curriculum plans. All teachers stated they were planning to repeat it in their curriculum with some changes, and one school noted they were planning for it to become part of the normal curriculum.

- *I'm really happy with how it came out. I'll probably push it to a little bit earlier in the year.*
- *It's something that I want to do with my 2D classes as well. Well, I only get two of those. Technically, I get four of them every year. But I think it could be something really neat.*
- *I collaborate a lot with the core teachers, and so I'm already seeing opportunities for science and art collaborating to create data visualizations. You know, whether we co teach it, or they do part of it, the data collection in science, and then I create the art in my room, or however that works going forward. I really think that it's another, just an excellent way to reach kids that maybe wouldn't under like I am the I am a visual learner, and I have a hard time looking at a bunch of numbers, it just like makes my brain cross, but then if someone presents it to me in another way. One, it makes it easier to understand. And two, I'm going to remember it longer.*
- *We're hoping to nor that it's a norm for, it's a norm for using data that the kids are experience every day, I would say our next growth steps. Our next growth steps is we're typically just using data that's sitting within our curriculum right now. And I think we would love to be able to get to a point where we're collecting like the kids are collecting their own data, and being able to analyze, instead of it just being these sort of data sets that are hanging around, but they're actually becoming engaged in collecting the data, then internalizing it, then turning it into a vision so they get the*

full process. So it's still a process of like, here's the data we have. Let's figure out what this means. Means, so I feel like that, that's our next growing step.

- *For my STEM class, we are raising trout from eggs, and then we go release them into the rivers. And so for that portion, they take data for the water chemistry, how many fish we lost, how many eggs we lost, how many head mold. So, there's all kinds of data that they can grab that make their own grab, as it were. And then, then I'm going to explain. Then, you know, let's make this an art visualization, but still use our data. And I think that will help them understand more, or be able to convert the numbers into the artwork, rather than just some of the STEM curriculum is very dry, like do a printer, you know, but this way they can, not only, well, they just get their own data and make their own graphs.*
- *I think I was going to do something in the summer, I planned a whole different thing, and then I came back, and one of our science teachers says, we're doing this TVA grant thing, and we need people to do activities. And so I ended up using data from our electric and natural gas use and stuff. I think it was boring. The numbers were boring. They ended up making some good art. Again. I think they, a lot of them, stuck with it for me. I think I would rather do something they're more interested in. And so that's what I think I'm going to change. But I do want to do more art-based data visualizations, but I want to do them with different data.*
- *I think that right now, the unit that we're doing actually would have made more sense to do data visualization with, because right now we're talking about percentages, and I think that in the future, when I do this project, I definitely want to continue it every year, but I think that I will save it for this time of the year, when they will have the background knowledge to better understand the numbers. And I think that'll make it a little bit easier. But I also feel like throughout the school year, knowing how hard it is for them to understand numbers in their own data, I will also have them look at their own data a little bit more frequently than I had before doing this project.*

Student Surveys

The survey was offered in English, Spanish, and bilingual versions. It was completed by 276 Art and STEM Math and Science (STEM) students. The evaluator was not able to identify whether ten students were Art or STEM due to missing or incorrect ID numbers, in addition to the 133 of the respondents that were art students and 133 that were STEM. The ten students were not included in content-specific analyses, only the overall analyses. The students responded to questions asking them to select their level of agreement in the Data Visualization Attitudes section, confidence level in the Data Visualization Confidence section, and additional feedback in comment fields. Using an alpha level of .05, dependent-samples t tests were conducted to evaluate whether the differences between each group's pre- and post-program responses. Overall, statistically significant differences were found in a majority of items. Finally, 49% of the students reported that the program was pretty good or excellent. The following section illustrates the

results in aggregate for the overall, art, and STEM groups. The figures note statistically significant results, and formal APA tables of the results are included in the Appendices.

Student comments regarding their favorite parts, how art and data visualization go together, and the usefulness of data visualization.

- *I enjoyed weaving my data visualization. You can make interesting shapes that way.*
- *I enjoyed getting the options with data and making decisions about to draw. I like being able to make the choices for myself.*
- *One of my favorite insights about data visualization and art is how they intersect to tell compelling stories. I learned that data visualization goes beyond simply presenting numbers; it can evoke emotions and provoke thought when paired with artistic design.*
- *My favorite thing that I learned about data visualization and art was how we could use data to make art so we can be creative. Also we can use data for many things for art.*
- *We used a lot of different materials that made our pieces an art form. And we still communicated a message.*
- *It makes the data more interesting. The data itself is not something I would care about.*

