UNIVERSITY OF CALIFORNIA, SAN DIEGO

Collecting, Analyzing, Interpreting:

Using Mathematical Graphs to Promote ASL and English Academic Language

A Thesis submitted in partial satisfaction of the

requirements for the degree Master of Arts

in

Teaching and Learning: Bilingual Education (ASL-English)

by

Rachael Marie Colvin

Committee in charge:

Tom Humphries, Chair
Bobbie M. Allen
Carol Padden

2010

The Thesis of Rachael Marie Colvin is approved and it is acceptable in quality and form for publication on microfilm and electronically:

_____

_____

_____

Chair

University of California, San Diego

2010

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

First, I would like to thank Bobbie M. Allen and Tom Humphries for their support through this Master's program as well as for contributing their time and energy in helping me create this thesis. Without their input, vast knowledge, and years of experience I would not have accomplished this task.

To Mom, Dad, Rhonda, Donny, and Carlen. In the words of my brother, "Family will always be there for you!" Thanks so much for listening to me, keeping me sane through graduate school, and for being who you are. I appreciate the support you gave me by continuing to believe in me. You were always there for me, and I will always be there for you too!

To the UCSD teachers that made me the teacher I am today. Thanks so much for your knowledge and guidance! You are truly amazing educators, and I hope to one day also guide future educators in the same way that you all did for me. Special thanks to Rusty and Caren for letting me use their math materials to write this math curriculum. Thank-you to Cheryl for taking a special interest in me; I appreciate the time you spent chatting with me about life and my experiences in the program.

To the five other people who went through this program with me: Jessica, Autumn, Kendra, Jed, and David, thank-you for sharing this experience with me! It was a long road but we made it through. I enjoyed collaborating with you all and hope that our paths cross in the future! To Jessica and Autumn- we have a lot to be proud of! We made it through together. We will always share a special bond because of our shared experiences no matter where we are in life's journey! Good luck to you both!

ABSTRACT OF THE THESIS

Collecting, Analyzing, Interpreting:

Using Mathematical Graphs to Promote ASL and English Academic Language

by

Rachael Marie Colvin

Master of Arts in Teaching and Learning: Bilingual Education (ASL-English)

University of California, San Diego, 2010

Professor Tom Humphries, Chair

Many new technical and mathematical jobs require that Deaf and hearing students have excellent critical thinking and interpreting skills to support them in the workplace. This curriculum sought to increase Deaf students' critical thinking,

analysis, and interpreting skills through the use of mathematical graphs in the classroom while incorporating the English and American Sign Language (ASL) academic language that students need to interpret the graphs. The students spent eight days working with various types of graphs (pictographs, line plots, bar graphs, and Venn Diagrams) and learned different ways to collect data including making lists, filling out surveys, and interviewing their peers. As a culminating project they created their own graphs using the data they collected from their peers, wrote English sentences to describe the graph, and presented them in ASL to the class. An evaluation of the curriculum suggested that students experienced different types of graphs and methods of collecting data, developed the skills needed to analyze mathematical graphs from a set of data, improved their understanding of graphs in the real world, and were able to discuss their graphs in ASL and English as shown by their final projects.

I. Introduction and Overview

Educators of deaf students rely on a variety of teaching theories and strategies to achieve academic success. Deaf students, who do not have Deaf parents, are non-native English language learners (ELL's) by nature and, depending on their educational program, also use a visual language to communicate ideas, wants and needs. Most deaf students have parents who can hear and use a spoken language at home with their children. Some parents learn sign language or oral methods to communicate with them at home, but not all parents do this, which yields somewhat difficult parent-child communication. Hearing students, however, often have interactions with their parents where parents will ask them what they think about something or will explain things in more detail to give their children background knowledge or inferential skills. For example, a parent might say that he thinks it might rain because it is cloudy outside and it usually looks cloudy right before it rains. Parents model these inferential and critical thinking skills for their children. Deaf students may not have access to certain inferential and critical thinking skills because of the language barriers at home. As teachers we can address this issue directly by exposing deaf students to this type of language and skills using American Sign Language in the classroom.

During my experience working with deaf students in a total communication classroom where teachers used both American Sign Language (ASL) and English at the same time to communicate with students, I saw that students were often asked to answer questions and when asked why or how they arrived at the answer, they were often confused. Some students were unable to explain their answers. This indicates

that they had not learned critical thinking and inferential skills at home or school or possibly academic language as well. This thesis aims to improve deaf students' critical thinking, analytical, and interpreting skills through the use of a bilingual curriculum.

This curriculum is innovative because it is bilingual in approach and uses the students' natural curiosities as motivation for learning. It offers a hands-on approach through activities that motivate, excite, and encourage students to grow and learn. The students will learn graphing, critical thinking, analysis, and interpreting skills that can transfer to other academic disciplines including science, English, reading, and history. Additionally, they will learn the academic language needed to talk about their projects in both ASL and English.

The curriculum I will introduce here has five goals. The first goal is for students *to experience different types of graphs*. There are many different types of graphs that we use in and outside of school. There are line plots, bar graphs, pie graphs, Venn diagrams, pictographs, and many more. Each graph has a different purpose and appearance and students will learn to identify the various types and the information they convey.

The second goal is for students *to experience methods of collecting data*. Through the curriculum lessons, students will create their own survey questions and collect data. Students will learn how to create a survey for use during an interview where they will videotape or record responses. There are many different ways to collect data for an inquiry project, and this curriculum implements many of them.

My experience working with deaf students has taught me that some students lack well developed critical thinking skills. Acquiring these skills requires encouragement and nurturing. Developing analytical skills with graphs is useful because it involves using critical thinking skills in a cognitively demanding context, which will transfer to other content areas such as science and social studies. Therefore, the third goal of the curriculum seeks to *develop skills needed to create and analyze mathematical graphs from a data set*. Students will create graphs for their final presentations.

The fourth goal of the curriculum is to *develop the academic language necessary to discuss graphs in ASL and written/spoken English using higher level thinking skills*. This curriculum includes activities to teach students the academic vocabulary and skills needed to talk about graphs with each other and for their presentations to the class. Students will experience a comfortable and non-threatening environment in small cooperative learning groups to practice the academic language through peer communication. In addition to presenting the results of their student interviews and surveys to the class they will write an English summary of their findings. Teachers can use the small discussion groups and presentations to gauge students' learning throughout the whole process.

Lastly, this curriculum aims at *improving students' understanding of the use of graphs in real world situations*. Many students wonder why they are required to solve certain kinds of math problems in school, and they do not see the importance, longevity, and necessity of learning such skills. However, newspapers, news magazines, textbooks, television news, and informational reports are inundated with

graphs of various kinds. Deaf students need to know that graphs are everywhere, they are important, and that they will encounter them in their daily lives beyond school

The curriculum is based on four key learning theories: cooperative learning, multiple intelligences, Basic Interpersonal Communication Skills/Cognitive Academic Language Proficiency (BICS/CALP), and authentic instruction. During the curriculum, students will participate in cooperative learning activities by working together in small heterogeneous ability groups to complete a task where they will be encouraged to discuss their graphs and surveys together. By working in small cooperative learning groups, students will develop interpersonal skills and will motivate each other to complete group learning activities.

Many school programs traditionally test students' linguistic and logical-mathematical skills in the form of standardized testing. While important, standardized tests should not be the end all in assessing students' achievement. Many students are musically very talented, but do not possess the same linguistic abilities. Likewise, students who are linguistically talented might not have great abilities in music or visual-spatial forms. The activities in the curriculum incorporate Gardner's Theory of Multiple Intelligences, which states that students have many methods of learning and teachers should capitalize on students' different abilities and talents rather than solely tapping into linguistic or logical-mathematical skills. In this curriculum students will be engaged in various types of learning engaging their diverse abilities and individual intelligence types including logical-mathematical, linguistic, visual-spatial, and interpersonal intelligences.

The curriculum is also based on James Cummins' theory of BICS/CALP (1996). According to this theory, students learn BICS (or Basic Interpersonal Communication Skills) naturally, assuming language input is constant, through the use of social cues such as gesturing, facial expressions, and pointing. BICS is not very cognitively demanding but incorporates many contextual aides. In contrast, students learn CALP (or Cognitive Academic Language Proficiency) through explicit instruction in the classroom. CALP is more cognitively demanding and may provide fewer contextual cues to assist in understanding. During the curriculum students will be using BICS when they conduct interviews with each other about their everyday interests and CALP when they communicate with peers and teachers about their graphs during context embedded activities. Also, students will use CALP when they analyze and interpret the results of their surveys and present their graphs to the class using appropriate math vocabulary.

Lastly, the curriculum includes authentic instruction and learning, a practice first associated with Fred Newmann (1993). Authentic instruction exposes students to teaching that is meaningful and lasting rather than instruction that is shallow and does not last beyond classroom assignments. To incorporate this teaching practice students will engage in meaningful, hands-on, experiential learning by creating their own inquiry project including a survey and interviews with peers during data collection. Students will communicate with their peers and make real-world connections by searching magazines, newspapers, and textbooks for graphs to use for an activity. All of this will occur in a positive learning environment. Through experiential learning

and authentic instruction students will make connections and develop skills that they can take with them beyond the classroom.

II. Bilingual Approach to Deaf Education

Bilingual education has many theories, ideologies, and practices. There are many different types of programs for hearing minority students who are English Language Learners (ELL's). These programs, while important and effective for hearing students who are learning English as a second language, are not always appropriate for deaf students. After a discussion of these programs, I will discuss the departure points for deaf students.

Until 1974 when the landmark *Lau vs. Nichols* Supreme Court case deemed them a violation of minority children's Civil Rights, minority children were taught in submersion programs, where teachers spoke English 100% of the time in a "sink or swim" environment. However, the modern era of English as a Second Language (ESL) instruction began when that court ruled that students need access to certified teachers of English as a Second Language (ESL) in order to improve their English skills.

In response to the need for ESL instruction, two new programs emerged. The first program, ESL pullout, pulled ELL students out of their mainstream English classrooms, where they were mixed with native English speakers, and brought them together for 45-minute learning sessions with other ELL students. During these sessions, students were exposed to explicit English instruction from an ESL certified teacher. The second program, called Structured Immersion, promoted English acquisition through sheltered English lessons where a trained teacher instructed students using Specially Designed Academic Instruction in English (SDAIE). The hope was that students would learn both the English language and academic content at

the same time. These two programs focused on English acquisition but did not advance the development of the students' native languages. The Bilingual Education Act of 1968 sought to address this problem by providing funding for bilingual education and provided a way for schools to offer bilingual education without violating segregation laws (Bilingual Education Act, 2009).

Hearing ELL students communicate at home with their parents in their native language (or L1), but communicate at school in English (L2). The *transitional bilingual method* was a way to promote students' L2 acquisition while maintaining their L1. The goal of transitional bilingual programs was to "help children keep up academically, while moving them as expeditiously as possible into the English mainstream" (Crawford, p. 43). Thus, this program was called the 'early-exit' bilingual program. Another method, called Developmental Bilingual Education, was created as an alternative.

Developmental Bilingual Education is sometimes called 'gradual-exit' or 'late-exit' bilingual education because ELL students get instruction first in their native language and the amount of English instruction is gradually increased while L1 instruction is eventually decreased. Instruction in English begins in math and science because they are visual and easier to understand in English and eventually students learn all subjects in English. Through this model, students get instruction that is *additive* in approach where both languages are seen as necessary.

The last bilingual program of interest here is the Two-Way Bilingual Education program. In this program, native speaking Spanish and English students (or two other spoken languages) are in the same classroom. There is a full separation of

the languages; that is one language is not translated into the other language to help the students learn but rather, instruction occurs in one language at a time. The students are mixed together in heterogeneous ability groups so that they can help each other with assignments. There are two versions of this program: the 90/10 model and the 50/50 model. In the 90/10 model, teachers use Spanish for 90% of their instruction in kindergarten and first grade and use English for 10% of the instruction. For each subsequent grade level change for 2nd and 3rd grades, there is a 10% increase in English instruction and a 10% decrease for Spanish. For 4th-6th grades, the breakdown is 50% in each language. The students acquire both languages through dual instruction. In contrast, in the 50/50 model, each language is used for 50% of the day, and the students learn all subjects in both languages throughout all grade levels.

With all of these bilingual programs available one might ask: Where do deaf students fit? Deaf students, due to their inability to hear, present a unique situation. They do not completely fit into the Developmental Bilingual programs or the Two-Way Bilingual programs because they will not eventually "drop" or decrease the ASL. In her book entitled "Rethinking the Education of Deaf Students", Sue Livingstone (1997) states, "… when Deaf students acquire communicative competence in both ASL and English, ASL will still be the language that best fits the constraints of the visual/gestural modalities both expressively and receptively" (p. 10). She goes on to say that "even after knowledge of English has been sufficiently developed and becomes part of a student's sign competence, English in signs should not replace ASL as the language of instruction" (p. 10) nor are students "exit[ed] out of ASL classes into mainstream classes where only English is used" (p. 10). Thus, not all models of

bilingual education that work for hearing students work for deaf students. However, deaf students still need a bilingual approach to their education so they can be successful in both the English and ASL communities. Next, I will present three arguments for a bilingual approach to educating deaf and hard of hearing students: one research-based, one pedagogical-based, and one socio-cultural-based.

Because deaf children cannot hear spoken language, they need a visual-spatial language that fits their linguistic and cognitive needs. Bilingual education advocates state that ASL "is easy to acquire and provides deaf children with a solid first language" (Singleton, Supalla, Litchfield, Schley, 1998, p. 18). As a first language, it can provide the literacy skills necessary to transfer to a second language. James Cummins' *Interdependence Theory* (Bilingualism, 1986) explains this rationale:

> To the extent that instruction in Lx is effective in promoting proficiency in Lx, transfer of this proficiency to Ly will occur provided there is adequate exposure to Ly (either in school or environment) and adequate motivation to learn Ly (p. 87).

In the 1960's linguists established the validity of ASL as a full-fledged language (Stokoe, Casterline, Croneberg, 1965). Thus, one can assume that the skills learned in ASL will transfer to English just as the skills learned in any other language would. Mayer and Wells (1996) have argued against this claim, saying that because ASL does not have a written form, it cannot benefit from the Interdependence Theory because students cannot read ASL and transfer their skills to written English. On the other hand, several studies on reading achievement, literacy, and writing have suggested that the Interdependence Theory with respect to ASL and English is valid.

The literature suggest that deaf children with deaf parents outperform deaf children with hearing parents in school on reading tasks even though ASL does not have written form (Meadow, 1968; Quigley & Frisina, 1961; Stevenson, 1964; Stuckless & Birch, 1966). Padden and Ramsey (2000) looked at reading achievement in deaf students from a residential school using ASL-based teaching methods and a mainstream school using a Total Communication method. One hundred and thirty five students participated in the study and data consisted of student records and scores from their SAT- Reading comprehension, SAT-HI, and SAT-Math computation tests. Padden and Ramsey looked at parental hearing status, age of onset of deafness, age of detection of deafness, degree of hearing loss, ethnicity, and age of first educational contact. They found that skill in fingerspelling correlates with reading success, as well as the ability to translate initialized signs, which are ASL signs that have a handshape corresponding to the first letter of the English word. They found these skills "are more likely to be found among deaf children who have grown up with ASL as with those with deaf parents, but they are also used by other children who perform well on tests of ASL ability" (Introduction, para. 6).

