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Utilizing Collaborative Learning to Analyze and Represent Data During a Graphing Unit

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Abstract

This capstone project reports the effects of various differentiated instructional and assessment strategies that were integrated into a third-grade math unit on data collection and representation. The unit was conducted over 12 days. It consisted of nine lessons, a review lesson, a pre-test, and a post test. I will explain the data I collected, the instructional strategies I implemented, and the assessment strategy used to track student progress. The instructional strategies included collaborative learning, cues and questions, feedback. A pre- and post-test were administered, and the data analyzed. Based on the data I collected, the students improved in their knowledge and understanding of the content. I will discuss these strategies and the impact that they had on students and their learning.

Keywords: instructional strategies, collaborative learning, cues and questions, feedback

Background

For my clinical practice experience, I was placed at Anderson Grove Elementary school. This is a part of the Papillion LaVista Community School district in Papillion, Nebraska. I taught third grade in this building. I was placed with my cooperating teacher, Traci Driscoll, who has been teaching for 15 years. Anderson Grove is a smaller school, with about 300 students in attendance. Anderson Grove is one of 16 elementary schools in the district. This class had 23 students, 11 boys and 12 girls. Two students had an Individualized Education Plan (IEP), one of these two students received one-on-one paraprofessional support. One other student does not participate in the general education lesson due to various disabilities.

Introduction

The purpose of this unit was for students to be able to collect data, represent the data on various types of graphs, and interpret data independently. I led the students through bar graphs, double bar graphs, line plots, and pictographs. The foundation of the unit was gradual release, but I framed the lessons on collaborative learning. I believe that students can learn far more when working with others. I also analyzed the impact that cues and questions, as well as feedback, would have on student learning. The data collection and representation unit were conducted over ten instructional days, consisting of nine lessons, a review session, as well as the pre- and post-assessments. The students were expected, by the end of the unit, to be able to collect, analyze, and represent data on bar graphs, pictographs, and line plots with 70% accuracy. The unit was guided by this question: *What impact can collaborative learning, cues and questions, and feedback have on student learning?*

I utilized the following Nebraska State Standards to guide instruction:

3.D.1 Data Collection: Students will formulate questions to collect, organize, and represent data.

3.D.1.a Create scaled picture graphs and scaled bar graphs to represent a data set with more than four categories, including data collected through observations, surveys, and experiments.

3.D.1.b Generate and represent data using line plots where the horizontal scale is marked off in halves and whole number

units.

3.D.2 Analyze Data and Interpret Results: Students will analyze the data and interpret the results.

3.D.2.a Analyze data and make simple statements using information represented in picture graphs, line plots, and bar graphs.

Using these standards, I created four main objectives:

1. At the end of the lessons, students will be able to collect and represent data.
2. At the end of the lessons, students will be able to represent and analyze data on a bar graph.

3. Students will be able to represent and analyze data using a bar graph and a pictograph with 80% accuracy, after instruction.
4. Students will be able to represent and analyze data on a line plot with 80% accuracy, after instruction.

Understanding of Instructional Methods

Collaborative Learning

The primary goal for many teachers is to ensure students will not only learn content but be actively engaged with the content and participate in their education. I utilized a variety of instructional strategies to make our data unit more engaging for students. The main strategy I centered the unit on was collaborative learning. I formulated lessons using the Gradual Release of Instruction model, but each lesson was intended to be taught through collaboration. I began each lesson with a review of previous content, modeled the skill for the day, included students in the whole group lesson and discussion, and then assigned them either a small group or a partner to complete their "independent" work with.

Before planning my unit, I conducted research on the best instructional strategies for my students. Nokes-Malach et al. (2015) noted "there is much evidence for group-level benefits from collaboration over the average individual. The mechanisms that underlie these effects include pooled knowledge, explanation, cross-cueing, error-correction, reduced memory load, and observational learning" (p. 655). I observed these benefits come to fruition in the classroom. Throughout the unit, students who were actively engaged with their partners and the discussions were able to retain more information across lessons and become more advanced more rapidly. When students were able to learn actively and collaboratively, they retained information longer.

Cues and Questions

I also utilized the instructional strategy of cues and questions during the graphing unit. Because students were working collaboratively, I wanted to challenge the students to think deeper about the data in front of them. They worked with their group or partner to think out loud about their ideas. When I discussed the questions with them during a conference or the whole group lesson, student responses became more advanced. Prouty (2006) researched what would happen when students created study questions based on learning goals. Prouty found that when educators focused on smaller goals and questions, students could learn information in smaller amounts and retain more knowledge. The study also found that one formal assessment was not an accurate gauge of student growth or knowledge. There are too many variables that are available to get an accurate set of data from one assessment. Prouty concluded that when questions were casually presented to students daily, they felt more comfortable, and therefore retained more information. By asking questions of varying difficulty, I was able to assess student understanding more frequently.

Hattie and Donoghue (2016) also researched the effects of questioning as an instructional strategy. Hattie and Donoghue (2016) noted that "For students, posing their own questions is a first step towards filling their knowledge gaps and resolving puzzlement. The process of asking questions allows them to articulate their current understanding of a topic, to make connections with other ideas, and to become aware of what they do or do not know" (p. 2). Hattie and Donoghue concluded that students could communicate their understanding by asking questions, even when they were unsure of other topics. The types of questions students asked and answered communicated a variety of data.