Data Visualization Attitudes

Figure 9: Overall Students' Data Visualization Attitudes BEFORE

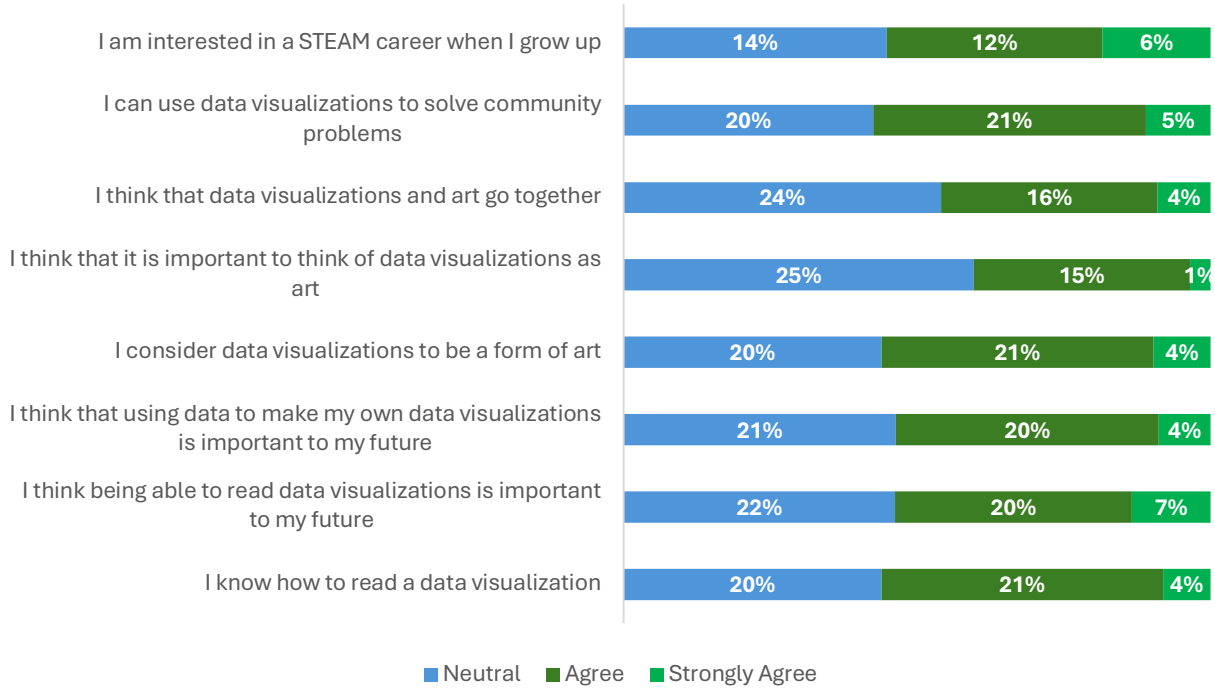
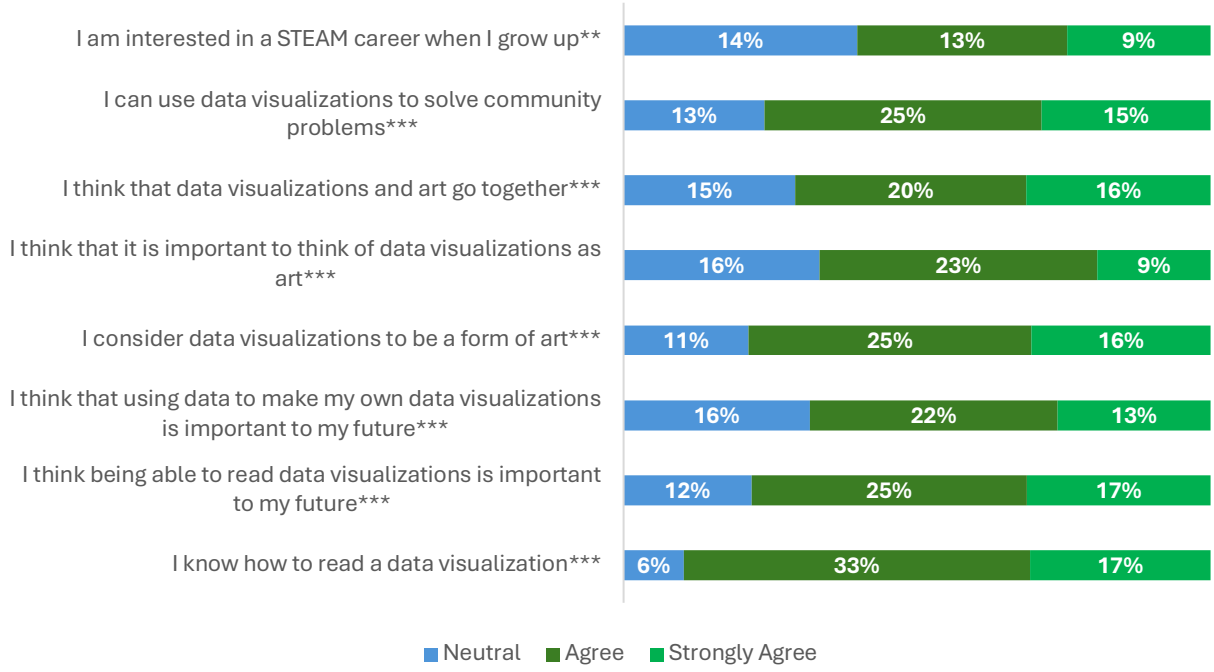