Strong and Prinz (1997) explored whether ASL skill is related to English literacy development in deaf children. One hundred and sixty deaf children with no other handicaps between the ages of 8 to 15 years old were recruited for their study. A total of 40 students had deaf parents and 115 students had hearing parents. The students were divided into two age groups: 8-11 years old and 12-15 years old and were given English and ASL literacy tests as well as a nonverbal IQ test. The English tests included: a comprehension of English vocabulary, sentences, and paragraphs; a

productive vocabulary test; an English syntax test for sentence writing abilities; and an English written narrative produced by the students based on a child's picture book. ASL tests included: a story comprehension task where students watched a native deaf signer telling a story and answered questions about the story; a classifier comprehension test; a time marker test; and a map marker test.

The results of the ASL and English subtests were standardized and each student was given a total English and ASL skills score. Strong and Prinz found that children with higher ASL skills had higher English skills. They also found that when ASL skill level was held constant there was no difference in performance between the deaf children with hearing parents and those with deaf parents. Strong and Prinz further stated that "Deaf children's learning of English appears to benefit from the acquisition of even a moderate fluency in ASL" (p. 45). From this study it seems that a plausible bilingual program that develops and maintains ASL and English, regardless of parental hearing status, has much to offer deaf students.

Hoffmeister, de Villiers, Engen, and Topol (1997) looked at the relationship between English reading and writing skills, comprehension and production of what they called "through-the-air" English in simultaneous sign and speech, and comprehension and production of ASL syntactic and semantic features. Fifty deaf participants ranging in age from 8 to 16 years old met the study's qualifications including: age of onset of deafness, decibel loss, and completed all subsets of the testing. The participants went to one of four schools, all using Total Communication methods of teaching; some were day schools and some were residential schools.

Fourteen of the students had deaf mothers and 12 of the 14 had two deaf parents. The remaining 36 students had hearing parents.

The students were tested on a range of tests including: the Stanford Achievement Test (SAT-HI), which has been normed with deaf students, the Rhode Island Test of Language Structure for comprehension of English sentence structures, a sentence production test, and an assessment of ASL skills using a variety of video-based tasks. The authors found that students who had sophisticated knowledge of the structure of ASL also had high English reading achievement. Thus, the authors concluded that a "mastery of higher level skills in both ASL and English facilitates the development of good reading skills in English" (Conclusion, para. 1).

These studies underscore the importance of bilingual methods when educating deaf students. Students must have a high level of ASL *and* English skill level in order to achieve high English reading skills. Deaf students, as well as all students, must have pedagogical instruction in an environment that promotes learning. Bilingual education for deaf students provides such an environment, where through a natural visual language, students learn English, which then facilitates communication with the hearing majority. Next, I review some pedagogical arguments for bilingual deaf education.

Krashen's *Affective Filter hypothesis* in second language learning (in Crawford, 2004) described how certain factors can impede students' ability to learn. He talked about a theoretical *Language Acquisition Device* (LAD) in the brain that is modulated by affective factors. According to Krashen, there are three factors that determine how we acquire a second language: motivation, self-confidence, and

anxiety. For example, low motivation and high anxiety blocks language input to the LAD whereas high motivation and low anxiety allows language input to the LAD. If students do not feel motivated to learn in their classroom, they tend to seek less language input and have a high Affective Filter. Similarly, students with low self-esteem and/or low self-confidence, or with high anxiety will have a high or strong Affective Filter, causing input not to arrive at the LAD in the brain.

Teaching styles and the environment the teacher provides for deaf students can greatly affect how students learn. The learning environment should be interactive, challenging, and exciting and should allow students to express themselves linguistically when they feel ready to do so. Teachers can give students more time to think about an answer rather than "cold calling" on students who have not volunteered. When teachers call on students and they do not know the answer, their self-esteem and confidence could drop, yielding increased anxiety, which can lead to a high Affective Filter. Another strategy is to have students discuss their ideas with a partner or small group before asking for volunteers to report to the class. Discussion with peers can lead to increased confidence in linguistic skills as well as insights into the accuracy of possible responses. Students may be more likely to offer an answer if they are in agreement with their peers' answers. Additionally, language input and classroom material must be comprehensible to students in order for them to acquire it. Teachers can utilize visuals in the form of posters and drawings in the classroom to help students connect with new material, which may augment feelings of confidence.

Cummins and Swain's theory of *Comprehensible Input* (1986) is language that contains some new element such that the learner understands it due to linguistic,

paralinguistic, or situational cues, and/or world knowledge. In other words it is "i+1", or information that a student already knows plus a little more that the student does not yet know. The student can still process the information because the new input is comprehensible in that it includes some sort of additional cue. One practical way of making input comprehensible in the classroom is using Total Physical Response (TPR) activities where students use their bodies to learn new language or concepts. For example, to learn the concept "under", students can physically get under a desk or table so that they understand what it means to be under something. Another strategy for making input comprehensible is using visual representations of concepts such as diagrams, charts, graphs, acting, and theater.

Cummins' (1986) framework lists four factors that empower or disable minority students: incorporating the minority culture and language into the classroom; community participation; pedagogical assumptions and practices in the classroom; and the assessments used in the classroom. He suggests that schools can promote 'additive' or 'subtractive' bilinguality depending on how they incorporate these factors. An additive bilingual model for deaf education uses ASL in the classroom and incorporates students' cultures by portraying them positively, rather than negatively. For example, teachers can bring deaf community members into the classroom through guest lecturers, dancers, entertainers, book readers, storytellers, and deaf poets. The additive model supports a pedagogy that requires student involvement in activities rather than promoting passive learners in the classroom and sets high expectations for student achievement.

Finally, teachers in an additive bilingual model for deaf students assess students using a broad array of authentic as well as standardized assessments. Teachers analyze students' work samples, language logs, informal reading assessments, and writing samples to determine the students' ability levels. The results inform teachers of next steps in planning. Incorporating the additive approach into bilingual education is important because students feel their language and culture are valued and have a positive self-image, which in turn enables more learning. When students feel empowered, they can learn better and participate more fully in the educational process.

The Swedish Deaf bilingual program (Mahshie, 1995) is an example of a bilingual program that incorporates the four factors that empower students rather than disable them. It starts with early family intervention in which doctors make home visits to check infants' hearing and if the infant is deaf they assemble a team of counselors, Deaf community members, audiologists, and teachers to inform the parents of their child's hearing status. The team provides educational program options so parents are able to make informed decisions regarding the best educational route for their child. Most parents choose to put their child in a deaf residential school. Regardless of what route they choose, both the children and parents are required to learn Swedish Sign Language (SSL) and interact with the Deaf community. Students who go to one of the six deaf schools get access to deaf and hearing signing teachers and plenty of language interaction. The Swedish Deaf bilingual model empowers Deaf students by giving them access to language and culture through teachers, the Deaf community, and paraprofessionals at the school.

The Swedish model also incorporates critical pedagogy in the classroom and invites Deaf community participation. The children learn to read using 'Adam's Book', which is a book about the adventures of a healthy and happy deaf family. They watch a signed translation of the book in SSL and then teachers stop the video and discuss it. This method exposes the children to the content before they read it so they have background knowledge prior to moving on to read the book. The book is used multiple times and children learn various versions as well as other stories. In addition to learning SSL and written Swedish, children learn all of the same subjects and material that the compulsory hearing students learn and generally perform either at grade level or one year behind the hearing students. Families with deaf children are required to go on outings and camping trips with the Deaf community where families can interact in a positive way with other signing Deaf children and adults.

Assessments in the Swedish classroom take on many forms. Because Deaf children are learning written Swedish and are learning SSL simultaneously, the teachers in the Deaf schools allow students to express their ideas in any form they can (written Swedish or signed Swedish). This gives students the opportunity to choose which language they feel comfortable in expressing themselves and promotes the idea that both languages are equally important (Mahshie, 1995). Additionally, children can put their thoughts into drawings, building models, acting out plays, sharing ideas with a friend, signing in front of a video camera, or writing down their ideas in a list or rough draft form. Teachers guide students through the writing process by having writer's workshops where the students can have one-on-one conferences with the teacher about their work in a fun environment (Mahshie, 1995). To be more exact, the

Swedish bilingual model of education allows students to freely express their ideas and thoughts without limiting the medium through which the students express themselves and this contributes to a positive school experience with both written Swedish and SSL.

This last section looks at the socio-cultural reasons for a bilingual approach to educating deaf and hard of hearing students. Deaf with a 'D' refers to a linguistic and cultural minority group who use ASL whereas deaf with a 'd' refers to the audiological condition. People in the Deaf community have their own humor, stories, poetry, language, and cultural experiences that shape the group. It is these aspects of Deaf culture that Deaf adults contend are important for young deaf children to be exposed to in order for them to create a sense of self and a sense of belonging.

Many deaf students come from hearing families who do not know ASL. These students, because of their deafness, frequently do not acquire the spoken language of their parents completely. Ramsey (2004) argued that deaf students have two cultures: the culture of their families and the American Deaf culture. Ramsey believes that culture is transmitted from parents to their children through language. If this is true, how is culture transmitted in the case of deaf students with hearing parents who do not sign? She goes on to say, "partial or ambiguous language does not fill the requirements for participating in culture, nor does receiving basic skills instruction second-hand through an interpreter" (p. 55). Bilingual instruction offers deaf students from hearing families the opportunity to engage in direct language sharing and learning experiences with children from deaf families, deaf adults, and hearing signing adults. It also offers them a sense of belonging to a culture and helps them develop an

identity. When they see other deaf children and deaf adults they realize there are other people that are deaf like them.

Additionally, the bilingual approach gives equality to both English and ASL. Both languages are viewed positively and are used in different situations: written or oral English with hearing people and ASL with Deaf people, generally speaking. Returning to the additive model to bilingual programs and all of the benefits students can yield from that approach, bilingual education shows students that both languages are useful and important in their lives and both languages are necessary for success. Likewise, students learn that both the Deaf and hearing cultures are equal but different. This is vital for students' views of themselves and the world. In a subtractive program, ASL is suppressed and students have little contact with Deaf role models. This may result in a poor self-image, which could yield poor academic achievement.

Hamers (1998) said, "Almost all deaf persons fit the definition of bilinguality" (p. 52). Because deaf people are a minority in a linguistic majority, they are bilingual. Deaf people need to use both languages to interact in their two cultures. This bilingual ability has cognitive and social benefits. Bilinguals generally score higher on intelligence tests than monolinguals (Peal and Lambert, 1962), which may result from greater mental flexibility required for switching between two languages. Social benefits include the ability to communicate with different people of different cultural groups, gaining a bicultural identity with all its benefits, and world knowledge that is different from that of a monolingual. Deaf students have the opportunity to move between two languages, cultures, and world-views when they become bilingual

through a bilingual education program. In the next section, I will discuss the need for a bilingual math curriculum for deaf students.

III. Description of the Need for this Curriculum

As a student teacher, I worked with deaf and hard of hearing students who were in a K-4th cluster. During a math lesson with the older students who had number recognition and counting skills, I hid a penny under a cup that had a number between one and ten on it. Students guessed which cup it was under based on clues I gave them (whether their number was higher or lower than my number where I hid the penny). I found that some students were not able to guess accurately when given the clue of higher or lower. For example, Student 1 guessed number three, and I told him that my number was higher than three. Student 2 then guessed number six, and I told her that my number was lower than six. An "appropriate" guess for Student 3 would have been number four or number five based on the clues given so far but instead the student guessed number eight. After more explaining and prompting, some students were able to explain why they picked their number based on the clues. Other students were not able to explain their reasoning or guess an appropriate number even after playing the game many times and much explanation from peers and me.

I did the same math lesson with the younger students from the K-4th cluster who were either learning to count or had some counting and number recognition skills. This time I used cups numbered between one and five and wrote the numbers on the board so we could cross off which numbers were not appropriate guesses. During the game I had the students tell me which number they wanted to guess and point to that numbered cup to assess their number recognition. One student guessed a number but pointed to a different numbered cup when asked to point to the number he picked. I drew a representation of the ASL handshapes underneath the number symbols on the

board so that the student would be able to connect the printed number symbol with the ASL form of the number on the hand. This visual representation seemed to help the student succeed in playing the game.

In my preschool student teaching placement, some of the students were in the early stages of number recognition as well and faced the same challenge of matching number symbols and ASL handshapes with a quantity of items on a table. During my student teaching experiences I also noticed that the students had an additional challenge in math, in that, in addition to learning the math content and concepts, they also needed to learn the representations of mathematical terms and numbers for English print and ASL. From this experience, I learned that deaf students, in general, need quality math instruction that meets their unique linguistic and cognitive needs.

The *Third International Math & Science Study* (TIMSS) from 1995 compared the math and science scores of hearing students in different countries and examined teaching practices to see if teaching styles and mathematics content affects student achievement. Schmidt, Houang, and Cogan (2002) noted that U.S. fourth-graders scored above the international average in science and math on the TIMSS but eighth grade students scored below average for math, and twelfth grade students scored better than only two of the 42 countries that participated. These scores show that U.S. students lag behind their international peers in the area of mathematics when they graduate. TIMSS found the six leading countries for math were Singapore, Korea, Japan, Hong Kong, Belgium and the Czech Republic. Thus, the U.S. needs to improve math scores and conceptual and procedural understanding of math concepts for both hearing and deaf students.

Deaf students, on average, lag behind their hearing peers in mathematics. Scores on the Stanford Achievement Test show that 18 year-old deaf and hard of hearing students average about a fifth grade achievement level in math problem solving and around a sixth grade achievement level for math procedures (Traxler, 2000). Furthermore, Nunes and Moreno (2002) reported that deaf students were, on average, 2.5 years behind hearing peers in mathematics in 1957 (The National Council of Deaf Teachers Research Committee). Another study showed the same results (Wollman, 1965) and a third study showed that deaf students were 3.4 years behind hearing students in math (Wood, Wood, and Howarth, 1983).

The state of California adopted new mathematics standards in 1997 in an effort to compete with the international community. The introduction of the Mathematics Content Standards for California Public Schools (Ong, Lucia, and Yee, 1997) states:

> These content standards establish what every student in California can and needs to learn in mathematics. They are comparable to the standards of the most academically demanding nations, including Japan and Singapore two high-performing countries in the Third International Mathematics and Science Study (TIMSS). Mathematics is critical for all students, not only those who will have careers that demand advanced mathematical preparation but all citizens who will be living in the twenty-first century. (para. 3)

Washington State and other states have also developed new mathematics content standards. The Superintendent of Public Instruction in Washington says the following about the new content standards:

> These standards set more challenging and rigorous expectations at each grade level. In addition, they provide more clarity to support all students in developing and sharpening their mathematical skills, deepening their understanding of concepts and processes, and utilizing their problem-solving, reasoning and communication abilities. For students to develop this deeper level of understanding, their knowledge

> must be connected not only to a variety of ideas and skills across topic areas and grade levels in mathematics, but also to other subjects taught in school and to situations outside the classroom. (Washington K-12 Mathematics Standards, 2008, Letter from the Superintendent of Public Instruction)

These states are leaders in their mathematics standards and will help to establish mathematics reform in all states.