Feedback

An emphasis on written and verbal feedback was placed throughout this unit. Students received verbal feedback after questions or responses. They received written feedback from myself or my cooperating teacher on each assignment and assessment they completed. Hattie and Timberley (2007) noted that "although feedback is among the major influences, the type of feedback and the way it is

given can be differentially effective" (p. 82). Hattie and Timberley concluded that feedback was only effective when the students could apply it to their learning.

This strategy is only effective if the feedback being provided is also effective. Whalen et al. (2023) studied the impact of implementing "re-attributional feedback." Whalen et al. (2023) noted that "Re-attributional feedback suggests, for example, that the reason for poor performance on a task was (too) low effort rather than (too) low ability (e.g., "If you work in a more concentrated manner, you will have good results"). By receiving such feedback, the student should gradually shift his or her attribution for poor performance from low ability to low effort (e.g., "I made this mistake because I didn't concentrate enough.")" (p.675). Whalen et al. concluded that re-attributional feedback is a highly effective form of feedback that comments on student effort and attitude. For example, I provided comments such as "Great effort, you made a lot of progress" or "You'll get it next time" instead of a quick "good job" or "nice try". I noticed an increase in student engagement when I provided extensive and specific feedback.

Assessment of the Unit

To assess the students and their learning, I implemented a pre and a post-assessment into the unit. By conducting a pre-test, prior to instruction, I was able to create a baseline of student understanding. Hornbuckle (2022) found that "Pre- and posttests are an excellent way for educators to gather that data to improve instruction and, ultimately, benefit future students" (para. 20). I found that the pre-test was crucial for planning the lessons and the assessments. I utilized formative assessment throughout the unit to continuously monitor student progress.

Participants

The participants of this unit and research were 22 third grade students at Anderson Grove Elementary School. Our class had 23 students, 11 boys and 12 girls. Two of the students had Individualized Education Plans (IEPs), one of these two students received one-to-one paraprofessional

and special education support during math. One other student did not participate in the general education lessons due to a variety of disabilities.

Methods and Materials

The data collected for this unit was collected over twelve days. The unit included nine lessons, a review lesson, and the pre- and post-assessments. The goal for the unit was for students to be able to collect, analyze, and represent data on bar graphs, line plots, and pictographs.

Before instruction, the students were given a pre-test (Appendix A), created by the third-grade team. The pre-test consisted of 11 questions. Students who scored 9 out of 11 of the questions or more were considered “advanced”; students who scored between 8 and 6 questions out of 11 correctly were “proficient”; and students who scored 5 or fewer correctly were “progressing”. Based on this data, I was able to create specific lessons for questions that were the most difficult for students and built small groups to either enrich or support the learners.

At the end of the unit, a post-test (Appendix B) was administered. The post-test was created by the district, and contained “leveled” questions, based on their level of difficulty. The first few questions were “level 2”, or questions that are considered to be below grade level. “Level 3” questions are on grade level. The last question is a “level 4” question. The levels are based on the proficiency scale provided by the district (Appendix C). The students needed to reference three separate graphs specifically, to make a suggestion about books a library should purchase. The guidelines given by the district do not allow for teachers to teach the skills necessary for this question, students truly need to have an advanced level understanding of the content to answer this question correctly.

On the first day of the unit, I administered the pre-test (Appendix A). Using the data I collected from the pre-test, I created nine lessons for the unit. The first four lessons were focused on bar graphs and double bar graphs. Students worked both independently and with partners during these lessons. Lesson five was an introduction to pictographs. During lesson six, students worked with a small group to

create their own graphs. Lessons seven and eight were centered around line plots and how to create their own from start to finish. Lesson nine was a cumulative review lesson before the summative assessment.

On the first day of instruction, students were introduced to data collection and surveying, as well as the proficiency scales (Appendix C). During lesson one I introduced bar graphs. We collected data about who they thought would win the Super Bowl, where they liked to eat, and who liked chicken nuggets in our class. We then used the data from where they liked to eat and created a bar graph as a whole class. I modeled how to create categories based on the data, the necessary parts of a graph like the groups, the title, and the even increments on the side with labels. I created groups based on who liked fast food, who liked sit-down restaurants, or who liked “at home” meals. The students helped me to place their responses into the three categories on the bar graph.

As we worked through the unit, students were given a choice regarding what type of data they wanted to collect. They were also given the choice of which type of graph they would use to represent their data. Throughout the unit the students were engaged in collaborative learning. Following the last day of instruction, the students completed the post-test.

Results and Data Analysis

Tables 1 and 2 report the results of the pre and post-test. The scoring guide was as follows: (1) indicated a correct answer, (0.5) indicated a partially correct response, and (0) indicated an incorrect response.