Figure 10: Overall Students' Data Visualization Attitudes AFTER



*** Indicates significance at $p < .001$. ** Indicates significance at $p < .05$.

Figure 11: Art Students' Data Visualization Attitudes BEFORE

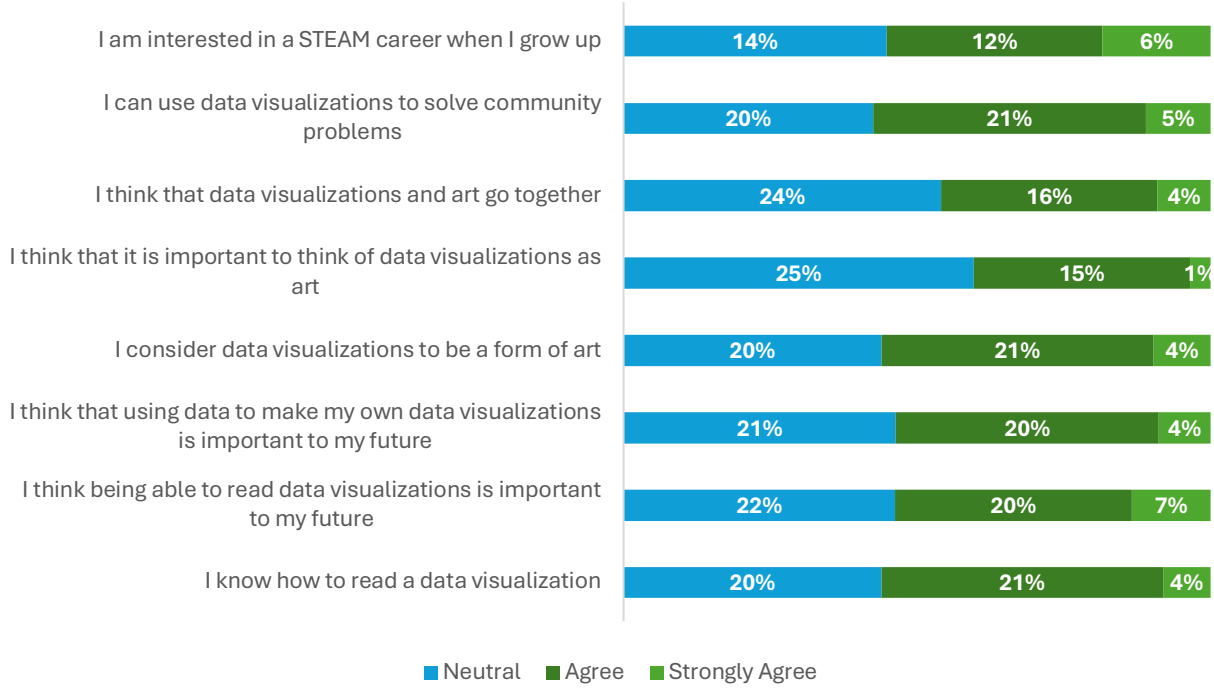
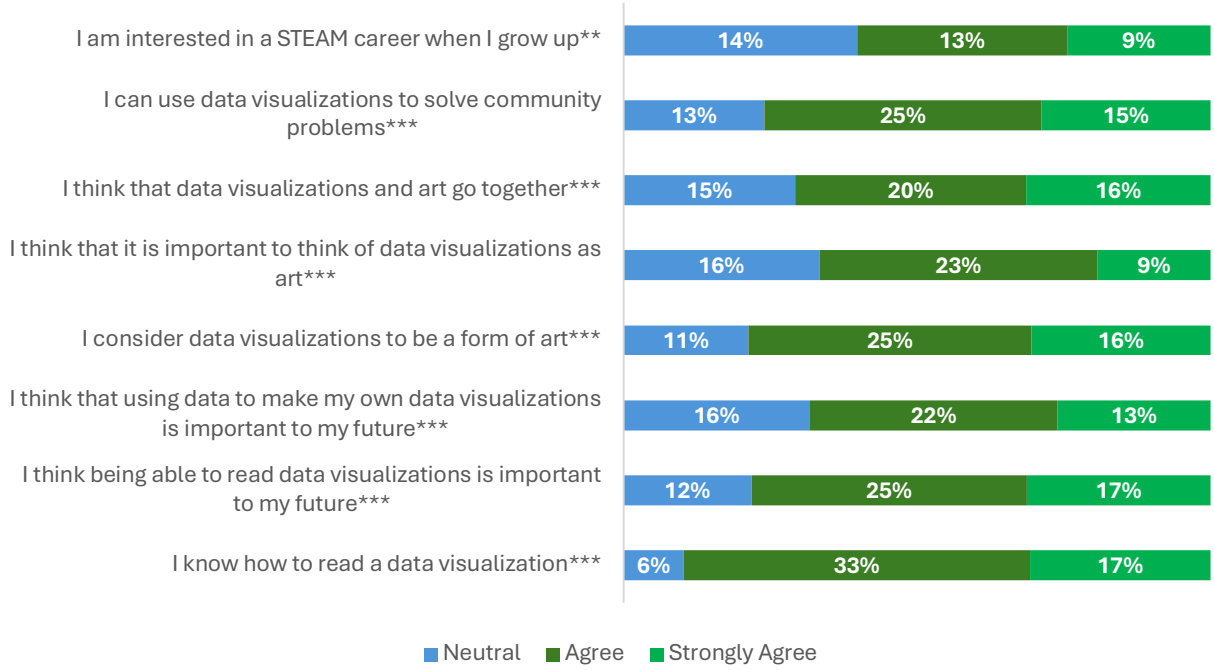


Figure 12: Art Students' Data Visualization Attitudes AFTER



*** Indicates significance at $p < .001$. ** Indicates significance at $p < .05$.

Figure 13: STEM Students' Data Visualization Attitudes BEFORE

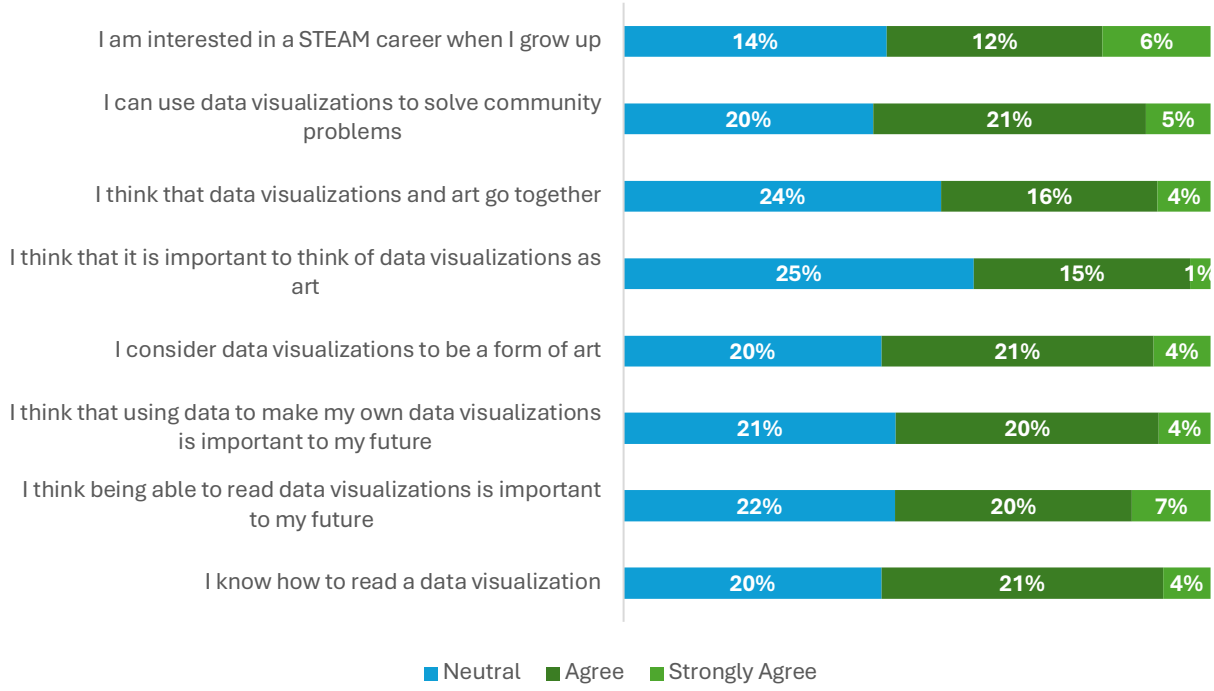
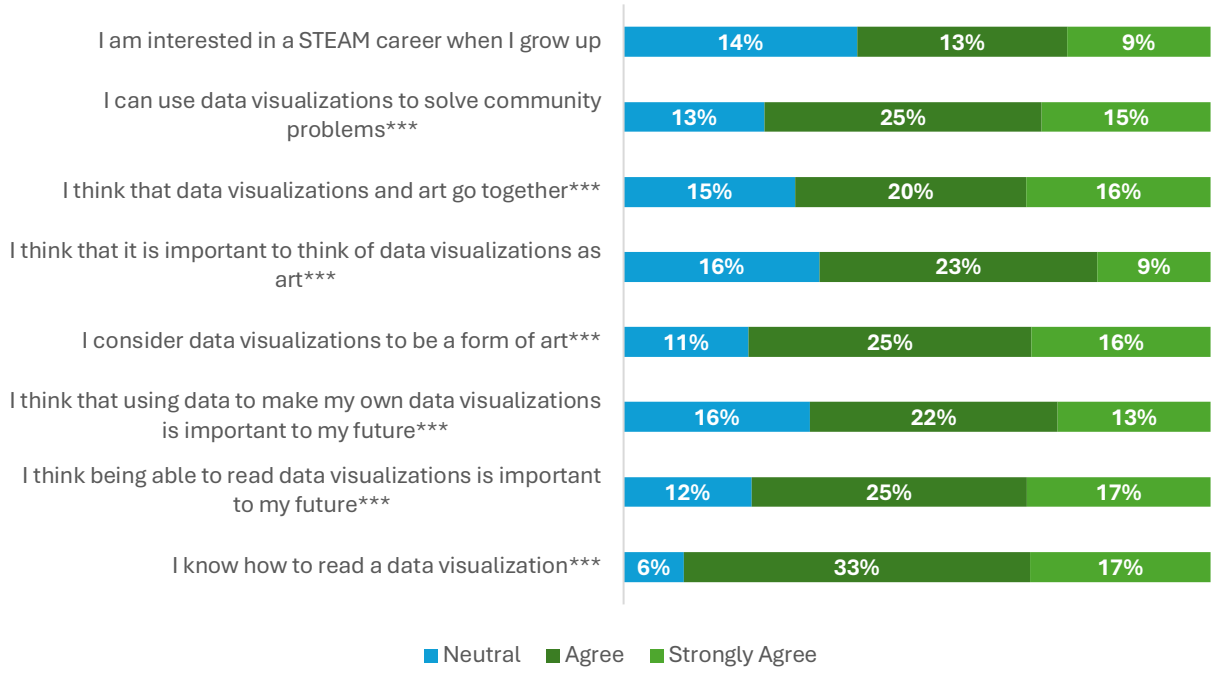