Furthermore, the National Council of Teachers of Mathematics established principles and standards in 2000 for all areas of mathematics instruction in U.S. schools. With respect to data analysis and probability, the standards state that instructional programs for pre-kindergarten through grade 12 should enable all students to "formulate questions that can be addressed with data and collect, organize, and display relevant data to answer [the questions]" (Principle and standards, Overview: Standards for School Mathematics, Data Analysis and Probability, para. 1). Additionally, students should be able to understand basic principles of probability, use statistical methods to analyze their data, and develop and assess inferences and predictions based on their data.

Along with new standards and principles of mathematics, deaf and hearing students need teachers who utilize the best strategies and methods available. Easterbrooks and Stephenson (2006) list twenty best practices for teaching literacy, math, and science to deaf and hard of hearing students and these strategies can be used for hearing students as well. They list authentic, problems-based instruction; use of technology; active learning; visual organizers; instruction through the primary language; specialized content vocabulary; and critical thinking, among others, as some

of the best practices to use with deaf and hard of hearing students. These strategies are all incorporated into the curriculum in this thesis.

Lastly, students need curriculum that utilizes their need for experience-based and visual learning. Students learn through doing rather than by passively listening or reading. The curriculum is designed so students complete hands-on, experiential, student-based projects. It develops their analytical, interpretation, and mathematics skills through inquiry projects. Being able to read, analyze, and interpret graphs in a math curriculum will enable students to improve their comprehension and critical thinking skills. More importantly, the skills learned in this curriculum transfer across to multiple subject areas including science and social studies.

IV. Review of Existing Curricula

Typically, graphing in mathematics is taught in a standard approach where students learn graphing tasks through a series of activities. Many times these activities are not meaningful in that they do not relate to students' lives and are not hands-on. Additionally, I found through personal experiences that deaf students often have difficulty with math and critical thinking skills that accompany the math tasks. I started my search for existing curricula by examining the theses done by previous Education Studies graduate students.

Vrbancic (2000) focused her thesis on math and language. Her curriculum sought to help students make connections between math and everyday life and show how math concepts can be used across content areas such as science, reading, and writing. A goal of her curriculum was to help students gain a clearer understanding between math and language (ASL), reading and writing. Her curriculum offers the connection between language, math and everyday life, but it differs from mine in that it does not involve graphing activities. Vrbancic referenced a master's thesis from Melissa Casado (1990) who created a curriculum that connects math to students' lives through various activities but again this curriculum does not involve math graphing activities as mine does.

Mann's (2004) focused on math and number sense and getting the family involved in their child's learning through the use of math games. The goals of the curriculum were to encourage parent-student interaction through games; for students to feel motivated, stimulated and challenged; to focus on understanding rather than rote memorization of facts; and to explore number sense through fun games. This

curriculum was very different from my curriculum because it did not deal with graphs or academic language and it involved interaction with family whereas my curriculum focuses on peer interaction.

Zernovoj (2005) and Bluestein (2007) completed their thesis curricula on math and number problems. Zernovoj's curriculum promoted students' use of prior knowledge and daily experiences to show how number stories are connected to everyday life. Also, he wanted students to develop strategies to use for reading and solving word problems, to develop metalinguistic awareness of ASL and English as well as develop academic language needed for word problems. Bluestein's curriculum also sought to develop academic language needed for word problems and to give students a method to use for deconstructing word problems. She taught them symbols they could use to decode each problem in order to solve it.

Next, I used keywords such as "deaf", "math", and "graphs" in the SAGE database through UCSD's library. There, I found journals and databases that related to deafness including: National Association of the Deaf (NAD), Journal of Deaf Studies and Deaf Education (JDSDE), and many others. I searched JDSDE using these keywords but had to narrow down my search to find articles. Finally, I found one article using the art of origami to teach deaf students math and number relationships (Chen, 2006). In this article, Chen talks about how some deaf learners need to feel objects and origami can be useful for all students because they can hold and manipulate the paper to make different shapes.

I met with a math methods specialist at UCSD to get ideas about my project. She gave me good ideas for the lessons in my curriculum as well as four math

graphing curriculum books to use for reference. The books are units from a series called "Used Numbers: Real Data in the Classroom" (Corwin, R.B., & Friel, S.N., 1989; Russell, S.J. & Corwin, R.B., 1990; Russell, S.J. & Corwin, R.B., 1990; Friel, S.N., Mokros, J.R., & Russell, S.J., 1992). These books were structured with lessons on sorting and graphing activities and statistics activities. They had whole-class activities mostly rather than activities for individual students or small groups. One book focused on predictions and sampling while another book focused on means, medians, and averages using data collection strategies with students.

Still another book (1989) focused on different types of graphs and how to analyze the "shape of the data". It had example lessons to introduce the different types of graphs and analysis strategies using real world items such as raisins. Each student receives a box of raisons and counts them and then the teacher graphs the data. This book is perhaps the most useful because of the graphing ideas and pictures of each type of graph. All of the books were very helpful though, in that, they had examples of units for various grade level students, including materials that teachers can use. They helped me get ideas for my own units and how to sequence them appropriately for my curriculum. My curriculum differs from all of these however, because it will encourage students to come up with their own survey and inquiry question and will incorporate looking for graphs in the real world through magazines, newspapers, and textbooks.

Next I searched the *Laurent Clerc National Deaf Education Center* website using the same keywords from before and found a program called "Families Count!" that has materials and manipulatives for interactive family math activities. It comes

with a DVD that explains math concepts in ASL using pictures and props. Additionally, the kit comes with a math storybook that is signed in ASL that families can use together. The program is available in several levels corresponding to student age and correlates with the National Council of Teachers of Mathematics Principles and Standards. While this program does not incorporate graphing activities into the materials, it was interesting to see what toolkits are available for purchase.

I further searched on Google for "math graphing curriculum" and found a curriculum called "Folklife" by Rivers of Steel National Heritage Area (Math Graphing, 2008). This curriculum incorporates cultural and immigration issues into the short graphing activities by giving students facts and figures about different groups of people. Students have to select the best graph for the data and research that time period to figure out why people were immigrating to certain places. While this curriculum does not completely match mine, it came close in comparison to the actual activities that my students will do, which include collecting data and selecting the best graph to represent the data. The Folklife curriculum however, is not set up so students will collect their own data as they will do in my curriculum. Also, in my curriculum students will use peer cooperative learning groups to discuss their graphs and their presentations whereas in the Folklife curriculum students work individually to complete their tasks.

On a few teaching websites I found graphing units that explained the different types of graphs and gave a figure with corresponding questions. Students then had to answer questions using the graph. These types of activities are common in curricula

but they do not provide a connection to students' lives. My curriculum is interactive and students will be engaged throughout the entire process doing hands-on activities.

In my search for existing curricula, I found some definitions of graphs that I want to use in my curriculum and highlight here.

Table 4.1: Table of the different types of mathematical graphs

Type of Graph	Description
graph	a diagram that shows the relationship or the changes in the relationship between two or more things
bar graph	uses a series of rectangles or bars of different lengths to show the different quantities
line plot	uses a series of dots, connected by lines, to show the changes in quantities
circle graph	uses a circle, divided into sections, to represent the different amounts of a total
pie graph	another name for a circle graph
specialty graph	can use any type of diagram or drawing to represent the quantities or the changes in the amounts of data.
pictograph	a diagram that uses pictures to represent the data
Venn Diagram	a diagram using two or more overlapping circles to show logical relations between groups of things.

While I did find many helpful resources, I did not find any existing curricula that are exactly like my curriculum. My curriculum offers a hands-on approach through a student-centered inquiry project while teaching students useful mathematical conceptual skills, analytical, and interpreting skills.

V. Key Learning Theories

While designing my curriculum connecting math graphs, ASL, and English, I found four key learning theories that serve as the foundation for this curriculum: cooperative learning, multiple intelligences, BICS/CALP, and authentic instruction. Collectively, these theories address the need for curriculum to be cognitively and linguistically accessible to students and provide different avenues to learn through experience-based instruction. In the next few pages, I explain these theories and how my curriculum makes use of each.

The first learning practice on which my curriculum is based is *cooperative learning* (Cohen, 1986). "Cooperative learning may be defined as an instructional organization strategy in which students work collaboratively in small groups to achieve academic and social learning goals" (Peregoy & Boyle, 2005, p. 89). Under this method of learning, students work together in heterogeneous groups, which are either randomly assigned or are balanced for personality type, gender, ethnicity, language proficiency, and academic achievement. In cooperative learning tasks, students get both an individual and group grade for their work on a collective project. This means they must complete their work and encourage others to finish their work as well. Students are thus accountable for their own learning as well as for group learning.

The cooperative learning method allows students to use their strengths while working in a group setting and allows them to strengthen their weaknesses by giving them a safe environment to practice their weaker skills. My curriculum helps students build communication and social skills as well as academic skills by having students

work in small groups to create a questionnaire, and to interview and survey a small group of other students, and discuss their data with group members as well as with the whole class. The lessons in the units teach students the social and interpersonal skills that they will need to work in groups for the curriculum, later in the workforce, and generally throughout their lives.

The second learning theory that I base my curriculum on is Howard Gardner's *Theory of Multiple Intelligences* (1983). This theory suggests that students learn, remember, perform, and understand in different ways called their "intelligences". Some students have high visual-spatial intelligence, some bodily-kinesthetic, musical, or intrapersonal. Some students have linguistic or word intelligence and some are logically or mathematically intelligent. Gardner states that teachers traditionally rely on high or low I.Q. scores to tell us if our students are intelligent. These tests generally are linguistic and/or logical-mathematical in type and some students do not perform well on such tests (Armstrong, 2000). Gardner suggests that we should teach our students using different intelligence strategies and allow them to do well with the intelligences with which they can succeed. My curriculum encompasses activities that are based on different intelligences such as linguistic (discussing the questionnaire and graphs in groups), logical-mathematical (how to put the data into a graph, analyzing and interpreting the data), spatial (drawing/ representing the data in a graph), and interpersonal (interviewing other students, communicating with peers and teachers). In addition, students are free to use other intelligences in designing their presentations to the class.

My curriculum is also based on James Cummins' theory of *Basic Interpersonal Communication Skills (BICS)* and *Cognitive Academic Language Proficiency (CALP).* He theorizes that language has two "faces": contextualized and decontextualized. The contextualized language is what Cummins' refers to as *BICS*, and he refers to the decontextualized language as *CALP* (1996). Pauline Gibbons (1991) uses the terms "playground language" and "classroom language" to describe the same two faces of language. Students learn and are able to socially interact on the playground due to their BICS but they learn about math, science, English, art, history, how to hypothesize, analyze, infer, predict, etc. through the language of the classroom or CALP. These two language types are very different, in that, the BICS is less cognitively demanding and is full of contextual and linguistic cues and CALP is more cognitively demanding and less contextualized.

In my curriculum, students will use BICS to communicate with each other and discuss graphs and their surveys in small cooperative groups. They will also use BICS when interviewing other students and communicating with teachers. Students will use CALP when discussing different types of graphs (pie graphs, Venn diagrams, line graphs, bar graphs, etc.), analyzing their data and interpreting the results, and during their ASL presentations of the data to the class. Also students will use their CALP to write an English summary of their data and findings. I will explicitly teach the *CALP* that is needed to talk about graphs mathematically in both American Sign Language and English during the curriculum units.

The fourth and final learning practice that I used for my curriculum is Fred Newmann's idea of *Authentic Instruction*. This is instruction where activities and

teaching yield students who "(1) construct meaning and produce knowledge, (2) use disciplined inquiry to construct meaning, and (3) aim their work toward production of discourse, products, and performances that have value or meaning beyond success in school" (Newmann & Wehlage, 1993). Newmann & Wehlage established five standards that make instruction truly authentic. My curriculum will encompass those five standards: 1) Students will use **higher-order thinking** to construct a survey and use it to collect data, analyze and interpret the results, decide on an appropriate graph for the data, and present it to the class. 2) They will demonstrate **depth of knowledge** through their discussions of different types of graphs and the results of their interviews and data collection. 3) They will show they have made **connections to the world beyond the classroom** by learning about and searching for graphs in magazines, newspapers, other school textbooks and literature, and through the projects that they complete. 4) Students will be required to have **substantive conversation** about graphs, their data, and their results throughout the entire process in their small groups, and they will converse with teachers and other students during the interviews. 5) Lastly, the classroom and curriculum setup will provide **social support for student achievement** through the cooperative learning groups and teacher-scaffolded lessons.

The four theories discussed here together provide a strong foundation for my curriculum. Students will be challenged to do an authentic activity while working in cooperative learning groups. They will work on communication and interpersonal skills in their groups as well as learn new language to talk about graphs in an academic manner. The students will be challenged to use their different intelligences and talents through this curriculum, and they will feel motivated by student-centered activities,

rather than traditional teacher-centered tasks. At the end of the curriculum students will have gained skills needed to work in groups, improved critical thinking skills, and gained confidence in their work. They will also gain a wealth of knowledge about mathematical graphs.

VI. Curriculum Description

The curriculum in this thesis teaches students graphing, critical thinking, analysis, and interpreting skills that can transfer to all academic disciplines. It contains three units with several lessons in each unit. The lessons engage students with graphing activities that are challenging, exciting, and fun. Each lesson includes: the standard, goal, and objective on which the lesson is based; materials for the teacher and students; introduction, process, and conclusion for the student activity; and assessment where needed.

The first unit assesses students' prior knowledge about graphs using a KWL chart (what students **K**now about graphs, what they **W**ant to know about graphs, and what they **L**earned about graphs through the lessons). Students learn the names and distinguishing features of the various types of graphs and create their own graphs through student-centered activities. Teachers will also show students how to analyze graphs using specific vocabulary. Lastly, students learn about graphs in the real world by searching newspapers, magazines, and textbooks for graphs and then sort them into different types by name.

The second unit gives students more opportunities to analyze the graphs they learned about in unit one. Students will fill in blank graphs with a given set of data and analyze them in a group with their peers or with a partner. They will answer questions about graphs without a title such as "What could this graph be about?", "What could it not be about?", "How do you know?", "What do you think the data shows?", etc. This unit will really enhance their understanding of graphs and how to analyze them so students will be ready to create their own graphs for the final unit.

The third unit focuses on using surveys and collecting data. As a small group students will survey the class and collect data from their peers. They will learn to work in small groups to analyze and interpret the data from the survey, and they will graph the data onto a poster board. The unit concludes with group presentations to the class.

VII. Math Graphing Curriculum

Unit 1

Unit 1	Title of the Lesson
Lesson 1	Introducing Graphs
Lesson 2	Raisin Counting and Line Plots
Lesson 3	Time & Bar Graphs
Lesson 4	Animals & Venn Diagrams
Lesson 5	Parents & Circle Graphs
Lesson 6	Graphs in the Real World

Unit 2

Unit 2	Title of the Lesson
Lesson 1	Mystery Graphs Part I
Lesson 2	Mystery Graphs Part II
Lesson 3	Chrysanthemum Activity
Lesson 4	Methods of Collecting Data
Lesson 5	Brainstorming Questions

Unit 3

Unit 3	Title of the Lesson
Lesson 1	Making a Plan
Lesson 2	Today's the Day: Collecting Data
Lesson 3	Workshop: Graphing Data
Lesson 4	Reviewing Data/Preparing to Present
Lesson 5	Presentation Day!