Table 1

Pre-Test

Name	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q 10	Q 11	Total Correct
A	1	1	1	1	1	1	1	1	1	1	1	11
B	1	1	1	1	1	1	1	1	1	0	0	9
C	1	1	1	1	1	1	1	0	1	0	1	9
D	1	1	1	1	1	1	1	0	1	1	0	9
E	1	1	1	1	1	1	1	0	1	0	1	9
F	1	1	1	1	1	1	1	1	1	0	0	9
G	1	1	1	1	1	0	1	0	1	0	1	8
H	1	1	1	1	0	1	1	0	1	0	1	8
I	1	1	1	0	1	1	1	0	1	1	0	8
J	1	1	1	1	1	1	1	0	0	1	0	8
K	1	1	1	1	0	1	0	0	1	1	1	8
L	1	1	1	1	1	1	1	0	1	0	0	8
M	1	1	1	0	0	1	1	0	1	0	1	7
N	1	1	1	0	1	1	0	0	0	0	0	5
O	1	1	1	1	1	0	0	0	0	0	0	5
P	1	0	1	0	1	0	0	0	0	0	1	4
Q	1	1	1	0	0	0	1	0	0	0	0	4
R	0	1	1	0	1	0	0	0	1	0	0	4

S	1	1	1	0	0	0	0	0	0	0	0	3
T	1	1	1	0	0	0	0	0	0	0	0	3
U	0	0	1	1	0	0	0	0	0	0	0	2
# Correct	19	19	21	13	15	13	13	3	13	5	8	

Note: The pretest data showed that 33% of the students were proficient, 29% were advanced, and 38% were progressing (Appendix D). Students needed to score 7/11 of the questions or more to be considered proficient, 9/11 or higher to be considered advanced, and 6/11 or less was not considered at grade level.

Table 2

Post-Test

Name	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q 10	Q 11	Q 12	Total Correct
A	1	1	1	1	1	1	1	1	1	1	1	1	12- 4.0
B	1	1	1	1	1	1	1	0	1	1	1	1	11- 4.0
C	1	1	1	1	1	1	1	1	1	0	1	0.5	10.5-3.0
D	1	1	1	1	1	1	1	0	1	1	1	0.5	10.5-3.0
E	1	1	1	1	1	1	1	1	1	0	0	0.5	9.5-3.0
F	1	1	1	1	1	1	1	1	1	1	1	1	12-4.0
G	1	1	1	0	1	1	1	1	1	1	0.5	0.5	10-3.0
H	1	1	1	1	1	1	1	1	1	0	1	1	11-4.0

I	1	1	1	1	1	1	1	1	1	1	1	0.5	11.5-3.0
J	1	1	1	1	1	1	1	1	1	1	1	1	12-4.0
K	1	1	1	1	1	1	1	1	1	1	1	0.5	11.5-3.0
L	1	1	1	1	1	1	1	1	1	0	1	0.5	10.5-3.0
M	1	1	1	1	1	1	1	1	1	1	0	0.5	10.5-3.0
N	1	1	1	1	1	1	1	0	1	0	0	0.5	8.5-2.0
O	1	1	1	0	0	1	1	0	1	1	0	0.5	7.5-3.0
P	1	1	1	1	0	1	1	0	1	1	1	0	9-3.0
Q	1	1	1	1	0	1	1	1	1	1	1	0.5	10.5-3.0
R	1	1	1	0	1	1	0	0	1	0	0.5	0.5	7-2.0
S	1	1	1	1	1	1	1	1	0	1	1	0.5	10.5-3.0
T	1	1	1	1	1	1	0.5	0.5	1	0	0	0.5	8.5-2.0
U	1	1	1	1	1	1	1	1	0	0	0.5	0	8.5-3.0
V	1	1	1	1	1	1	1	0	0	1	1	0	9-3.0
# Correct	22	22	22	19	19	22	20.5	15.5	19	14	15.5	12	

Note: The post-test results reported that 14% of students (3) were progressing. 64% of the students were proficient, nearly doubling since the pre-test (Appendix E). The decrease in advanced scored can be attributed to the variation in scoring guidelines set by the school district.

Discussion

I utilized the pre-test data to guide the focus of the lessons and to create the small groups. I tallied the number of correct responses for specific questions and determined which graphing lessons would need explicit instruction during whole group instruction. I placed the students who scored 5 out of 11 or lower in an intervention group. These students were placed in a collaborative small group to receive explicit instruction on their deficit areas. Students who scored 9 out of 11 or higher were placed in an extension group to challenge them as they understood the concepts tested. Because the extension group demonstrated understanding of the concepts on the pre-test, I was concerned they would be disinterested in the whole class lesson. Therefore, I intentionally challenged them in their collaborative learning groups and encouraged them to share their knowledge during whole class instruction. This kept these students engaged and contributed to the success of the collaborative learning nature of the unit. The more advanced students of the group could share their understanding with the progressing level group of students.

I found that collaborative learning improved the engagement of the class and encouraged participation, even among the students that are typically categorized as intrinsic learners. I noticed that students were more inclined to share their ideas and provide peers with feedback and support when we worked collaboratively.

Beginning each lesson with a whole group discussion gave me an opportunity to formatively assess the students collectively. I was able to ask students higher level questions after collaborative work. Instead of asking students to read numbers from a graph, I asked questions like “How many more students walk home than bike?” or “If I added five more votes to this section of the pictograph, how many more symbols would I need to add?”. I observed that collaboration helped students to answer these questions more efficiently. To assess individual understanding, I also asked questions like “How did you get that answer?” or “Can you explain your thinking?”. These allowed me to gauge whether

students had a deeper grasp of the content and if they could logically answer questions that were more advanced. Students also participated in turn and talks with people near them, and their table groups, daily.

Overall, collaborative learning was and continues to be highly beneficial for students and their learning. This strategy not only benefited individual students, but the classroom community. I noticed that students made academic growth while also being able to work with their peers to think deeper about the content being presented to them.