Figure 14: STEM Students' Data Visualization Attitudes AFTER



*** Indicates significance at $p < .001$.

Data Visualization Confidence

Figure 15: Overall Students' Data Visualization Confidence BEFORE

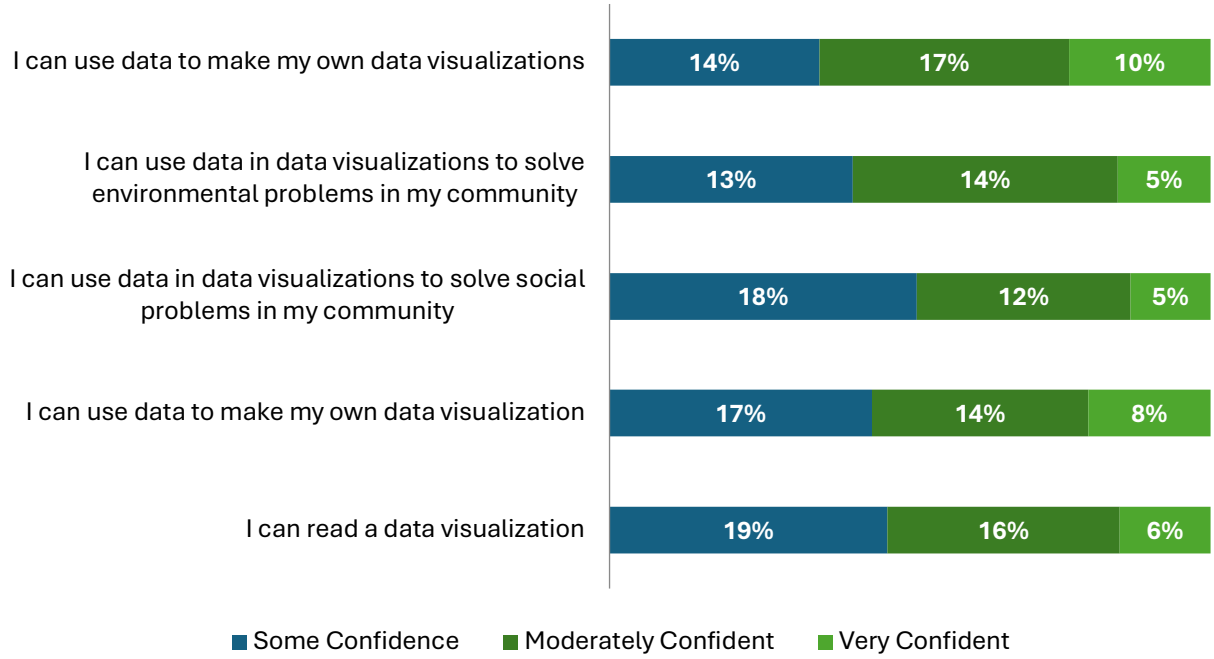
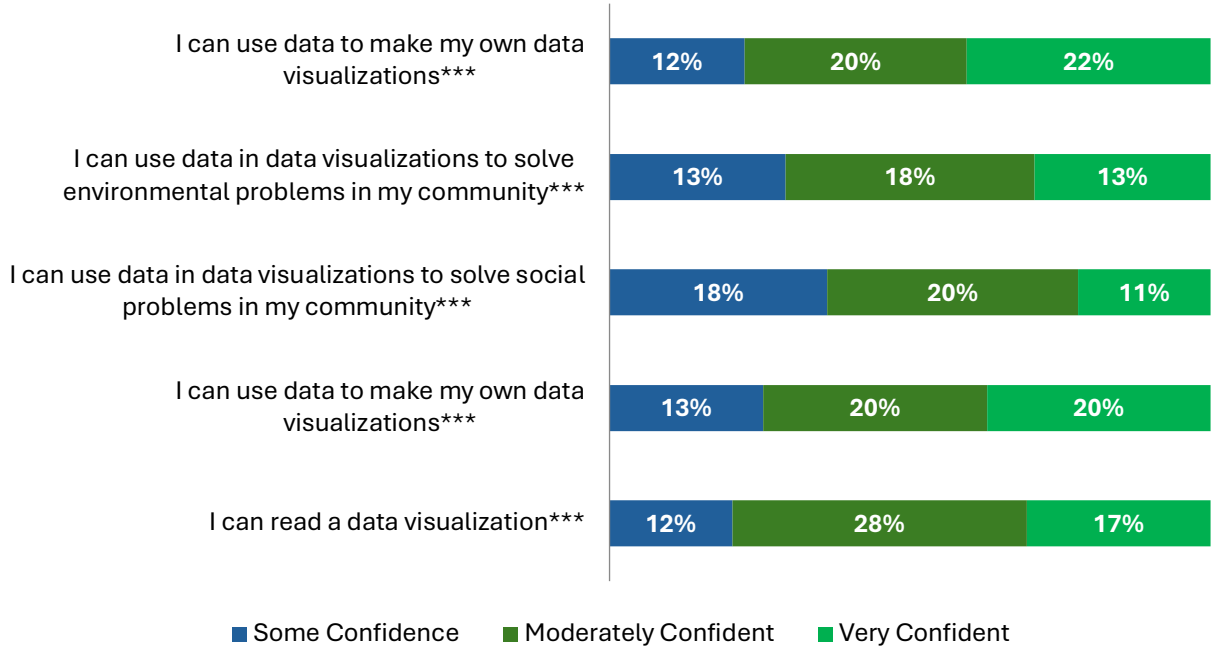