Unit 1 | Introducing Graphs | Lesson 1

Goal: The goal of this lesson is for students to experience different types of graphs.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students will participate in a K-W-L activity about graphs and answer teacher-generated questions.

Materials:

- K-W-L chart paper
- Colored markers
- Blank chart paper (2)
- Shoe pictograph handout
- Student math journals

Procedure:

Getting Started:

1. Post the blank chart paper on the board and tell the students that we will be making a K-W-L chart about graphs and write the word "Graph" on the top.

2. Tell them the "K" stands for what we **K**now about graphs and ask students if they have seen graphs before and what they know about graphs. (ie: graphs have different shapes, they display information, they have points or lines on them, they are circle-shaped, I use them in math class, etc.)

3. Record student answers in the "K" column.

4. Say, "Wow you guys know a lot about graphs! What do you **W**ant to know about graphs?".

5. Record what they want to know in the "W" column of the K-W-L chart. (ie: When/why do we use graphs?, Can graphs have color on them?, How many kinds of graphs are there?, etc)

6. Tell students that we will now learn about one of the many types of graphs.

Steps:

1. Tell the students they have 30 seconds to turn and tell a partner their favorite animal. Post two sheets of blank chart paper on the board while

students do this.

2. Regain students' attention and ask for volunteers to share in ASL their favorite animal. List all of the animals in English on the blank chart paper and draw a small picture of a paw print next to the word. Repeat this until all of the students have responded.

3. Next, write down the English names of the first five animals on the pictograph chart paper to the left of the vertical line. Ask students to raise their hand if this animal is also their favorite and draw a paw print to the right of the line next to the name for each student who raises his/her hand. Tell students that one paw print equals one student. This is the 'key' of the graph that tells you how to read it.

4. Continue this process until all of the students have answered and the graph is filled. Teachers can also add their favorite animal for more data as well as data from another class if you have a low number of students.

5. Say, "I notice that this graph uses pictures and words instead of numbers. That's because it is called a 'Pictograph'." Write *Pictograph* on the top of the graph. Also say, "We need to give this graph a name. What should I name this graph based on the data we collected?" (ie: pictures of animals). Give students 30 seconds to turn and tell a partner their idea for a graph name.

6. Regain students' attention and ask for some ideas. (ie: Favorite Animals Graph, Our Favorite Animals, etc). Pick one together to use and write it at the top of the graph. Tell students this is called the 'title' of the graph.

7. Model to students what you notice about the graph (ie: a lot of people like horses, only one person likes a dog, ½ the class likes either a dog or cat, etc). Ask students what they notice about the graph and discuss their answers.

8. Pass out blank shoe pictographs to students. Tell them this is another pictograph and that we will collect the data together and they will fill it in themselves.

9. Ask students to talk to a partner about the shoe pictograph (ie: what words do you see on the page?, what's this graph about?). Have student volunteers share out to the class. Review the graph together including what each type of shoe is.

10. Explain to the students that you will say a shoe type (flip flops) and ask who is wearing that kind of shoe. Students will raise their hands and you will put

the number on the board. You will continue with each shoe type until all of the shoe types have been covered or all of the students have answered.

11. Once all of the data has been collected tell students they can create their own key to fill in the graph with the pictures of those items. Allow students to complete the graphs themselves.

Conclusion:

Instruct students to write one sentence on the bottom of their graphs about what they noticed about the graph (ie: how many people are wearing tennis shoes compared to flip flops, etc). Have students share with a partner what they notice about the graph and then have volunteers share with the whole class.

Pass out a math journal to each student and have him or her write down the important information they learned about the Pictograph (including what it looks like, a sketch of a pictograph, written details, etc). Collect the journals.

Assessment:

Formal Assessment:

Teachers can gauge student understanding with the Shoe Pictograph that students complete.

Informal Assessment:

Teachers can gauge student understanding throughout the lesson through teacher questions and responses.

Extensions/Adjustments:

Students can use the data from our graph to represent it in another way (ie: using interlocking cubes, pencil and paper, another kind of graph, small stuffed animals or markers for each animal, etc). Students can then draw the new representation on a piece of paper and present it to their peers/whole class.

"KWL Chart"

Know	Want to know	Learned

Name: _____ Date: _____

Shoe Pictograph
Handout

Instructions: Create a key and use the symbols to fill out this graph.
Use the data from class discussion.

Key
 = ___ shoe(s)

tennis shoes
flip flops
sandals
dress shoes
high heels

What do you notice about the pictograph?

The graph has _____

_____.

More people are wearing _____ than _____.

Unit 1 | Raisin Counting & Line Plot Graphs | Lesson 2

Goal: The goal of this lesson is for students to experience different types of graphs.

Standard:

- Record the possible outcomes for a simple event and systematically keep track of the outcomes when the event is repeated many times. *AND* Summarize and display the results of probability experiments in a clear and organized way. (*CA-Math Standard Grade 3- Statistics, Data Analysis, and Probability 1.2 & 1.3*)

Objective:

Students will participate in a group activity, write three things they notice about a set of data, and draw a representation of the data.

Materials:

- Blank chart paper
- Document camera (if available)
- Paper
- Pencils
- Student math journals
- Box of raisins for each student
- Napkin for each student

Procedure:

Getting Started:

1. Give each student a box of raisins but tell them to keep them closed. Tell students that these are raisins (fingerspell it and write it on the board) and ask them if they have eaten raisins before.

2. Ask students if they know how many raisins are in each box. Allow students to guess and give suggestions to how many are in their box.

3. Have students open their boxes of raisins and ask if anyone wants to change their number based on how many raisins are in the top layer of the box. Allow students to explain their answers as to why they changed their number or kept it the same (I realized there are only five raisins on the top row so there cannot be 100 raisins in this box, etc).

Steps:

1. Pass out a napkin to students and tell them to count the number of raisins in their box. When they are finished counting, have them tell the number of raisins to you as you write the numbers up on the board or on chart paper in a list. Tell students this is called a 'data set' in English (write this on the

board). In ASL we sign it this way (fingerspell 'data' then sign GROUP).

2. Ask students to draw a representation of the data themselves and have them write down three things they notice about the data (most people had 90 raisins in their box, not many people had under 80 raisins, etc).

3. Have students share in pairs what they drew and what they wrote down about the data. Ask for volunteers to share what they drew to the whole class using a document camera or by holding it up. Tell students that there are many ways to represent data sets.

4. Post a blank sheet of chart paper on the board. Tell students that mathematicians use a special type of graph to show this data called a *Line Plot*. Fingerspell 'Line Plot', sign it in ASL and then tell students that in English it is written this way (write it on the board).

5. Draw a line plot of the data. Tell students that we put a number line on the bottom (could be from 95 to 115 or whatever range of raisins you have) and put an 'x' above the number for each data point in our set. Finish the graph.

6. Ask students what the 'range' of the graph is (the highest number of raisins minus the lowest number of raisins equals the range). Ask students what the mode of the graph is (the number on the line plot with the most x's). Discuss the range and mode with students.

7. Ask students what they think will happen if we open five more boxes of raisins. (There will be 115 raisins in each, There will be about 90 raisins in each box, etc). Guide students if they are having trouble. You can say: Do you think the boxes will have five raisins in them or 100 raisins? Why or why not?

Conclusion:

Ask students what else we can say about the data? (Half the class had 100 raisins in their box or more, or half the class had 95 raisins or less in their box.) Ask students "So about how many raisins are in a box?"

Have students write down important facts about line plots in their math journals. Allow students to eat the raisins.

Assessment:

Formal Assessment:

Teachers can collect student representations of the data and their three sentences as a formal assessment.

Informal Assessment:

Teachers can gauge student understanding during the part of the lesson where students give opinions or make estimates.

Extensions/Adjustments:

Teachers can use sentence frames for student responses to what they notice about the graphs. For example:

I notice my graph looks like _____.
My graph is _____ and _____.
Our data is _____.

Teachers can also use the empty boxes from students to post on the graph instead of using an 'x' for each data point. This will be visually pleasing to the students.

Name: _____ Date: _____

Line Plot Handout
Counting Raisins

Directions: Count the raisins in your box. Fill in the chart and make a line plot of the data. Then answer the questions below.

Group Data

Student Name	# of Raisins in their Box

I notice my graph looks like _____.

Most boxes have _____ raisins.

Unit 1 | Time & Bar Graphs | Lesson 3

Goal: The goal of this lesson is for students to experience different types of graphs.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students will create their own bar graph using data from the class and write three things they notice about the graph.

Materials:

- Blank chart paper
- Graph example
- Markers
- Pencils
- Blank graph paper
- Student math journals

Procedure:

Getting Started:

1. Say: "During the week do you guys have to wake up early for school? What time do you have to wake up? (Why do you need to wake up so early? (If we do not wake up, we might miss breakfast and be hungry all day. We can't go to school if we don't wake up.) Ask students: "What about on the weekend? Do you have to wake up early or can you sleep in late?"

Steps:

1. Ask students what time they wake up on the weekends. Have students give answers (8am, 9am, etc). Write the answers on the board. Tell students what time you tend to wake up on the weekend (make this drastically different from their wake up times).

2. Tell the students that we will learn about a new graph today called a 'Bar Graph'. Fingerspell and sign this and then say in English it is written this way (write Bar Graph on the board). Post a piece of chart paper on the board.

3. Write "Weekend Wake up Times" on the top of the chart paper and tell students that this is the 'Title' of our graph. On the left side of the paper draw a vertical line, dashes on the line at even intervals, and the numbers 0-10 on the line. Tell students that this is our 'scale'. Draw a horizontal

line at the bottom of the vertical line connecting them together.

4. Write these time ranges on the bottom of the graph: 7-7:30am, 7:30-8am, 8-8:30am, 8:30-9am, 9-9:30am, 9:30-10am. Make sure to include all of the times the students say.

5. Tell students that we need to label this graph so that we know what it shows. Tell students that the bottom represents "Wake up Time" because and the side represents the number of students who wake up at each time listed on the bottom. Label the side "Number of Students".

6. Tell students that the labels are very important because they tell us about the graph. If someone in 6^{th} grade came into the class after we did this activity, he could pick up the graph and understand it because we added the labels.

7. Fill in the data by taking the first data point and coloring in the bar one square. Mark off that point from the data so the students know and you know you have already added that point. Continue until all of the data points have been filled in. Talk about what you are doing while you do this so that the students see your thought process.

8. Ask students what they notice about this graph. (What does it look like?, etc) Have students talk with partners about the graphs and what they notice. Then have students share with the whole class.

9. Next pass out a blank piece of graph paper. Tell students we will make another bar graph with some more data from our class.

10. Ask students to tell you different hair colors. Write down the different hair colors that students sign. Stress that each sign also has a name in English and write the names down. Show the sign after and fingerspell the word. Next ask, "How many people have blond hair in the class?" and put the number next to the word 'blond'. Continue with each hair color until you have finished them all.

11. Next instruct the students to create a bar graph with the data. Show them how to make the graph if they need help. Ask students what we should put on the vertical line of the graph (numbers from 1-10 and the label 'Number of Students'). Ask students what we should put on the horizontal line (blond, black, brown, red, etc and the label 'Student Hair Colors'). Also ask students an appropriate title for the graph.

12. Allow students to work alone or in pairs to complete the graph by using the data on the board to fill in the squares. Have students down three things

they notice about their graph on the back of the paper.

Conclusion:

Have students share one thing they wrote down about the graph with the class. Collect the student work and ask students what we need to remember to put on a bar graph (including names, labels, numbers, title, etc). Have them write this information down in their math journals for reference later.

Assessment:

Formal Assessment:

Teachers can gauge student understanding by looking at the student work samples from today's lesson.

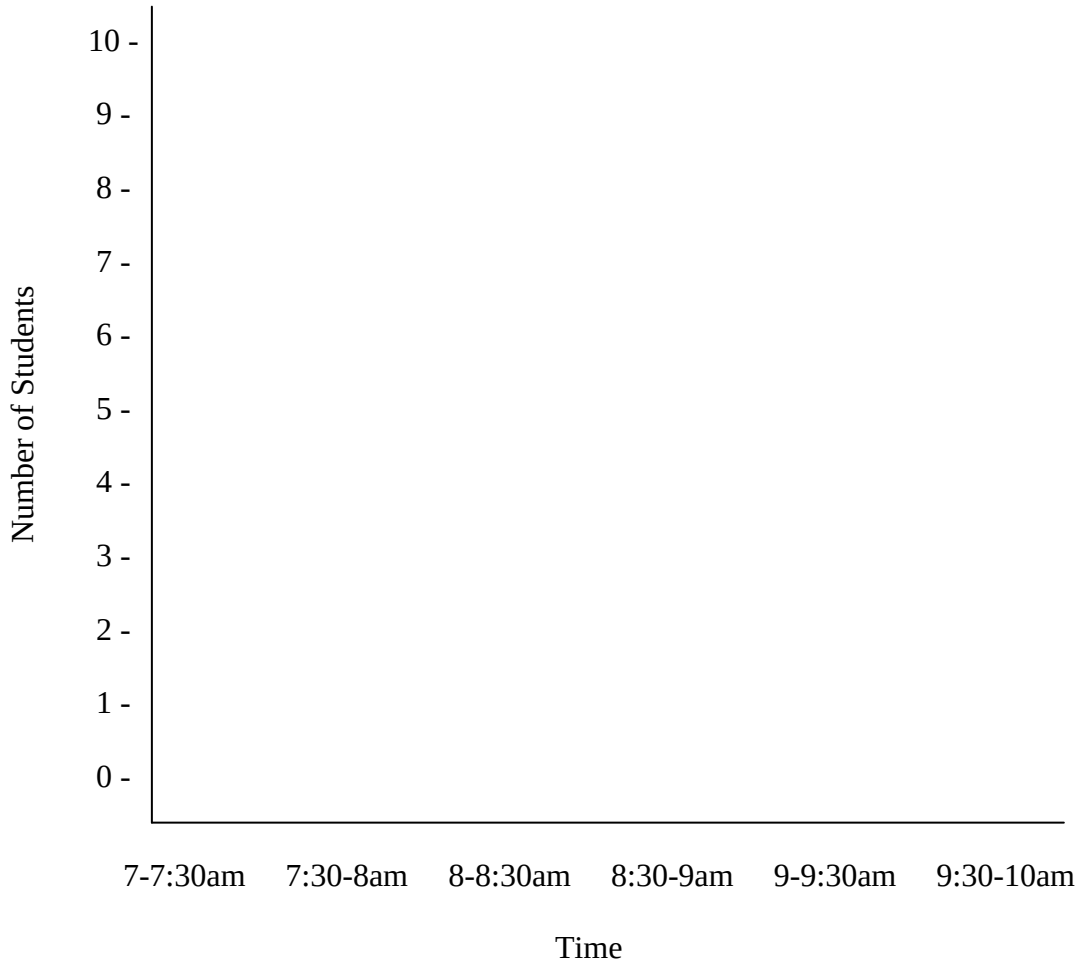
Informal Assessment:

Teachers can gauge student understanding throughout the lesson through student responses to teacher questioning.