By integrating different types of questions, I observed that students were able to think more deeply about the concepts presented. I concluded that the varied questions contributed to their learning of the unit and the level of retention students had. Therefore, improving their post-test scores. Collaboration allowed students to learn from their peers and gave students more control of their learning. Students became more confident and engaged with their learning due to continuous feedback. The pre- and post-tests provided students with a baseline and a structured end goal to work towards.

Conclusion

After analyzing the data, it was noted that 32% of students demonstrated improvement from the pre-test to the post-test. It was also noted that 50% of students maintained proficiency, but still made an improvement within the proficiency range. Prior to instruction, 33% of students scored at grade level. After instruction, 64% of students were able to score at grade level, or proficient. This demonstrates that the instructional strategies implemented were effective and successful for the students. I noted that the results of the advanced student data demonstrated a discrepancy between the pre- and the post-test. I attributed this to the differing parameters for scoring between the district's scoring guide and how the pre-test was scored. Before instruction, 29% of students achieved an advanced score, whereas after instruction, this percentage decreased to 23%. Due to the varying stringency levels of the scoring guides, I question the validity of this statistic.

Following analysis of my observations of the students engaged in collaborative learning, it was noted that the students were actively engaged in the lessons and shared ideas with their peers. During the collaborative learning groups, the students accepted feedback openly from others. I analyzed that the integration of varied cues and questions enabled students to demonstrate their learning regardless of their academic level. The questions asked were easily modified to meet each student's needs. Based on the post-test results, it can be concluded that the instructional strategies I integrated into the unit were successful.

References

Demirbag, B. et al. (2016). Training of Critical Thinking Skills in Teacher Candidates and Placebo Effect: A Quasi-Experimental Study. *Eurasian Journal of Educational Research. (63),* 375-392. https://doi-org.leo.lib.unomaha.edu/10.14689/ejer.2016.66.18

Hattie, J., & Donoghue, G. M. (2016). Learning Strategies: A Synthesis and Conceptual Model. *npj Science of Learning*, 1(1), 1-13.

Hattie, J. & Timperley, H. (2007). The Power of Feedback. *Review of Educational Research*, 77(1), Abstract. https://doi.org/10.3102/003465430298487

Hornbuckle, M. (2022, January). *Why pretests and Posttests in education matter*. 5 reasons pretests and posttests in education matter.YouScience. https://www.youscience.com/pretest-and-posttest-in-education/#:~:text=Pretests%20establish%20what%20students%20need,each%20of%20the%20knowledge%20standards

Nokes-Malach, T.J., Richey, J.E. & Gadgil, S.(2015). When Is It Better to Learn Together? Insights from Research on Collaborative Learning. *Education Psychol Rev,* (27), 645–656 . https://doi.org/10.1007/s10648-015-9312-8

Prouty, A. (2006). Score One for Alternative Assessment. *Science Scope*, *30*(1), 34–37. https://login.leo.lib.unomaha.edu/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=eue&AN=507910324&site=ehost-live&scope=site

Whalen, K. A., Renkl, A., Eitel, A., & Glogger-Frey, I. (2023). Digital Re-Attributional Feedback in High School Mathematics Education and Its Effect on Motivation and Achievement. *Journal of Computer Assisted Learning.*, *40*(2), 478–493. https://doi.org/10.1111/jcal.12889

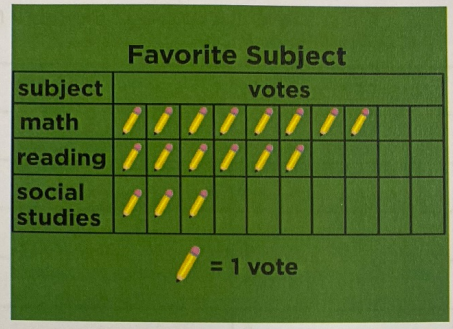
Appendices

Appendix A: Pre- Test

Here's What's Coming Up!

It's OK to not know yet, but do your best to show me what you know!

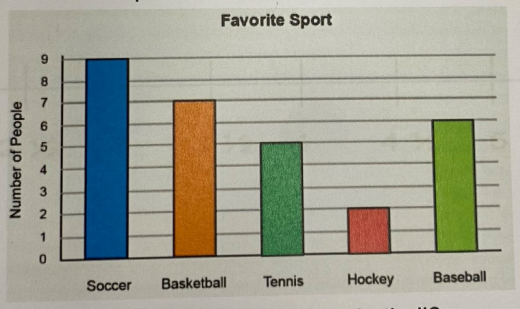
Look at the graph.



Write three statements about the data represented graph.

1.
2.
3.

Use the graph to answer the questions.



4. How many more people like soccer than basketball?

5. How many fewer people voted for hokey than baseball?

Use the graph to answer the questions.