Figure 16: Overall Students' Data Visualization Confidence AFTER



*** Indicates significance at $p < .001$.

Figure 17: Art Students' Data Visualization Confidence BEFORE

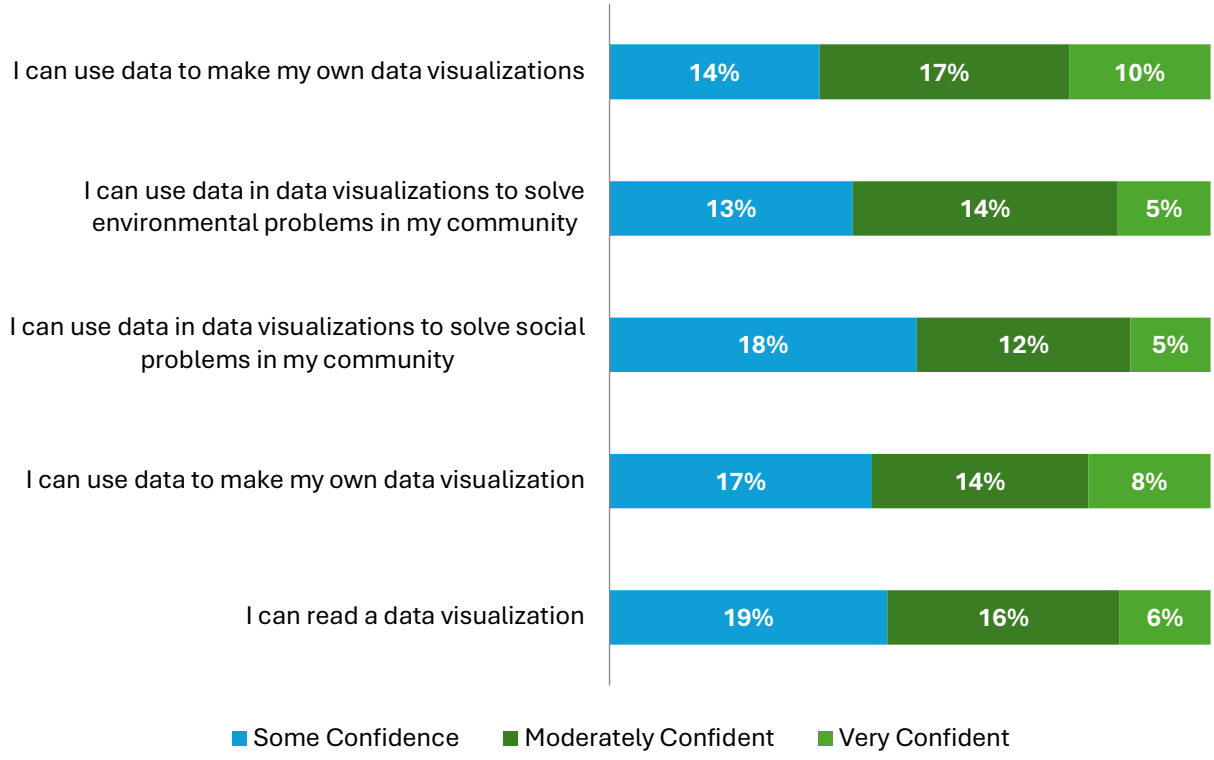
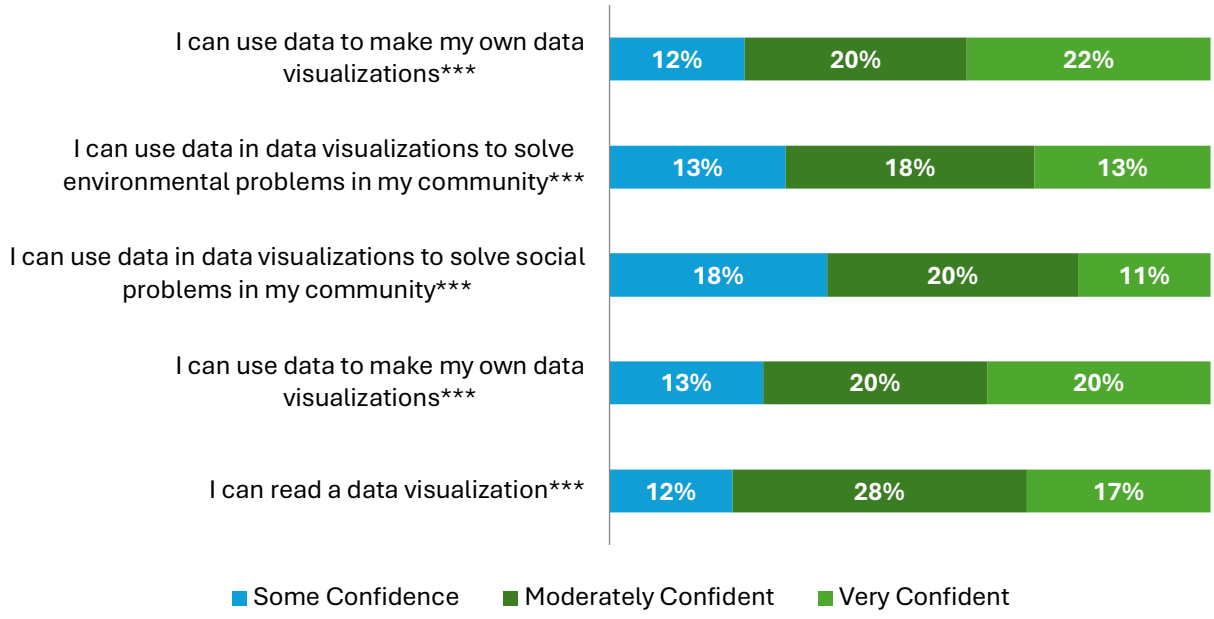