Extensions/Adjustments:

Students can create their own bar graphs for a data set or the teacher can make the graphs more difficult by adding double bar graphs if students have already mastered the basic bar graph. Teachers can also introduce histograms as an extension, which are another type of bar graph using historical information such as year, month, date data.

Bar Graph Example
"Weekend Wakeup Times"



1. What do you notice about this bar graph? _____

_____

2. MOST people wake up at _____ am in the morning.

Unit 1 | Animals & Venn Diagrams | Lesson 4

Goal: The goal of this lesson is for students to experience different types of graphs.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students will create their own Venn Diagrams using the class activity as a guide.

Materials:

- Blank chart paper (2)
- White board
- Markers
- Pencils
- Venn Diagram handout
- Student math journals

Procedure:

Getting Started:

1. Tell the students they will play a game called "Guess My Rule". Explain that you will bring students to the front of the class based on something that is similar about them. The students then need to guess what rule they all follow.

2. Start by bringing all of the female students to the front of the classroom. Ask what do all of these students have in common? (They are all girls/females.) Have them sit down at their seats. Then bring up all of the male students and do the same.

3. Next bring up all of the students with one color hair, eyes, or T-shirt color. Ask the students what all of the students have in common?

4. Once students understand the game tell them we will use this game to learn about a new type of graph called a *Venn Diagram*.

Steps:

1. Tell the students in ASL that we will brainstorm as many animals that we can think of that live in the forest. Sign forest and fingerspell it. On the top of the chart paper write "Animals that Live in the Forrest" and draw a large circle underneath the title (big enough to write in about five different animal names).

2. Ask the students which animals live in the forest (deer, bear, squirrel, raccoon, turkey, snake, etc) and write the animal names inside the circle. Repeat what the student signed and fingerspell the name and point to the word in the circle to reinforce the English word and the ASL sign. Continue until you have five animals.

3. Draw another circle (not connected to the first one) on a second piece of chart paper. Tell the students in ASL that we will now think of animals that can hop. Sign the word JUMP and fingerspell hop. Write "Animals that Hop" underneath the circle.

4. Ask students which animals hop rather than walk (frog, rabbit, kangaroo, grasshopper, deer, etc). Write the animal names inside the circle and repeat what the student signed, fingerspell the name, and point to the word in the circle.

5. Next compare both of the lists and ask students if some of the animals fit into both categories. Tell students that you could write them into both categories but mathematicians have a way to represent that an animal belongs to both categories.

6. Draw two interlocking circles on the board. Label both of the circles again. Ask which animal in our two lists fits into both categories (such as deer). Write 'deer' in the center of the interlocking circles.

7. Ask the students which animal only fits into one category (bear, squirrel, etc) and write the name in the category where it belongs. Ask students where should I put the turkey? Have students tell you where they would put it and why. Write turkey in the category for "Lives in the Forest".

8. Ask students to turn to a partner and tell them where they would put the frog and kangaroo (animals that hop). Have student volunteers give answers for where they would write the animal names and why.

9. Ask students what they would do with an animal like a whale and where they should put that. Have students discuss with a partner where they would put a whale on the diagram. Ask students if the whale lives in the forest (no) and if I should write whale in the "Animals that Live in the Forest" circle. Ask students if the whale can hop (no). Ask where you should write the whale. Show students that because the whale does not fit into either category, you would write 'whale' on the outside of the circles.

10. Fill in the rest of the diagram using the animals listed on the two separate charts. Ask students to think of some animals that would fit in both categories, some more that only fit in one category, and some that don't fit

either category. Ask students to tell you something they notice about the graph.

11. Hand out the Venn Diagram handout to the students. Tell them now it is their turn to show me how much they learned about Venn Diagrams. Explain that they will work on their own or with a partner to fill out the handout with new information. Tell students that this graph is for "Animals that Live in the Ocean" and "Mammals".

12. Ask students what they could write down for animals that live in the ocean (turtle, whale, shark, dolphin, fish, starfish, sea horse, etc). Take some examples. Ask students what they could write down for animals that are mammals (human, otter, whale, dolphins, etc). Take some examples. Ask students what could be put in the center of the Venn Diagram- what is an animal that lives in the ocean and is a mammal? (whale, shark, dolphin)

13. Give students time to work on the Venn Diagram and have them fill in 5 responses to each category if possible. Students can also put animals outside of the circles if they do not fit in the categories. Ask for student volunteers to share what they wrote down and why.

Conclusion:

Pass out the student math journals. Have students write down three things about Venn Diagrams in their notebooks and draw a picture of a Venn Diagram from class (either the first or second one they did today). Have students share one thing they wrote down about the graph with the class and review what goes on a Venn Diagram (if needed). Collect the student work and math journals when students are finished.

Assessment:

Formal Assessment:

Teachers can gauge student understanding by assessing students' individual Venn Diagrams.

Informal Assessment:

Teachers can gauge student understanding through the discussion about Venn Diagrams.

Extensions/Adjustments:

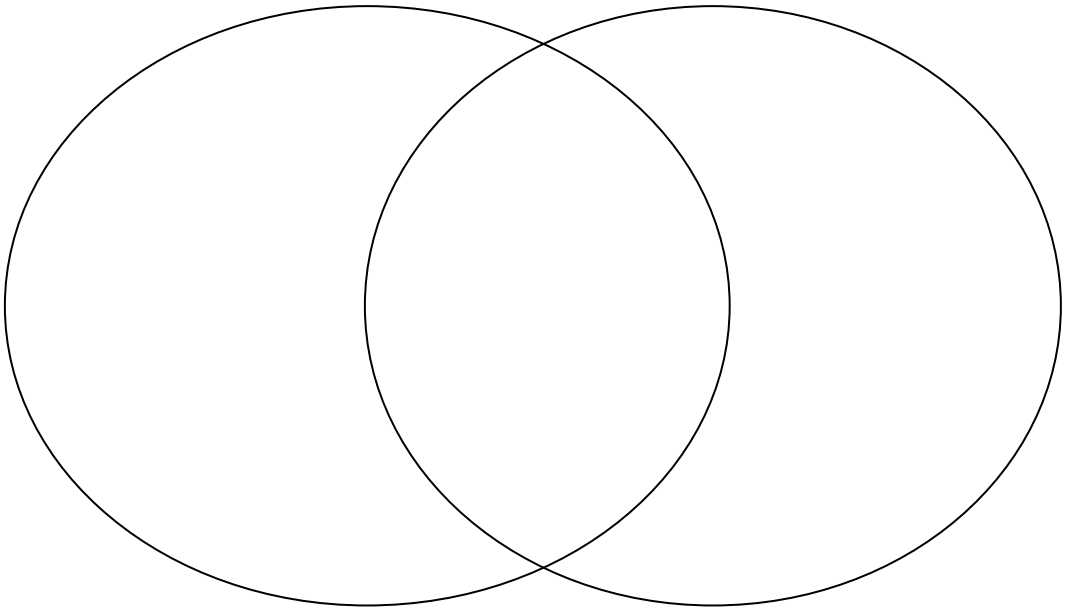
Students can create their own Venn Diagrams using categories that they come up with themselves. Teacher can introduce three-way Venn Diagrams as well. Students can ask their partner ten questions about him/herself and then create a Venn Diagram about similarities and differences between the two students.

Name: _____ Date: _____

Instructions: List 5 animals that live in the ocean and 5 animals that are mammals.
Then create a Venn Diagram.
Circle the animals that can go in the center of the Venn Diagram.
(Hint: they need to live in the ocean AND be a mammal.)

Animals that Live in the Ocean	Mammals
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Animals that Live in the Ocean Mammals



Unit 1	Parents & Circle Graphs	Lesson 5

Goal: The goal of this lesson is for students to experience different types of graphs.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students will participate in a group activity about circle graphs.

Materials:

- Blank chart paper/board
- Marker/chalk
- Pencils
- Circle graph handout
- Student math journals

Procedure:

Getting Started:

1. Start by telling students that you love ice cream and ask them if they like ice cream too. Ask students their favorite ice cream flavor. Write Favorite Ice Cream Flavors" on the board and sign it as well emphasizing each word.

2. Write student flavor responses on the board and next to each flavor write the number of students who prefer that flavor (chocolate-2, vanilla-4, etc).

3. Next say that we can represent this information on a graph that is easy to see called a "Circle Graph". Write this on the board.

Steps:

1. Draw a large circle on the board with your marker or chalk. Ask students how many total students are in the class and write down "Total" with the number on the board.

2. Next say two out of 10 students like chocolate ice cream. Can anyone tell me what fraction that is? (Two divided by ten is 1/5).

3. Continue through each flavor until they all have a fractional value.

4. Next draw in the pieces of the circle. Ask students how big the pieces should be. Draw something obviously wrong (1/2) for 1/5 and ask if you

should make it smaller or bigger for 1/5. Allow students to offer and explain their answers. Ask the other students if they agree or disagree.

5. Draw in the entire circle graph with student help. Draw in the key at the bottom and shade in each piece a different color to represent the information.

6. Give the graph a name like "Our Favorite Ice Cream Flavors".

7. Ask students to share one thing they notice about the data (1/5 of the class likes chocolate and ½ likes vanilla, more than half of the class likes strawberry, etc).

8. Next pass out an activity for the students to do individually or in pairs. Have students work on the assessment.

Conclusion:

Have students share one thing they wrote down about the graph with the class. Collect the student work and ask students what we need to remember to put on a circle graph (including names, labels, numbers, title, etc). Have them write this information down in their math journals for reference.

Assessment:

Formal Assessment:

Teachers can gauge student understanding of the circle graph by their individual worksheet that teachers will collect.

Informal Assessment:

Teachers can gauge student understanding of the circle graph by student responses during the group discussions.

Extensions/Adjustments:

Students can first do the circle graphs with fractions and then teachers can ask what the decimal amounts would be so students can make the visual and fractional connections to decimal amounts. Students can create their own circle graph using student data or students can create a bar graph representation from the circle graph data to make connections to different kinds of graphs.

Unit 1 | Graphs in the Real World | Lesson 6

Goal: The goal of this lesson is to improve students' understanding of the use of graphs in real world situations.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students will look for graphs in student newspapers, magazines, books, and textbooks and categorize the different kinds of graphs by the their appearance and the data they convey.

Materials:

- ZooNoos Magazines
- Student newspapers
- Student textbooks
- Student workbooks
- Student friendly books
- Paper
- Markers
- Pencils
- White board/ chalk board
- Student math journals

Procedure:

Getting Started:

1. Ask students some names of graphs we have been talking about. Have students sign the names, fingerspell them, and have them write the names up on the board for all everyone to see. Ask students some things they remember about each graph (ie: what it looks like, the information on it, etc)

Steps:

1. Tell students that graphs are everywhere and that we will look in magazines, textbooks, newspapers, and in books for some of the graphs we have been learning about.

2. Tell students their job is to find as many of the graphs we have been learning about with their table partners. We will have 15 minutes to look for the graphs in the resources and then we'll do another fun project with them. Tell students to make a quick sketch of the graphs they see in the textbooks and books (we don't want them to tear out the pages).

3. Regain students' attention and ask for volunteers to show some of the graphs they found. Ask students to tell us what type of graph they found (ie: line plot, circle graph, pictograph, bar graph, Venn diagram, etc) and which

name on the board it would go under. Ask why it fits where they put it and not under another name (ie: it has a line and numbers, it is circular, it has pictures, it has bars with the information, or there are two interlocking circles with information in each circle, etc).

4. Repeat this process until students seem to understand how to categorize their pictures. Then have each table talk about where to put their graphs before taping their own graphs to the board. Everyone must agree before they can post the graphs.

5. Discuss the posted graphs in pairs first. Ask students to think about these questions: Are all of the graphs in the correct place? Why or why not? Would you move any of the graphs? Where would you move them to and why? Have students regroup and ask for volunteers to discuss with the entire class about the posted graphs and make changes where necessary.

Conclusion:

Ask students to talk with a partner about their favorite kind of graph and tell the names of the graphs again. Ask students why we see graphs in books, newspapers, magazines, etc and ask if they think it is important to learn about graphs.

Have students write down important facts about why we use graphs and where we can find graphs in their math journals.

Assessment:

Formal Assessment:

Teachers can gauge student understanding of different graphs by the charts that students make and post on the board collectively.

Informal Assessment:

Teachers can gauge individual student understanding by observing students when they decide on graphs and during the discussion about where the graphs fit on the board and why.

Extensions/Adjustments:

Students can draw their own graphs that they remember from math class in addition to looking through magazines for them. The teacher can guide younger students through this process by modeling it first for them. The teacher can use a set of magazines for the whole class and can guide students through page by page to find graphs. The class can discuss graphs as they go through (Find a picture and ask: Is this a graph? What does a graph usually look like? etc).

Unit 2 | Mystery Graphs Part I | Lesson 1

Goal: The goal of this lesson is to develop skills needed to create and analyze mathematical graphs from a data set AND to develop the academic language necessary to discuss graphs in ASL and written/spoken English using higher level thinking skills.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students will look at graphs without the labels or title and discuss title and label options with the class.

Materials:

- SMART board or overhead projector
- Mystery Graph 1
- Mystery Graph #1 Handout
- Graph Paper
- Scissors
- Tape
- Chalkboard/whiteboard
- Mystery Graph #2 Handout

Procedure:

Getting Started:

1. Start by asking students if they remember the graphs we worked on in the past unit. Allow students to give answers of names or what the graphs looked like.

2. Show students the Mystery Graph 1 using a smart board or overhead projector. Cover the name and the labels.

3. Ask students what kind of graph it is (vertical bar graph) and ask what they notice about the graph (it has month names on the bottom and numbers by 2's on the scale from 0 to 14).

4. Ask students what they think the graph is about (number of days of sunshine in those months, number of rainfall in inches, etc).

5. Ask students what the graph cannot be about (about animals, about the months that are not listed on the graph, about the days of the week, etc) and

why they think that. Tell students they must explain their reasoning.

6. Show students the graph labels one by one starting with the months and then the number of inches. Continue to ask students what they think the graph is about as you reveal each label and ask them if they want to change any of their answers/predictions as you do this. Lastly, reveal the name of the graph.

Steps:

1. Next have students transfer the graph onto some graph paper. Have each student write the names of the months on the back of the bars and cut them out. Collect the "March" bars from all of the students and connect them all together using tape. Continue doing this until you have all of the months collected and taped together.

2. Mark the backside of the bars so you know when March starts and ends and when April, May, and June start and end. Tape all of the bars into one large circle. Put the circle against the white board or chalkboard. Mark where each month starts and ends on the board. Connect the marks making a large circle. Then draw the lines of the pie to make the circle graph. Label all of the pieces for each month.

3. Show students visually that the pieces equal the bar graph. Ask students to convert the numbers on the graph into a fraction by looking at the pieces or by using the numbers on the original bar graph handout. Review the circle graph with the students.

4. Next, tell students we have another mystery graph to work on. Have students work in pairs or individually on the Mystery Graph #2 Handout for the line plot.