Mode of transport	Number of students
Bus	☺ ☺ ☺ ☺ ☺ ☺ ☺
Car	☺ ☺ ☺ ☺
Walking	☺ ☺ ☺ ☺ ☺ ☺
Bicycle	☺ ☺ ☺

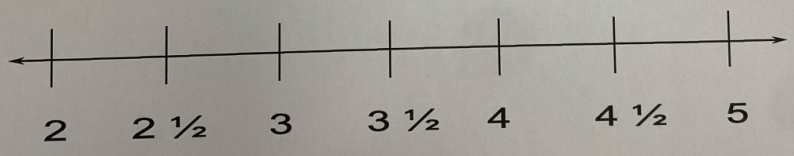
Key : ☺ Represents 3 children

7. How many children ride in a car to get to school?

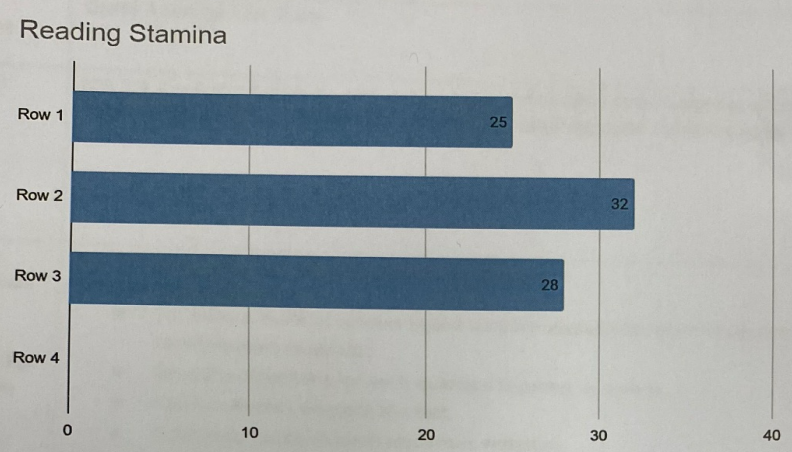
8. If four more students walked to school, how many smiley faces would be added to the graph?

6. The table below shows how many miles people like to run each week. Use the data from the table to create a line plot.

Miles	Number of People
2	3
2 ½	2
3	2
3 ½	1
4	3
4 ½	1
5	5



Use the graph to answer the questions.



10. Mrs. Olson said she would give two extra tickets to her students for every minute their row read. How many tickets would row 2 get?

11. If the class read for a total of 103 minutes, how many minutes did the fourth row read? Color it in on the graph.

Appendix A: Example of the pre-test given to students to assess understanding prior to the unit.

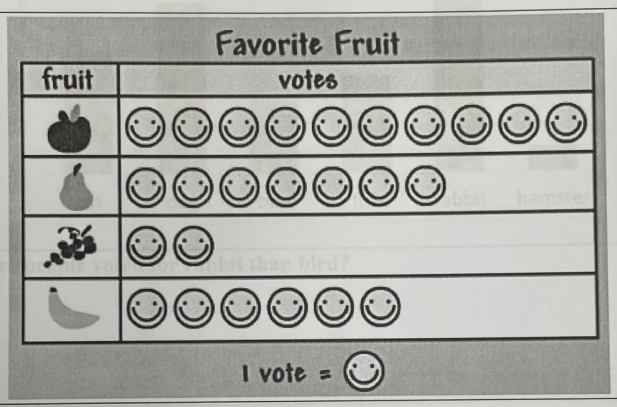
Appendix B: Post-Test

ame: _____

ndicator(s): MA 3.4.2.a: Solve problems and make simple statements about quantity differences (e.g., how many more and ow many less) using information represented in pictographs and bar graphs.

Level 2

Directions: Make 3 statements about the data represented in the pictograph.

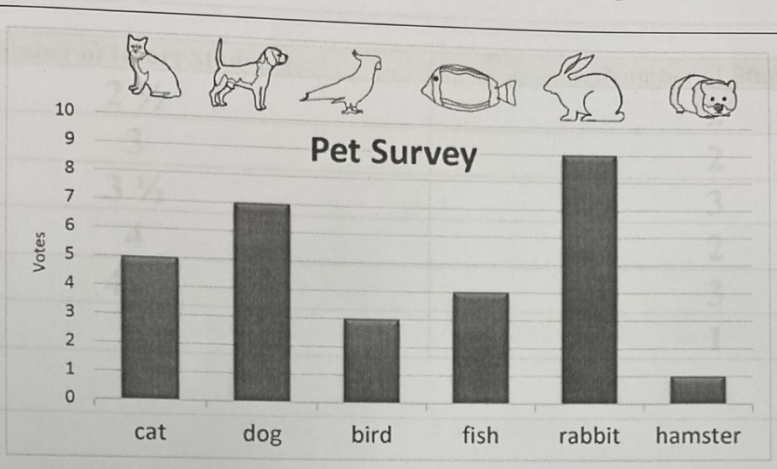


1.

2.

3 .

rections: Use the data represented in the bar graph to answer the questions.



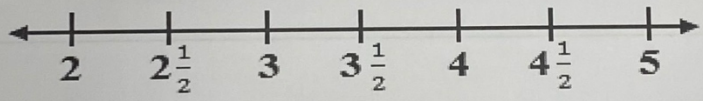
4. How many more people voted for rabbit than bird?

5. How many fewer people voted for fish than dog?

rections: The table below indicates the number of hours students in the 3rd grade spent studying each ek. Use the data from the table to create the line plot.

Number of Hours Studying	Number of Students
2 ½	2
3	2
3 ½	3
4	2
4 ½	3
5	1

6.