Figure 18: Art Students' Data Visualization Confidence AFTER



*** Indicates significance at $p < .001$.

Figure 19: STEM Students' Data Visualization Confidence BEFORE

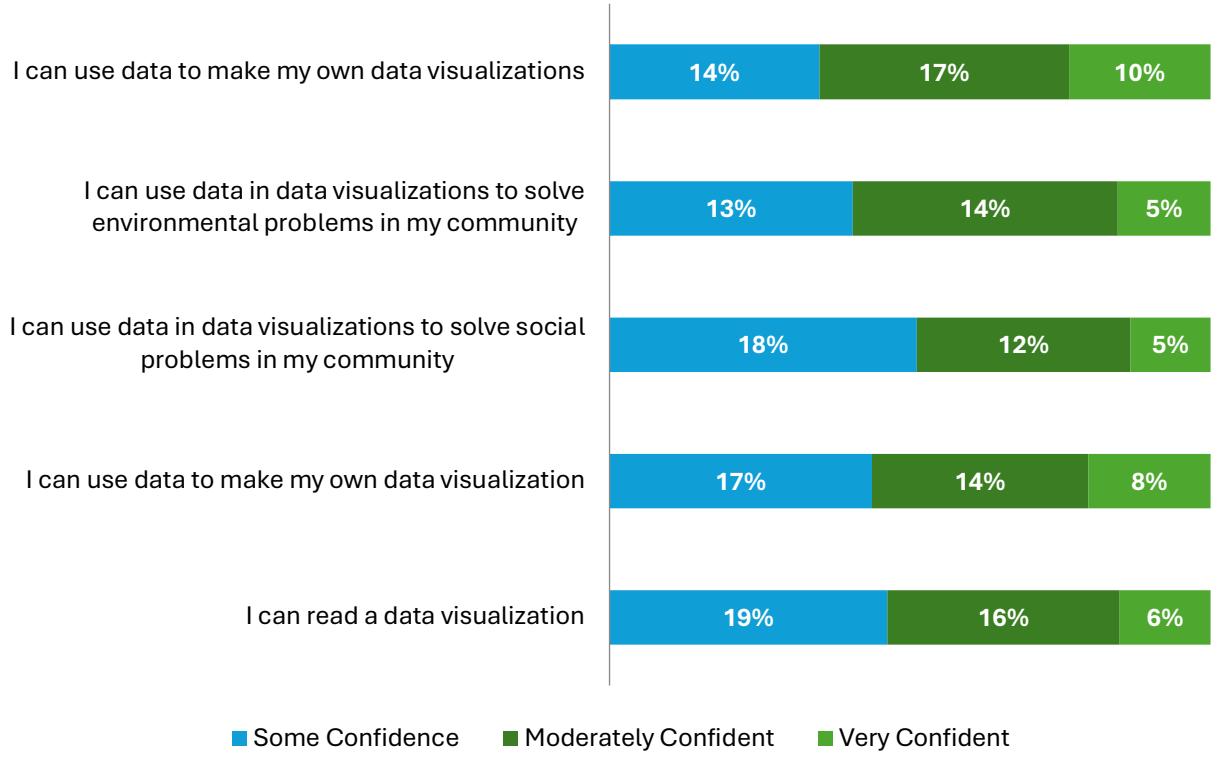
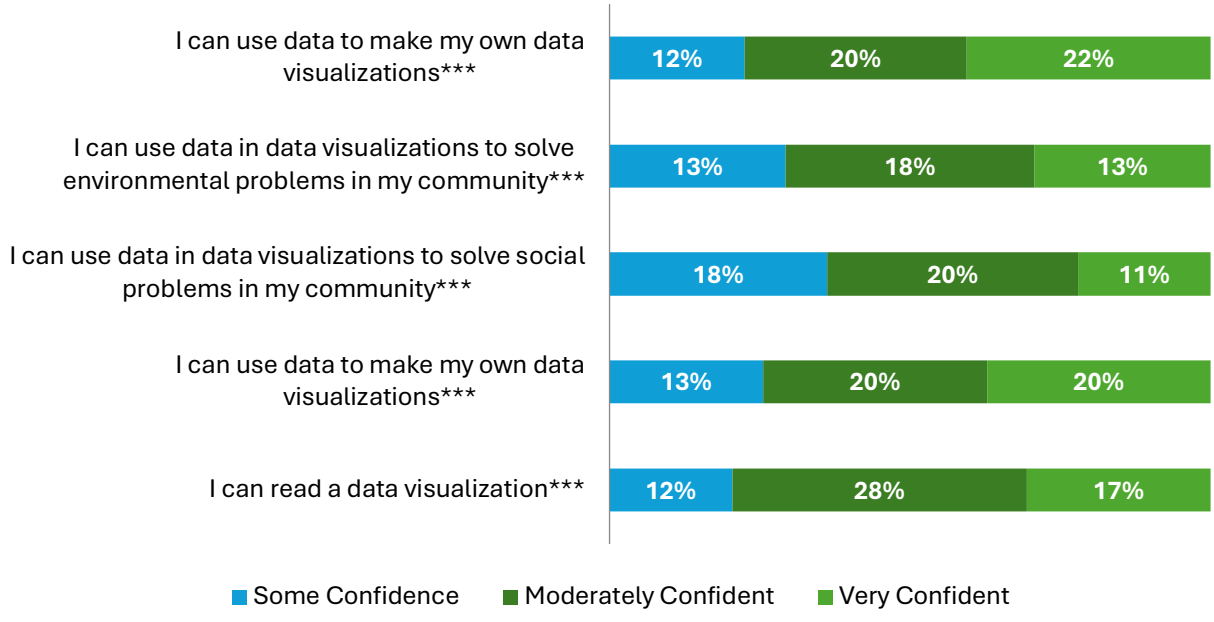


Figure 20: STEM Students' Data Visualization Confidence AFTER



*** Indicates significance at $p < .001$.

Reference

Saldana, J. (2012). The Coding Manual for Qualitative Researchers. United Kingdom: SAGE Publications.