5. Collect the handout and review the answers together out loud.

Conclusion:

Close by asking students which graphing activity was their favorite. Have students share one thing they learned from today's activities.

Assessment:

Formal Assessment:

Teachers can gauge student understanding by collecting the worksheets and graphs from students and checking their accuracy.

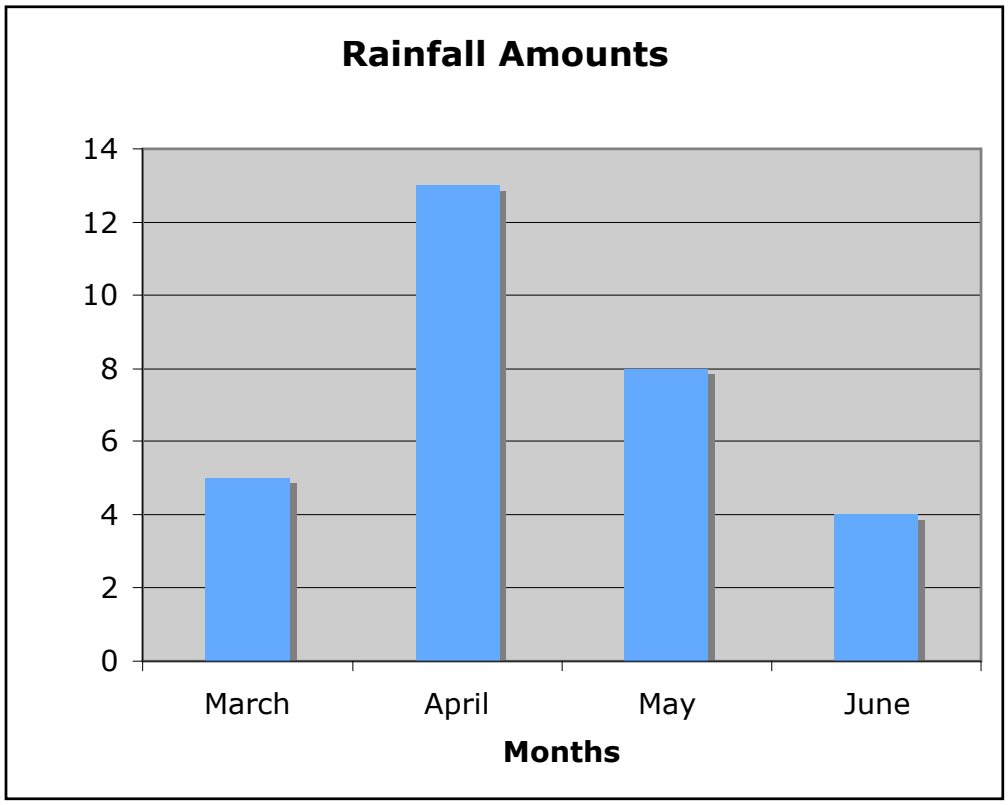
Informal Assessment:

Teachers can gauge student understanding throughout the lessons through teacher generated group discussions.

Extensions/Adjustments:

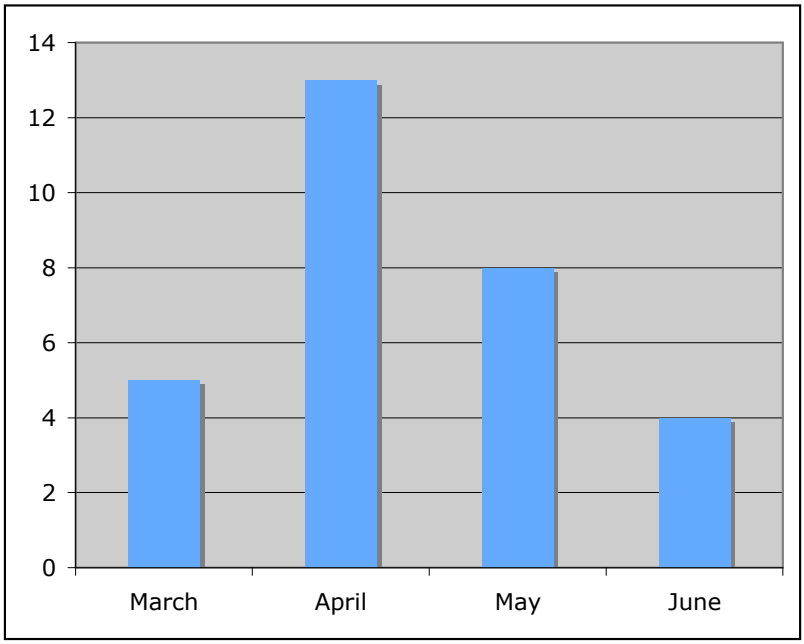
Students can make their own graphs using data they created themselves if they want a little challenge. Students can also create a graph and come up with some questions for interpretation to ask another student. Make sure to check student work throughout the entire process.

Mystery Graph #1



Name: _____

Mystery Graph #1
Handout



Questions for Researchers:

1. What could this graph be about? _____

_____

2. What do you think the numbers on the left side represent?
   (How are they related to the month?)

_____

3. What could be a good title for this graph? _____

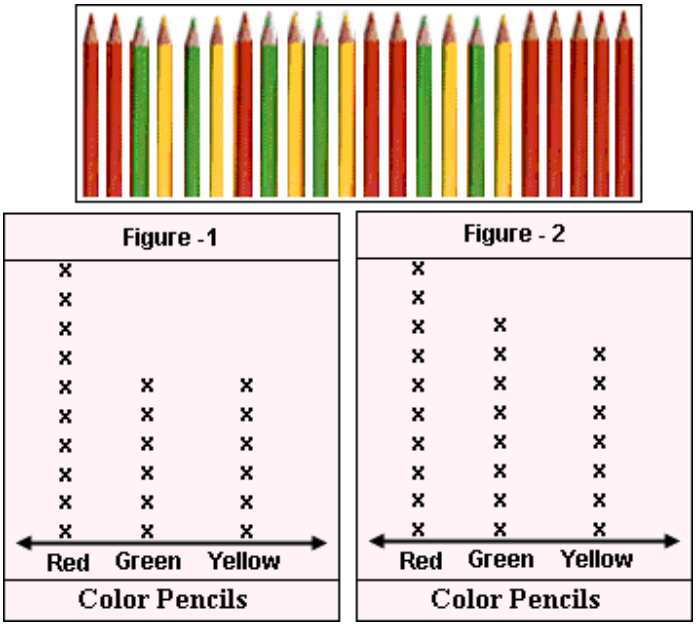
_____

4. What is this graph NOT about? _____

_____

Name: _____

Mystery Graph #2
Handout



Photo*

Questions for Researchers:

1. What kind of graph is this?

_____

2. Which graph is correct for the number of red, green, and yellow pencils in the picture above? Why?

_____

_____

3. Can you make this graph into a bar graph? Draw a bar graph of this information on the back of this paper.

4. Write one thing you notice about the graph.

_____

_____

Unit 2 | Mystery Graphs Part II | Lesson 2

Goal: The goal of this lesson is to develop skills needed to create and analyze mathematical graphs from a data set AND to develop the academic language necessary to discuss graphs in ASL and written/spoken English using higher level thinking skills.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students will look at graphs without the labels or title and discuss title and label options with the class.

Materials:

- SMART Board or overhead projector
- Chalkboard/whiteboard
- Venn Diagram
- Blank sheets of paper
- Pencils
- Pictograph Handout and Checklist

Procedure:

Getting Started:

1. Start by asking students if they remember the graphs we worked on in the past unit. Allow students to give answers of names or what the graphs looked like.

Steps:

1. Put out the Venn Diagram and show the students your response using a SMART Board or overhead. Say I have a cat at home and I have a dog at home so I will place my 'x' in the "both" part of the circles.

2. Review where to put an 'x' if you have two cats and no dogs or if you don't have either a cat or a dog.

3. Call the students by table group to come up and record their responses. Ask students to interpret the graph using vocabulary they have learned (most, ½ the class, more than, less than, etc). Review the signs and English words for the vocabulary.

4. Have them write down three things about the Venn Diagram on a piece of paper. Have students tell a partner one thing they notice and ask for volunteers to share what they notice about the Venn Diagram. Collect the papers as an assessment of their understanding.

5. Next hand out the "Pictograph" data and checklist. Students can work individually or in partners. Explain to the students that we have a set of data and we want to make a visual representation with a pictograph. Ask for any questions. Tell students that they will post their work later and get to see others' work as well so they should do a good job.

Conclusion:

Close by asking students which graphing activity was their favorite. Post student work on the wall and students can do a gallery walk through to see each other's work.

Assessment:

Formal Assessment:

Teachers can gauge student understanding by collecting the worksheets, graphs, and checklists from students and checking their accuracy.

Informal Assessment:

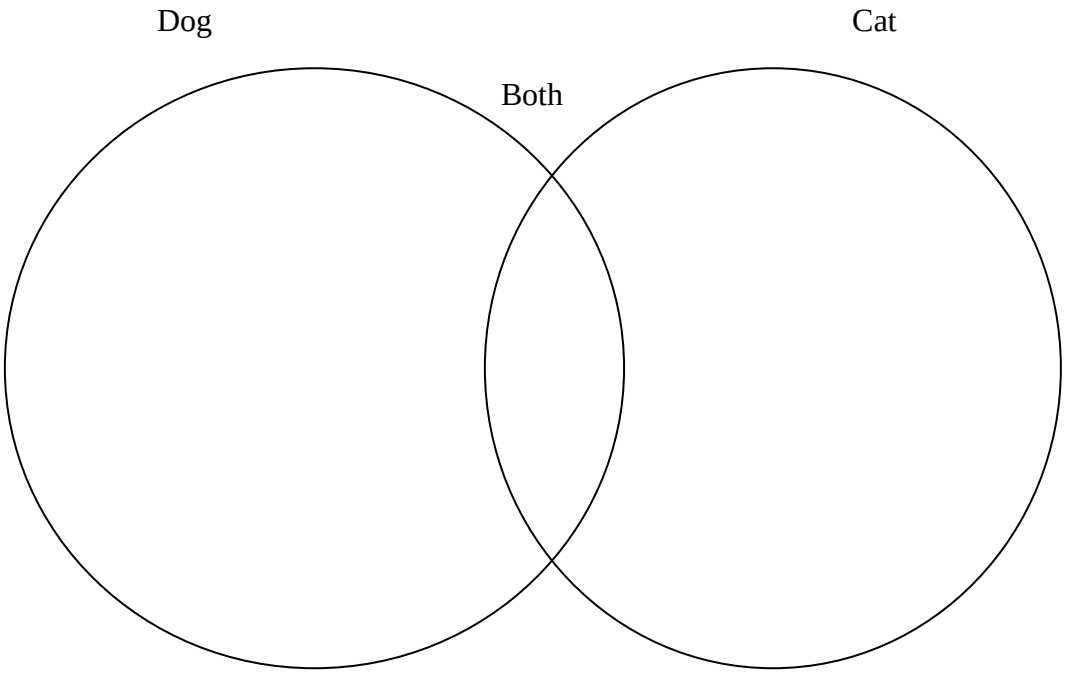
Teachers can gauge student understanding throughout the lessons through teacher generated group discussions.

Extensions/Adjustments:

Students can make their own questions for use on a Venn Diagram. Teachers can use the three-way circle Venn Diagram to compare more things. Teachers can post a Venn Diagram without the question on it and students can guess what the question is, what it can't be, and discuss the graph based on the labels. Then teachers can reveal the question.

Venn Diagram

Question: Do you have a dog or a cat at home?
(Write an ‘X’ for your answer.)



Pictograph Handout and Checklist

Number of Sandwiches Made During the Week

Day of the Week	Number of Sandwiches
Monday	30
Tuesday	15
Wednesday	5
Thursday	45
Friday	10
Saturday	20
Sunday	16

Checklist for Pictograph

Task	Completed (√) Yes ☺	No ☹
I made a pictograph using the data above.		
I included a key on my pictograph.		
My math is correct on my pictograph.		
I wrote three things I notice about the data.		
My pictograph is clear and easy for others to read.		
I shared my pictograph with a partner. My partner's name is _____.		

Unit 2 | Chrysanthemum Activity | Lesson 3

Goal: The goal of this lesson is for students to experience different types of graphs, to develop skills needed to create and analyze mathematical graphs from a data set AND to develop the academic language necessary to discuss graphs in ASL and written/spoken English using higher level thinking skills.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students will participate in a read aloud and complete graphing activities using the letters in their classmates' names and their own name as data.

Materials:

- *Chrysanthemum* by Kevin Henkes
- Chrysanthemum Checklist
- Chrysanthemum Handout
- Index cards
- Colored pencils
- Markers
- Pencils
- White board/chalk board
- Dry Erase markers/chalk

Procedure:

Getting Started:

1. Start by doing a picture walk through of the book *Chrysanthemum*, by Kevin Henkes, with the students. This should be done in the reading area or on the group rug. Ask students what they think the book will be about based on the pictures. Ask if any of the students have read the book in the past.

2. Sign the book aloud with the students and read in English separately.

3. When the book is finished ask students what their thoughts and feelings are about the book and if they liked it.

4. Explain to the students that everyone has a different name and that the main character in the book, Chrysanthemum, had 13 letters in her name. Ask the students to count their own names and call on students to share how many letters their name has in it.

5. Tell students they will do some graphs with their own names and with the names of the other students in the class. Show them the checklist of

activities. Ask students if they have any questions before they go back to their seats.

6. Excuse students to go back to their tables. Have one student gather materials for each student and pass them out.

Steps:

1. Have students work alone or in pairs on the Chrysanthemum activities (pictograph, line plot, bar graph).

2. Teacher may need to review the Venn Diagram with the students and brainstorm some things that we notice about the student names together to get students going (I notice that some names are the same length and some are different lengths, some names start with the same letter and some sound the same, etc).

3. Collect the handouts when students are finished.

4. Tell students that Chrysanthemum had a unique name and some of your names are unique too. Ask: why did your parents choose the name they gave you? (It is my grandma/mom/dad's name, my mom always liked this name, my parents made up the name, it was popular, etc.) Brainstorm ideas and draw a circle graph on the board with the students. Use reasons for student's names as the labels and fractions.

5. Interpret the circle graph with the students. Teachers should model their thinking for the students. Use fractions and add in decimals as well. Ask students what is ½ in a decimal? What does it look like? Encourage students to come forward and write the decimals on the board. How do you write ½ in English?, etc.

Conclusion:

Have students draw their name on an index card and post them around the room. Encourage students to be creative and use colored pencils or markers. Do a walk through of student name cards so everyone can see each other's art.

Assessment:

Formal Assessment:

Teachers can gauge student understanding of graphs and graphing concepts through the worksheets that students complete and turn in to the teacher as well as from the checklist students complete.

Informal Assessment:

Teachers can gauge student understanding of graphing concepts and vocabulary through the informal discussions with the group.

Extensions/Adjustments:

Teachers can adjust the handouts to make them harder or easier for students. Teachers can also do the assignments as a group rather than assign them for individual work. Teachers can also talk about name shapes and what letters come up more often in names (a, e, h, etc). Also teachers can tie the lessons in with science and talk about the chrysanthemum flowers and what they look like, etc.