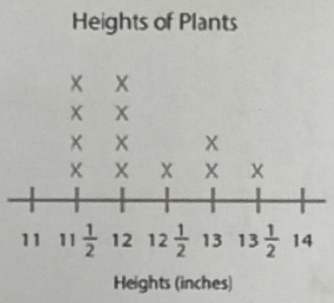
Number of Hours Studying

ections: Select the line plot that represents the data

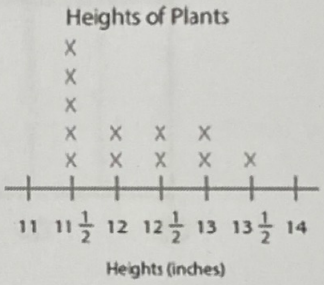
Ms. Judd's class recorded the following heights in inches for plants they grew.

13	$11\frac{1}{2}$	13
$11\frac{1}{2}$	12	$13\frac{1}{2}$
$12\frac{1}{2}$	12	$11\frac{1}{2}$
$11\frac{1}{2}$	$11\frac{1}{2}$	12

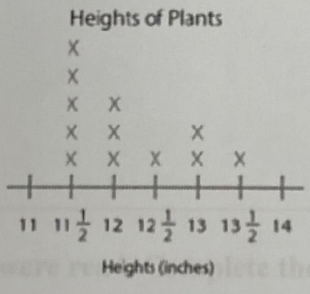
A.



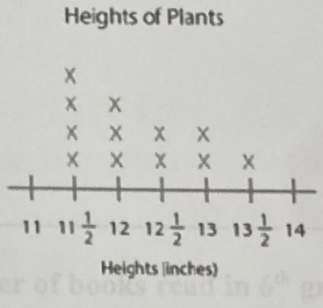
B.



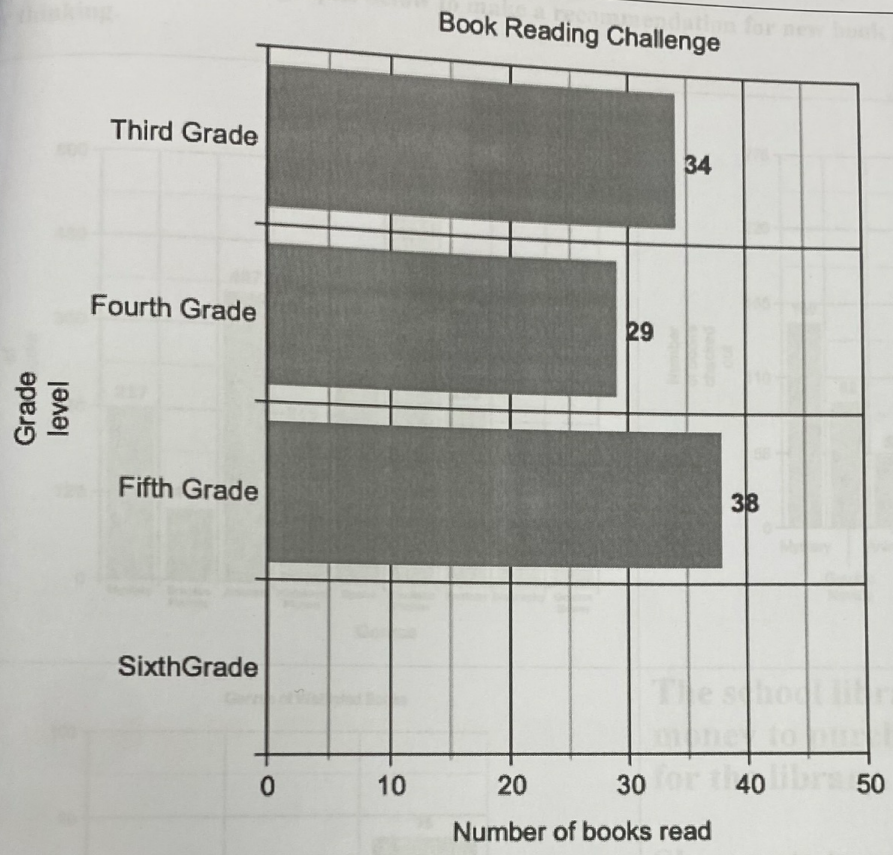
C.



D.