Appendix A: Teacher Fall 2023 Post-Implementation Survey

This survey is being sent to all the participants of the Data Visualization Summer Institute hosted by The Data Visualization Project (DVP) at the University of Tennessee in the College of Education, Health & Human Sciences. The results of the survey will be used to show evidence of your learning at the institute and help improve future workshops. The information that you provide on this survey will be confidential, and the results will only be reported in the aggregate with the leadership of DVP. Your name will not be associated with any of your responses, but the grant's leadership will be notified that you completed the survey. If the data from the evaluation survey is deemed necessary for use in future publications about the program, Institutional Review Board approval will be sought for the use of archived data to ensure that your confidentiality is protected. You may exit the survey at any time, and the survey should take approximately 10 minutes to complete. If you need to leave the survey, you will be able to return and pick up where you left off.

Overall, how do you feel about the implementation of your curriculum?

- ○ It went terrible
- ○ I didn't care for how it went
- ○ It went pretty good
- ○ It was excellent

What did you like about implementing your curriculum?

_____

_____

_____

What could have made implementing your curriculum better?

_____

Please indicate your agreement to the below statements:

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Attending the DVP Summer Institute was a good use of my time	○	○	○	○	○
I was excited to implement my own transdisciplinary curriculum about data visualizations and art in my classroom	○	○	○	○	○
Based on my learning, I felt confident in what I learned so I could implement my own transdisciplinary curriculum about data visualizations and art in my classroom	○	○	○	○	○
I have a greater understanding of data visualizations which includes arts-based data visualizations	○	○	○	○	○
I feel comfortable using data visualizations to address ecological and social issues	○	○	○	○	○

Appendix B: Teacher Post-Implementation Interview Guide

You have been invited to participate in a research project through the University of Tennessee. The reason for the research is to investigate the opportunities and challenges associated with data visualization in K-12 art and STEM curriculum.

The results of this participation will be confidential, and will not be released in any individually identifiable form. The interviews will be audiotaped. The tapes will be transcribed, and your words may be quoted. If so, a different name will be used to ensure that you cannot be identified in any way.

For this project, you will participate in an interview on your experiences of implementing data visualization curricula, which will last approximately 40 minutes.

You are free to stop the interview and withdraw your participation at any time should you become uncomfortable with it. I hope you will enjoy this opportunity to share your experiences and viewpoints with us.

Do you have any questions?____

Do you agree to participate in this study? ____

Okay. May I begin recording? ____

Building Rapport:

I appreciate your help with this interview. Over the past few months, we have gotten to know each other. But during this interview feel free to tell me things that you might have mentioned before. Also, feel free to talk in as much detail as you can.

Primary Questions

1. Tell me about a time your students were first learning about data visualization and tell me about it in as much detail as you can.
    1. Tell me about any challenges you might have perceived.
    2. Tell me about any successes you might have witnessed.
2. Tell me about a time your students examined data closely.
    1. Tell me about any challenges you might have perceived.
    2. Tell me about any successes you might have witnessed.
3. Tell me about a time your students were creating data visualizations.

    1. Tell me about any challenges you might have perceived.
    2. Tell me about any successes you might have witnessed.
4. How do you see data visualization playing a role, if any, in your curriculum in the future?

5. What else would you like to share that I may not have asked?

Recommended Format for Probing Questions

1. You mentioned _____. Tell me more about that.
2. You mentioned _____. What was that like for you?
3. You mentioned that you _____. Walk me through what that was like for you.

Evaluation question:

Tell me about your overall thoughts about the program as a whole.
If the program is scaling up for next time, what is the most critical component they should make sure is included for next time.

Appendix C: Data Visualization Confidence Statistical Analysis Tables

Data Visualization Confidence	*n*	Pre - Survey	Pre - Standard Deviation	*n*	Post - Survey	Post -Standard Deviation	*t*	P-value	Cohen's *d*
I can read a data visualization	251	2.98	1.14	251	3.81	1.01	-12.258	<.001***	-.774
I can use data to make my own data visualization	251	2.99	1.19	251	3.73	1.12	-10.343	<.001***	-.653
I can use data in data visualizations to solve social problems in my community	251	2.68	1.21	251	3.34	1.16	-9.862	<.001***	-.622
I can use data in data visualizations to solve environmental problems in my community	251	2.71	1.22	251	3.29	1.27	-8.489	<.001***	-.536
I can use data to make my own data visualizations	251	3.07	1.21	251	3.78	1.09	-10.061	<.001***	-.635

Table 1: Data Visualization Confidence Statistical Analyses – Overall
*** Indicates significance at $p < .001$.

Table 2: Data Visualization Confidence Statistical Analyses – Art

Data Visualization Confidence	*n*	Pre - Survey	Pre - Standard Deviation	*n*	Post - Survey	Post -Standard Deviation	*t*	P-value	Cohen's *d*
I can read a data visualization	130	3.09	1.18	130	3.81	1.09	-7.096	<.001***	-.622
I can use data to make my own data visualization	130	23.11	1.23	130	3.74	1.14	-6.534	<.001***	-.573
I can use data in data visualizations to solve social problems in my community	130	2.78	1.15	130	3.35	1.15	-6.190	<.001***	-.543
I can use data in data visualizations to solve environmental problems in my community	130	2.70	1.19	130	3.18	1.31	-4.835	<.001***	-.424
I can use data to make my own data visualizations	130	3.14	1.27	130	3.75	1.14	-5.960	<.001***	-.523

*** Indicates significance at $p < .001$.

Table 3: Data Visualization Confidence Statistical Analyses – STEM

Data Visualization Confidence	*n*	Pre - Survey	Pre - Standard Deviation	*n*	Post - Survey	Post -Standard Deviation	*t*	P-value	Cohen's *d*
I can read a data visualization	121	2.85	1.07	121	3.82	0.92	-10.732	<.001***	-.976
I can use data to make my own data visualization	121	2.86	1.14	121	3.71	1.10	-8.126	<.001***	-.739
I can use data in data visualizations to solve social problems in my community	121	2.57	1.27	121	3.34	1.17	-7.785	<.001***	-.708
I can use data in data visualizations to solve environmental problems in my community	121	2.71	1.27	121	3.41	1.22	-7.388	<.001***	-.672
I can use data to make my own data visualizations	121	3.00	1.13	121	3.81	1.05	-8.539	<.001***	-.776