Name: _____

"Chrysanthemum"
Student Checklist

Task	Completed (√) Yes ☺	No ☹
I counted the letters in each of my classmates' names and I wrote down the number of letters to use in my line plot.		
I made a line plot of my classmates' names using the Class Roster.		
I answered the questions about the line plot.		
I made a bar graph from the data in the line plot.		
My graph was neat and easy to read.		
I answered the questions about the bar graph that I made.		
I made a Venn Diagram comparing the names of my classmates.		
My Venn Diagram was organized and neat.		
I participated in the discussion about the circle graph.		

Name: _____

"Chrysanthemum Handout"
Roster of Student Names

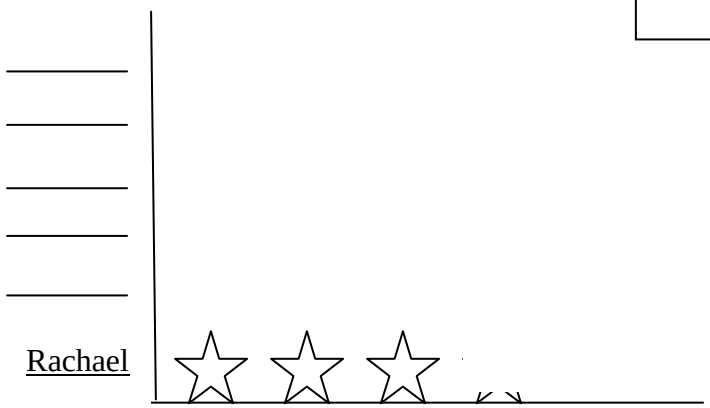
Instructions: Count the number of letters in each name.

Student Name	Number of Letters
Rachael	7
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Pictograph

Instructions: Choose 5 of your classmates' names and make a pictograph of the number of letters in their name.

Key
2 letters = ☆



Who had the most stars for their name? _____

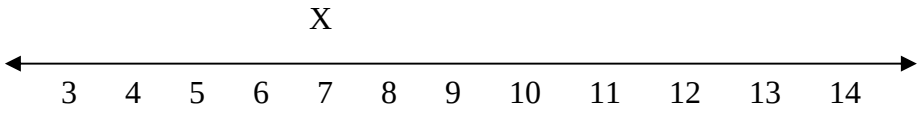
Who had the least amount of stars for their name? _____

What does the half star mean? _____

One thing I noticed about my graph is _____.

Line Plot of Classmates' Names

Instructions: Make a line plot using your classmates' names.
Example: Rachael – 7 letters



Questions for Researchers:

What is the *range* of this graph? _____

What is the *mode* of this graph? _____

What is one interesting thing about this graph?_____

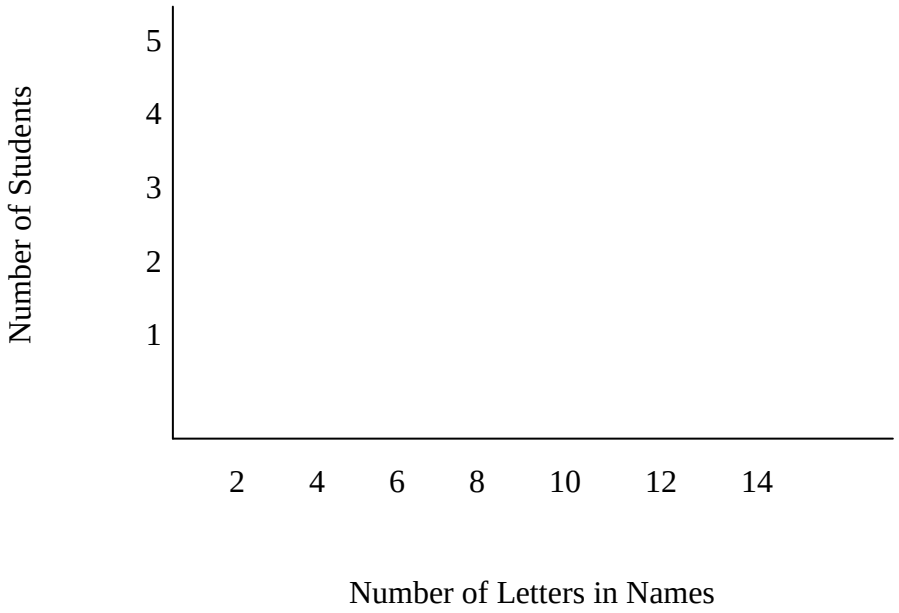
_____

What can you say about our classmates' names? _____

_____

Instructions: Use the data from the Line Plot and make a bar graph of classmates' names. Make sure it is neat and easy to read.

Bar Graph of Classmates' Names



Questions about the Bar Graph:

How many letters are in all of the names of the students in our class altogether? _____

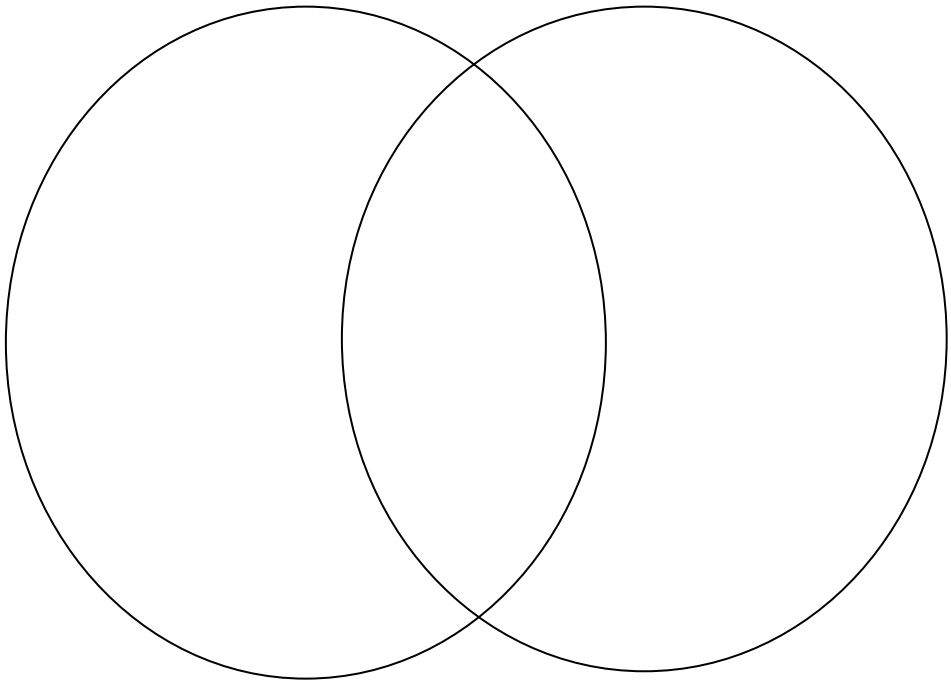
What is the most common number of letters in students names? _____

Write something new about this graph. _____

_____

_____

Instructions: Make a Venn Diagram.
What are some things you notice about the names of your classmates?



Unit 2 | Methods of Collecting Data | Lesson 4

Goal: The goal of this lesson is for students to experience different types of graphs and for students to experience methods of collecting data.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)
- Record the possible outcomes for a simple even (e.g., tossing a coin) and systematically keep track of the outcomes when the event is repeated many times. (*Statistics, Data Analysis, and Probability 1.2)*
- Summarize and display the results of probability experiments in a clear and organized way. (*Statistics, Data Analysis, and Probability 1.2 & 1.3)*

Objective:

Students will participate in centers where they learn about different methods of collecting data.

Materials:

- Centers for student work
- Pencils
- Student Questionnaire
- Student Survey
- Interview Handout
- Two spinners
- Chart for Recording Data
- Student math journals

Procedure:

Getting Started:

1. Start by saying, "These last few lessons we have done some graphs with data. Sometimes I asked you questions to get the data. Sometimes we had a chart with information in it that we used to make the graph. Today we will learn about different ways to collect data for a graph."

Steps:

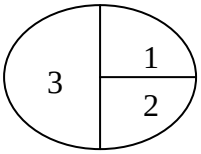
1. Explain each station to the students first.

2. The Questionnaire station will have a handout where students need to work individually to respond to each question.

3. The Survey station will have a handout that each student needs to fill out individually for himself.

4. The Interview station has a handout where students will work with a partner to ask each other the questions on the paper. Student one will ask questions and will write down student two's responses. Then they will switch and student two will ask student one the questions and write down their responses.

5. The Experiment station will have two spinners for student use and charts for students to record the outcome of the experiment. Students will spin the spinner and record which number it lands on by coloring in a box on the chart above that number (make a bar graph). Each student will take turns spinning and recording data for their own experiments with a partner. The spinner looks like this:



6. Split the students into four even groups, assign each group a center, and start the first rotation. Allow students 10 minutes at each rotation.

7. When walking by the experiment station ask students which number they will fill up on the chart first and why? (3 because that part of the spinner is twice as big as the part for numbers 1 and 2.)

8. Have each group go through all of the rotations and pull students together at the end.

Conclusion:

Have students share one thing they learned at the end of the rotations. Have students write in their math journals one thing about each of the centers and make sure they put down each method of data collection. Students can refer to their handouts from the centers.

Assessment:

Formal Assessment:

Teachers can gauge student understanding of the rotations by looking in their math journals at what students wrote down for each center. Teachers can also observe students at each of the centers.

Informal Assessment:

Teachers can gauge student understanding throughout the lesson by observing their answers to teacher-generated questions and through their work at the centers.

Extensions/Adjustments:

Teachers can teach the lessons to the whole class together rather than splitting students up for individual work in the centers. Or the teacher can break the lessons up into four mini lessons on consecutive days rather than teach them all in the same day. Students can get one more day of practice using these methods by using a neighboring class to interview or survey. This would engage the students because they could see their friends while using the methods of data collection.

Name: _____

"Student Questionnaire"

1. How many pets do you have? _____
2. How many teeth have you lost? _____
3. How many siblings do you have? _____
4. What is your favorite subject in school? _____
5. Do you have a favorite book? _____

   What is the name of your favorite book? _____
6. In which month is your birthday? _____

Name: _____

"Student Survey"

1. Where do you live during the week?

a. In the dorms on campus
b. At home with my parents
c. With another relative
d. None of these

2. What color are your eyes?

a. blue
b. brown
c. green
d. hazel
e. black

3. What do you want to be when you grow up?

a. doctor
b. lawyer
c. teacher
d. engineer
e. soccer player

4. Have you ever visited another country?

a. yes
b. no

5. What type of hair do you have?

a. straight
b. wavy
c. curly

Name: _____

Interview Handout
"Interview Each Other"

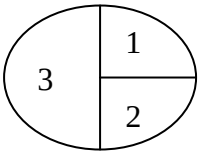
My partner's name is: _____

1. What is your favorite food? _____
2. What time do you go to sleep at night? _____
3. What do you do on the weekends? _____
4. Have you visited the zoo before? _____

   What animals did you see? _____
5. How many sisters do you have? _____

   How many brothers do you have?
6. Do you have deaf parents? _____

Instructions for Creating Spinners



1. Cut a 5-by-8 inch index card in half. Cut a circle, about 3 inches in diameter, from one half of the card. Divide and label it as you see above.

2. Mark a dot in the center of the spinner.

3. Place a paper clip in the center of the spinner. Hold it in place with your pencil tip.

4. Flick the paper clip so that it spins around the pencil and lands on one of the numbers on the spinner.

Other ideas: Use a brad to hold the paper clip in place so you don't need to use a pencil.

Name: _____

Chart for Recording Data
Spinner Experiment

Instructions: Spin the spinner one time. Color in the box above the number on which it lands. Spin 5 times then answer the questions below.

→*Example: If the spinner lands on 2, color in one box above the number 2 column.*

1	2	3

Questions for Researchers:

1. Is any number more likely to come up than any other number? Why?

_____

_____

2. Which number did you spin the least amount of times so far? _____

Instructions: Spin 10 more times.

3. What does your graph look like? Why do you think this happened?

_____

Unit 2 | Brainstorming Questions | Lesson 5

Goal: The goal of this lesson is for students to experience methods of collecting data AND to develop skills needed to create and analyze mathematical graphs from a data set.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students and teacher will brainstorm questions for a research project that the students will implement in the next unit.

Materials:

- White board/chalk board
- Suggested Questions
- Paper
- Pencils
- Presentation Rubric

Procedure:

Getting Started:

1. Start by saying that in the last few lessons we have created graphs from data that was already collected. The questions had already been decided on. Now let's decide what to collect data about. You and a partner will collect the data, make a graph of the data, tell us what you find interesting about the graph using math words, and present the graph to the class.

Steps:

1. Let's start by brainstorming some questions you all are interested in. What do you want to learn about? (Take some suggestions and write them on the board.) Say I would like to know how many times you can write your name in one minute. Write this on the board.

2. Write student questions on the board (What colors are on your t-shirt today, How many cubes can you hold in one hand, How many buttons are on your clothes today, What's your favorite food, Do you like to play soccer (yes/no), etc).

3. After you have created a list of about 10 questions assign students a partner and have them pick a question to use for their project. The students should

write down the question so they have it.

4. Give students 15 minutes to think about their project that they will create (How they will collect the data, what graph they will use to represent the data, what they can interpret from the graph, and their presentation to the class.)

5. Hand out a rubric for students to use to begin planning their project. Review the rubric with the students. Tell them to keep it in a safe place so they can use it later.

Conclusion:

Have students share one thing they are excited about for their project.

Assessment:

Informal Assessment:

Teachers can gauge students' understanding of questions for inquiry during the brainstorming activity. Teachers can also observe students during their partner time and check in with each group to make sure they understand what they will be doing and if they have any questions.

Extensions/Adjustments:

Students can come up with their own inquiry questions, experiments, or opinion polls to use for their final project rather than brainstorming questions together. Teacher can also adjust the level of the activity by providing two or three questions to choose from for the final project and students can do one of the three questions. Students can work individually if they want to or can work in larger groups if desired.

"Suggested Questions"

1. What colors are on your t-shirt today?

2. How many cubes can you hold in one hand?

3. How many buttons are on your clothes today?

4. What's your favorite food?

5. Do you like to play soccer? (yes/no)

6. Is your Halloween costume scary or not scary?

7. What's your favorite TV show?

8. How many scoops of rice do you think will fill the jar?

9. How much allowance do you get?

10. If A= $0.01, B= $0.02, C= $0.03 and so on, how much is your name worth?

11. How many of your feet equal your height?

12. How many glasses of milk do you drink in one day?

13. How many pencils are on your desk right now?

14. Which do you think there are more of on the U.S. flag- long red stripes, long white stripes, short red stripes, or short white stripes?

15. Are you left-handed or right-handed?

Unit 3 | Making a Plan | Lesson 1

Goal: The goal of this lesson is to develop skills needed to create and analyze mathematical graphs from a data set AND to develop the academic language necessary to discuss graphs in ASL and written/spoken English using higher level thinking skills.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students will work with a partner to refine their question and plan how they will collect their data from their classmates.