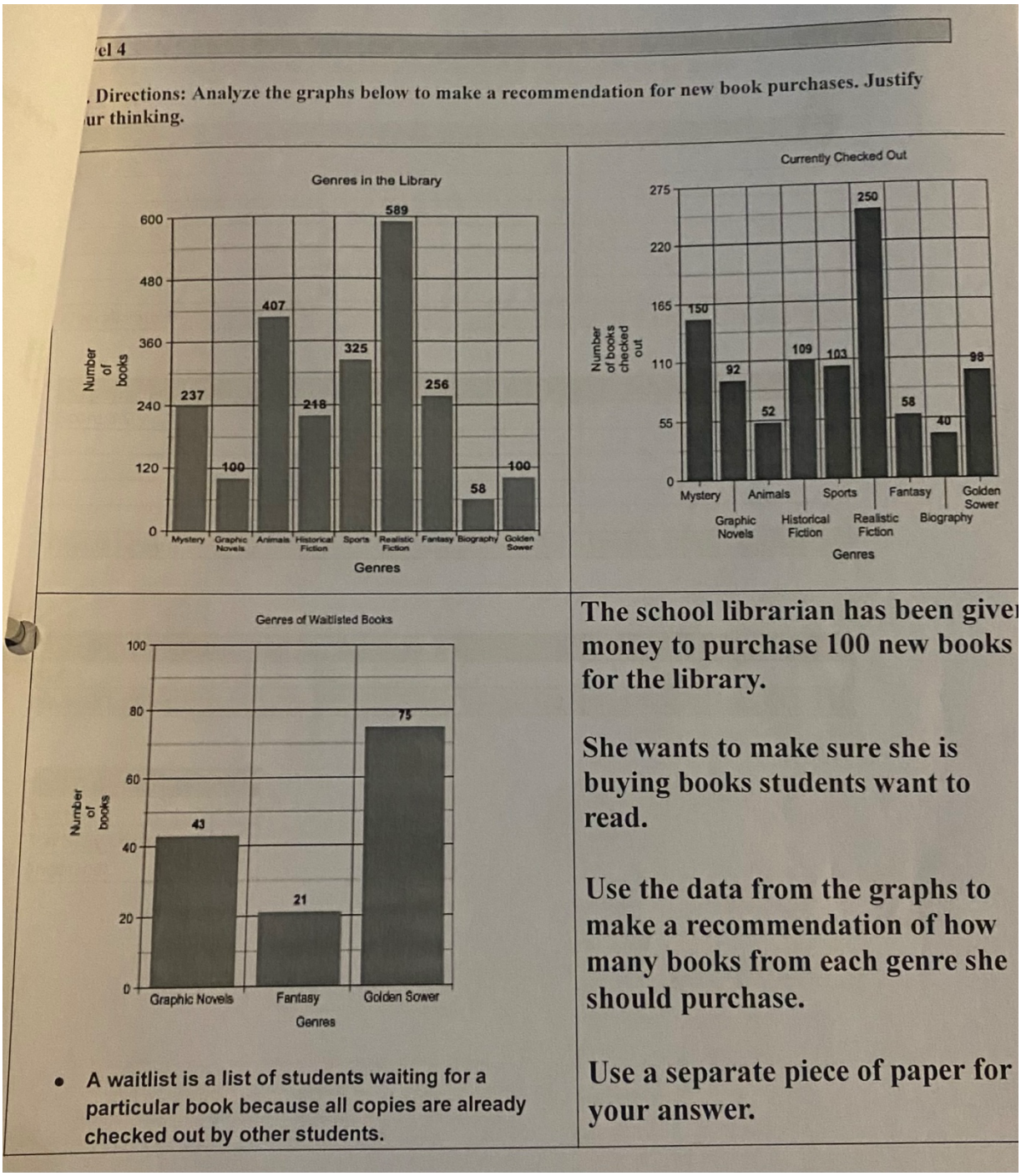


ections: Use the data from the bar graph to answer the questions.



10. The third-grade teachers said they would give the students 2 extra recess minutes for every book read. How many extra recess minutes were earned by third grade?

11. 144 total books were read. Complete the graph to show the number of books read in 6th grade.



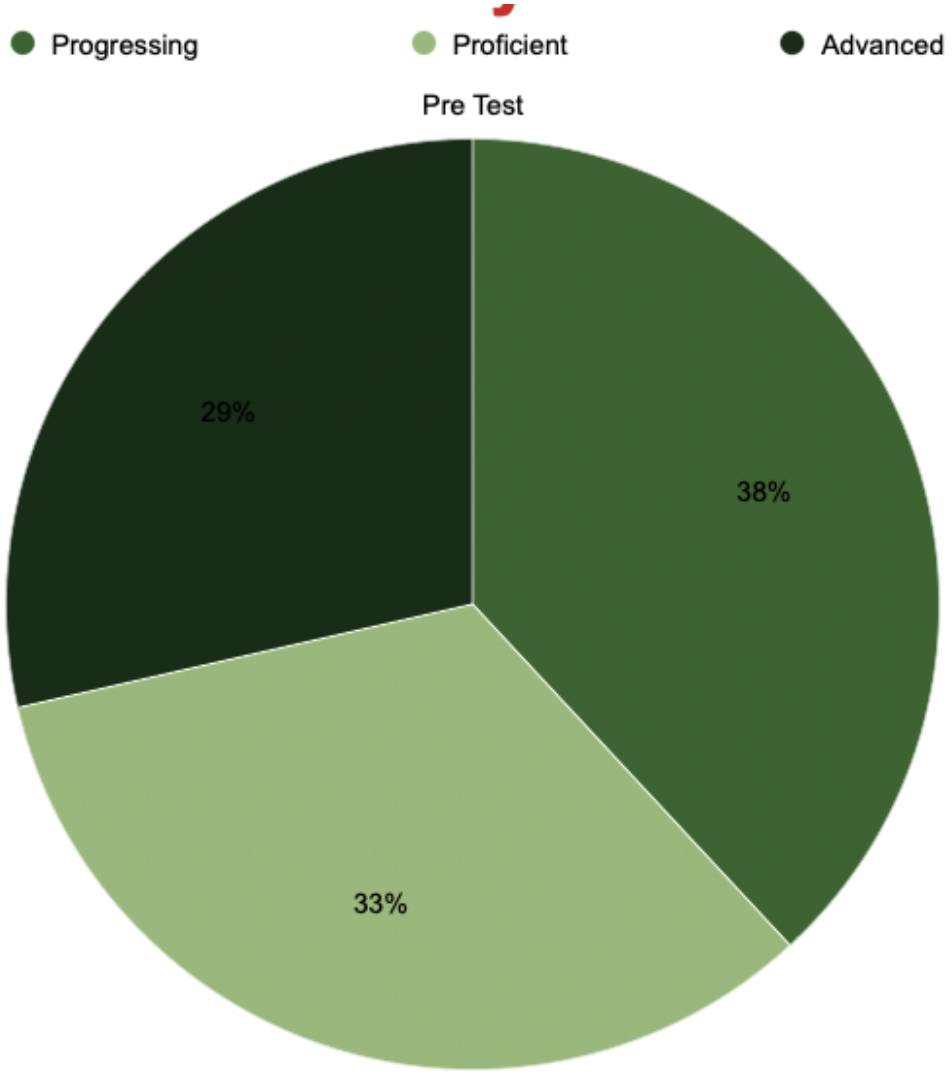
Appendix B: Example of the post-test given to students to assesses understanding after the unit.