*** Indicates significance at $p < .001$.

Appendix D: Data Visualization Attitudes Statistical Analysis Tables

Table 4: Data Visualization Attitudes Statistical Analyses – Overall

Data Visualization Attitudes	*n*	Pre - Survey	Pre - Standard Deviation	*n*	Post - Survey	Post - Standard Deviation	*t*	P-value	Cohen's *d*
I know how to read a data visualization	266	3.09	1.01	266	3.97	0.93	-13.497	<.001***	-.828
I think being able to read data visualizations is important to my future	266	3.29	1.07	266	3.79	1.07	-7.762	<.001***	-.476
I think that using data to make my own data visualizations is important to my future	266	3.20	1.04	266	3.67	1.08	-7.143	<.001***	-.438
I consider data visualizations to be a form of art	266	3.09	1.17	266	3.73	1.06	-9.585	<.001***	-.588
I think that it is important to think of data visualizations as art	266	2.96	0.99	266	3.49	1.05	-8.762	<.001***	-.537
I think that data visualizations and art go together	266	3.05	1.08	266	3.64	1.50	-8.982	<.001***	-.551
I can use data visualizations to solve community problems	266	3.21	1.06	266	3.74	1.04	-8.170	<.001***	-.501
I am interested in a STEAM career when I grow up	266	2.81	1.26	266	2.95	1.32	-2.527	.012**	-.155

*** Indicates significance at $p < .001$. ** Indicates significance at $p < .05$.

Table 5: Data Visualization Attitudes Statistical Analyses – Art

Data Visualization Attitudes	*n*	Pre - Survey	Pre - Standard Deviation	*n*	Post - Survey	Post - Standard Deviation	*t*	P-value	Cohen's *d*
I know how to read a data visualization	133	3.07	1.10	133	3.98	0.94	-9.063	<.001***	-.786
I think being able to read data visualizations is important to my future	133	3.29	1.06	133	3.72	1.12	-5.016	<.001***	-.435
I think that using data to make my own data visualizations is important to my future	133	3.16	1.08	133	3.62	1.09	-5.314	<.001***	-.461
I consider data visualizations to be a form of art	133	3.23	1.04	133	3.82	1.02	-6.954	<.001***	-.603
I think that it is important to think of data visualizations as art	133	2.95	1.03	133	3.50	1.06	-6.315	<.001***	-.548
I think that data visualizations and art go together	133	3.13	1.05	133	3.68	1.15	-6.041	<.001***	-.524
I can use data visualizations to solve community problems	133	3.15	1.03	133	3.69	1.05	-6.128	<.001***	-.531
I am interested in a STEAM career when I grow up	133	2.72	1.31	133	2.92	1.34	-2.505	.013**	-.217

*** Indicates significance at $p < .001$. ** Indicates significance at $p < .05$.

Table 6: Data Visualization Attitudes Statistical Analyses – STEM

Data Visualization Attitudes	*n*	Pre - Survey	Pre - Standard Deviation	*n*	Post - Survey	Post - Standard Deviation	*t*	P-value	Cohen's *d*
I know how to read a data visualization	133	3.11	0.94	133	3.95	0.92	-10.199	<.001***	-.884
I think being able to read data visualizations is important to my future	133	3.29	1.09	133	3.85	1.01	-5.931	<.001***	-.514
I think that using data to make my own data visualizations is important to my future	133	3.25	1.00	133	3.71	1.06	4.807	<.001***	-.417
I consider data visualizations to be a form of art	133	2.95	1.17	133	3.65	1.10	-6.678	<.001***	-.579
I think that it is important to think of data visualizations as art	133	2.97	0.95	133	3.48	1.03	-6.054	<.001***	-.525
I think that data visualizations and art go together	133	2.98	1.11	133	3.59	1.15	-6.638	<.001***	-.576
I can use data visualizations to solve community problems	133	3.28	1.09	133	3.78	1.05	-5.427	<.001***	-.471
I am interested in a STEAM career when I grow up	133	2.89	1.20	133	2.99	1.31	1.137	.258	-.099

*** Indicates significance at $p < .001$.

Appendix E: Student Post-Reflective Survey

What is your individualized student code? (This should be given to you by your teacher)

_____

Please mark your agreement level to the following sentences thinking about what you knew BEFORE the Data Visualization Project (DVP) and now AFTER the Data Visualization Project (DVP)

	BEFORE participating DVP					**AFTER we finished DVP**				
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I know how to read a data visualization	○	○	○	○	○	○	○	○	○	○
I think being able to read data visualizations is important to my future	○	○	○	○	○	○	○	○	○	○
I think that using data to make my own data visualizations is important to my future	○	○	○	○	○	○	○	○	○	○
I consider data visualizations to be a form of art	○	○	○	○	○	○	○	○	○	○

I think that it is important to think of data visualizations as art	○	○	○	○	○	○	○	○	○	○
I think that data visualizations and art go together	○	○	○	○	○	○	○	○	○	○
I can use data visualizations to solve community problems	○	○	○	○	○	○	○	○	○	○
I am interested in a STEAM career when I grow up	○	○	○	○	○	○	○	○	○	○

Please mark your level of confidence to the following sentences thinking about what you knew BEFORE the Data Visualization Project (DVP) and now AFTER the Data Visualization Project (DVP)

	BEFORE participating in the DVP					**AFTER finishing the DVP**				
	No confidence	A little confident	Some confidence	Moderately confident	Very confident	No confidence	A little confident	Some confidence	Moderately confident	Very confident
I can read a data visualization	○	○	○	○	○	○	○	○	○	○
I can use data to make my own data visualization	○	○	○	○	○	○	○	○	○	○

I can use data in data visualizations to solve social problems in my community	○	○	○	○	○	○	○	○	○	○
I can use data in data visualizations to solve environmental problems in my community	○	○	○	○	○	○	○	○	○	○

Please respond to the following questions with sentences written in the box:

What was your favorite thing that you learned about data visualization and art?

How do data visualization and art go together?

How useful is data visualization?

Overall, which statement best represents how you feel about learning about data visualizations and art?

- It was terrible
- I didn't care for it
- It was pretty good
- It was excellent