Appendix C: Proficiency Scales

3rd Grade	**Data** 3.4.2.a Solve problems and make simple statements about quantity differences using pictographs and bar graphs.	
4	I can analyze data using multiple types of graphs. I can make complex statements about the data.	
 3	I can solve problems using the data in pictographs and bar graphs, with a scale of 2, 5, or 10. I can solve problems using the data in a line plot with scales that include whole numbers, halves and quarters. I can match data to a line plot. The data could include whole numbers, halves and quarters.	
2	**Vocabulary:** Scale, outlier, solve, create, represent	I can create a pictograph, bar graph and line plots. I can make simple data statements about a pictograph, bar graph and line plot. I can solve problems about missing information using a pictograph, bar graph and line plot.
1	I can show some of what I know with adult help.	

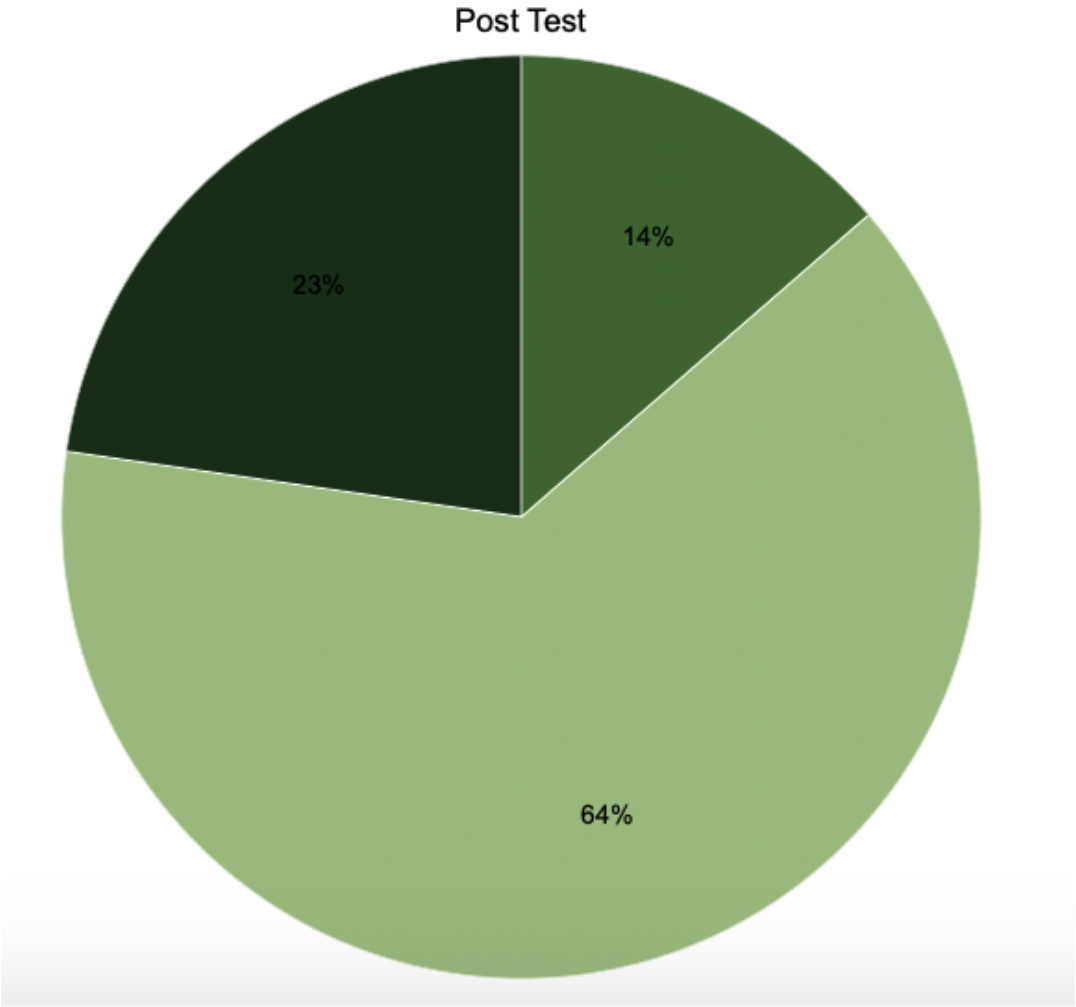
Appendix C: Proficiency Scales provided by the school district.

Appendix D: Pre-Test Chart



Appendix D: A pie chart reporting the results of the pre-test.

Appendix E: Post-Test Chart



Appendix E: A pie chart reporting the results of the post-test.