Materials:

- Question from Unit 2
- Data Collection Plan
- Paper
- Pencils
- Markers
- Student materials
- Student math journals

Procedure:

Getting Started:

1. Tell students that today we will work on the question they picked from Unit 2 for their final project. Tell students that before they can collect their data they need to do some planning. First, make sure you and your partner agree on the question you will ask your classmates. Second, plan how you will collect your data including the materials you need and how you will organize the data you are collecting.

Steps:

1. Have students find and sit next to their partner with whom they will work on their final project.

2. Give each partner group a "Data Collection Plan" to fill out. Review all of the questions on the Plan with the students so they understand them.

3. Give students time to work on their data collection method and materials (20 minutes).

4. Help students that are having difficulties or who seem to have plans that may require too much time. Review each group's Data Collection Plan if time allows. Answer any questions that students might have.

5. Students can prepare their materials for the following day when they will collect the data.

Conclusion:

Have students write their data collection plan in their math journals to wrap up the day and collect their Plans.

Extensions/Adjustments:

Students can work in small groups or do the final project individually depending on their mathematics and language levels. It is a good idea to have students work in groups so they are using the math language throughout the process of completing the project.

Name: _____

Data Collection Plan

1. I will collect data from: _____

_____

2. I will ask this question: _____

_____

3. I will collect these data by: (Write your plan here.)

_____

_____

_____

_____

4. The materials I will need are: _____

_____

_____

_____

_____

Unit 3 | Today's the Day: Collecting Data | Lesson 2

Goal: The goal of this lesson is to develop skills needed to create and analyze mathematical graphs from a data set AND to develop the academic language necessary to discuss graphs in ASL and written/spoken English using higher level thinking skills.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students will use their Data Collection Plan to collect data from their classmates.

Materials:

- Student materials
- Completed Data Collection Plan per partnership
- Paper
- Pencils
- Markers
- Student Math Journal

Procedure:

Getting Started:

1. Start by saying, "Yesterday we worked on our plan for collecting data. Today you will actually be collecting data from your classmates."

2. Model the behavior you'd like students to have when each group comes forward to collect data (pay attention, be respectful, answer their questions, etc).

Steps:

1. Have the first group come forward to the front of the classroom. Tell students that this group will begin collecting data. Allow these students to ask their question or distribute their survey to the other students and gather their data.

2. Rotate through all of the groups to make sure all students have collected their data.

3. Don't restrict data collection only to math class. Allow students to collect data in their dorms or on the playground after math is finished.

4. Say, "Now that you have collected your data what will you do next?" (Organize the data into a graph.) Allow students to sit with their partner so they can think about the data and organize it.

5. Allow students to organize their own plan for representing the data in a graph.

Conclusion:

Have students write down any notes from the data collection that they might have in their math journals. Students can also write down their experience from collecting data.

Extensions/Adjustments:

Students can post their surveys, diagrams, or charts with the question drawn on a large poster board or piece of paper and their classmates can walk by and post their answers on the poster board themselves. This would save a lot of time in a large class. Students can also have a short question and answer session after they collect their data. The other students can ask them why they picked their question, what they think the data will look like, or how they will represent the data, etc.

Teachers can assign a type of graph to each group or partnership so that the process goes quicker. Two groups can do the line plot, two groups can do the bar graph, etc.

Unit 3 | Workshop: Graphing Data | Lesson 3

Goal: The goal of this lesson is to develop skills needed to create and analyze mathematical graphs from a data set AND to improve students' understanding of the use of graphs in real world situations.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students will work with their partner to organize and represent their data in a graph.

Materials:

- Student-collected data
- Poster boards
- Markers
- Student Math Journals
- Pencils
- Crayons
- Colored Pencils
- Rulers
- Examples of graphs on the board
- Rough Draft-Graph Handouts

Procedure:

Getting Started:

1. Open by saying, "Yesterday you collected your data from your classmates. Today you will start to organize and think about how to make a graph from your data. Remember the different types of graphs we have learned about? Can you tell me some of the names of these graphs?" (Bar graph, line plot, Venn Diagram, circle graph, and pictograph.)

Steps:

1. Explain that students will work with their partner to think about how to represent the data. Use these questions as a guide:
   - What kind of graph will you use?
   - Is your graph clear to you? Is it clear to other people?
   - Is your graph neat and clean?
   - Did you write the question at the top?
   - Did you label the graph appropriately?
   - What did you find that was interesting about the data?
   - Think about the interpretation of the data.

2. Have students plan what they will do first and have them draw their graph second.

3. While students are working observe how they choose to graph their data, if the graph is correct, and how the students interpret the data.

4. Allow students plenty of time to draw their graphs and begin to think about the interpretation.

5. Gather students' attention and tell them that for the interpretation part of the graph make sure they use math vocabulary such as: most, least, mode, range, and add fractions. Review all of these terms in ASL and in English. Allow students more time to work on the interpretation.

Conclusion:

Have students draw a picture of their graph in their math journals so they will have it for later reference. Ask students to share about their experiences of creating their own data project. Allow volunteers to share.

Assessment:

Formal Assessment:

Teachers can look at students' finished posters to gauge how well they can create their own graph.

Informal Assessment:

Teachers will observe students during their group work and answer any questions during this time.

Extensions/Adjustments:

If students finish early, teachers can have them draw a second representation of the data using another graph or using cubes and then transferring that to a picture on the poster board. Students can also work more on their interpretation and add a second or third interpretation of the data.

For the interpretation of the graphs, teachers can give these sentence frames to the students if needed:

1. The _____ column has the most in it.
2. The _____ column has the least in it.
3. There are more _____ than _____.
4. There are _____ altogether.
5. There are fewer _____ than _____.
6. There are more _____ than _____.

Rough Draft-Graph Handout Name: _____

Draw your graph here:

Include the following for your graph:
-title
-key (Pictograph only)
-labels (Example: “Numbers”, “Names of Animals”)
-numbers
-the data
- the following sentences:

_____has the most.

_____ has the least.

Unit 3 | Reviewing Data/Preparing to Present | Lesson 4

Goal: The goal of this lesson is to develop skills needed to create and analyze mathematical graphs from a data set AND to develop the academic language necessary to discuss graphs in ASL and written/spoken English using higher level thinking skills.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students will use their data they collected previously to create a graph, and they will prepare for the final presentation.

Materials:

- Centers for student work
- Rough Draft-Graph handouts from yesterday
- Poster paper for groups/partners
- Markers
- Pencils
- Rulers
- Music stand for students to practice presenting the data

Procedure:

Getting Started:

1. Start by explaining that the students will transfer their graphs onto poster paper today. Tell students that one student will draw the graph and the other student can practice for the presentation.

Steps:

1. Have students break up into partnerships or groups and start working.
2. Check each group's rough draft graph and give feedback if needed so students can make changes on the rough draft before transferring it to the poster paper.
3. Allow student ample time to transfer the graph to the poster paper.
4. Explain to the presenters what you would like them to focus on and show them the presentation rubric (See Unit 3, Lesson 5 for rubric).
5. Walk around and assist groups where needed.

Conclusion:

Call students' attention and have them clean up their materials. Ask students about their experience creating graphs and getting ready to present for tomorrow. Ask if students have any questions that need clarification.

Assessment:

Formal Assessment:

Teachers can gauge students understanding by checking their math graphs and questioning them using their rough draft graphs handouts.

Informal Assessment:

Teachers can gauge student understanding by questioning them and observing them during the lesson.

Extensions/Adjustments:

Teachers can have students add more information to their graphs or presentations as an extension. Early finishers can create a different type of graph with the same data or can survey another classroom and add that data to their graphs.

Unit 3 | Presentation Day! | Lesson 5

Goal: The goal of this lesson is to develop skills needed to create and analyze mathematical graphs from a data set AND to develop the academic language necessary to discuss graphs in ASL and written/spoken English using higher level thinking skills.

Standard:

- Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (*CA-Math Standard Grade 3- Mathematical Reasoning 2.3*)

Objective:

Students will present their mathematical graphs to the class.

Materials:

- Student created graphs
- Math Presentation Rubric
- Clipboard
- Pencils
- Camera for teacher

Procedure:

Getting Started:

1. Start by gathering the students to the circle area. Tell students that they will present today and review expectations with the class about how to behave during classmates' presentations.

2. Tell students that you will give them time to review and finish up graphs (if necessary) before presenting.

3. Dismiss students and allow them time to prepare for the presentations.

Steps:

1. Flash the lights and have the students come back over to the circle area.

2. Make sure that you have the rubrics and the clipboard ready and have an aide or another teacher take pictures of the student presentations if desired.

3. Decide who will present first and begin the first presentation. Use the rubric as the students do their presentations.

4. Review at the end of each presentation if necessary. Repeat this with the rest of the groups.

Conclusion:

Ask students their feelings about the presentations and creating their own graphs. Allow students to share. Ask students the purpose of graphs and also if they can name some different types of graphs as a wrap up. Post graphs around the room for all students to see.

Assessment:

Formal Assessment:

Teachers can gauge student understanding and use of academic language through their presentations to the class and during the teacher questioning at the end of the lesson.

Extensions/Adjustments:

Teachers can have other classes or parents come and sit in the audience during student presentations. Parents or students can ask questions when student presentations finish. If time is an issue, teachers can have students do a gallery walk and look at the posters rather than do presentations but teachers should meet with each group to make sure that they understand the graphs and use the academic language correctly.

Name: _____

Math Presentation Rubric

Skill	Great Job	Need Practice
1. I signed my group's question.		
2. I identified the four choices.		
3. I included the data.		
4. I identified which kind of graph we drew.		
5. I explained the most/least for my graph.		

VIII. Evaluation Plan

In order to determine the effectiveness of my curriculum and assess student progress toward achieving the five learning goals, I developed an evaluation plan that was used during the implementation of my curriculum. The plan included three areas of data collection: student and teacher artifacts, field notes, and rating scales/rubrics. These three distinct methods of data collection provided different ways to assess the curriculum design, implementation, lesson and unit objectives, and achievement of the following five curriculum goals:

1. To experience different types of graphs.
2. To experience methods of collecting data.
3. To develop skills needed to create and analyze mathematical graphs from a data set.
4. To develop the academic language necessary to discuss graphs in ASL and written/spoken English using higher level thinking skills.
5. To improve students' understanding of the use of graphs in real world situations.

Collection of student and teacher artifacts was the first method of data collection. These artifacts included teacher and student generated work samples as well as students' individual and group work samples, student-teacher classroom charts and lists that were created for use during the lessons and activities, student and teacher surveys and rubrics used during a lesson, and teacher artifacts used for modeling such as drawings, lists, and examples. A file folder for each student was created to collect and organize student work samples and original work was collected whenever

possible; copies or photographs of original work were kept as artifacts when the originals were not available. Classroom charts and lists were kept in a folder marked "group artifacts" and were helpful in assessing student growth and progress as well as achievement of lesson objectives. Teacher surveys, rubrics, and sample artifacts were collected and filed in a separate folder marked "teacher artifacts". These artifacts were collected to assess the effectiveness of a unit or lesson as a whole. Student artifacts were used to reveal students' strengths or weaknesses and were helpful in planning the next steps in instruction.

The second method of data collection that I used was writing field notes based on classroom observations and situations. I recorded notes in a daily journal about events that happened in the class including the date, which student(s) were being observed, the nature of the event (social or academic), a description of what happened, and what type of field note was being recorded. There are several types of field notes that were used during my data collection including: anecdotal, methodological, theoretical, personal, and other. Anecdotal notes include anything that happened in an event (ie: who was involved, setting, activity). Methodological notes include instructional methods the teacher used during a lesson to make it successful or unsuccessful. Theoretical notes refer to students' application of a learning theory in the activity/setting. Personal notes refer to any events or feelings the teacher experiences that may influence the classroom environment, the effectiveness of lessons, or they way the teacher observes the class. Some personal notes might include teacher illness or fatigue, family or relationship distractions, or any other events that could affect the teacher's mood or teaching ability. Lastly, the other

category refers to any drawings or random notes that I took that did not fit into one of the other four categories.

I developed a method for recording notes using a bound journal as aforementioned. Anything that seemed significant in the classroom or pertaining to the students or teacher was documented daily in the journal. The notes were recorded for individual and group activities and during both academic and social situations. Notes were recorded whenever time allowed in the classroom and were updated in the journal at the end of each day when the events were recent enough to remember.

Lastly, rubrics were used to assess student progress on lesson objectives and skills, student attitudes towards the activities, completion of assignments, and teacher assessment of student performance. The rubrics were formatted to show whether students met the objective (happy face= yes and sad face= no) with a circle notating student performance. Students were sometimes asked to rate themselves using the rubrics and rating scales in addition to teacher assessment of students using the rubrics. Additionally, student understanding was assessed at the beginning and the end of the curriculum to determine changes in knowledge about math graphs.

The methods of data collection I used differed in format but supported each other in that they showed trends in student work and ability, and student misconceptions about math graphs which could then be addressed in subsequent lessons. Any one of these methods of data collection used alone would not suffice to show the effectiveness of the curriculum or the progress of the students. However, used together these three methods assessed students' academic progress towards the

goals and the effectiveness of the lesson and unit objectives and the curriculum as a whole as well as assessed the social and emotional progress of the students.

IX. Curriculum Implementation

Description of School Site and Classroom

The math graphing curriculum I designed was implemented during the spring of 2009 in a third grade classroom consisting of sixteen deaf students. The classroom was part of a K-12 residential school that is bilingual and multicultural in philosophy and practice. All teachers are trained using Gallaudet University's ASL/English Bilingual Professional Development (AEBPD) that instructs teachers how to incorporate bilingual techniques into their teaching. The school uses technology in the classroom including SMART Boards, document cameras, digital video cameras, Mac and PC computers, and pictures. High levels of academic excellence are promoted throughout the school including following a rigorous curriculum, conducting ASL/Deaf studies classes, ASL maintenance and immersion classes, and character education for all students.

The school encourages community through character education, high school and elementary level plays, multicultural celebrations, ASL Pah! Day, and many other events. All members of the staff are fluent in ASL so the students have full access to the language and are supported in all areas at school. Many dorm counselors have worked at the school for multiple years and are familiar with its inner workings, and staff have watched students grow up and graduate from high school. Additionally, parents in the community are highly involved as volunteers, substitute teachers, event organizers, and interpreters.

In my third grade classroom there was a team of three teachers who rotated teaching all academic subjects throughout the year. When group work was required,

the students were grouped heterogeneously so that they would have the opportunity to learn from each other (lower achieving students learned from the higher achieving students and vice versa). Mornings throughout the week consisted of morning meeting, literature circles, writer's workshops, DEAR (Drop Everything And Read), ASL class, physical education classes, and library time. In the afternoons students learned science with a K-5 science teacher, social studies in our classroom, and participated in Deaf studies and character education classes. Math instruction occured at the end of the day, four times during the week. My curriculum was implemented Monday through Thursday during the math hour over the course of two weeks.

There were typically five adults in the classroom at all times: the three teacher team, our aide, and myself. An ASL Specialist was present during ASL maintenance classes and helped with character education throughout the semester. The three teachers split responsibility for teaching various subjects and always supported students and each other at all times.

Participants

My students consisted of six boys and ten girls ranging in age from eight to ten years old. Seven of these sixteen students had at least one Deaf parent (HW, JW, KD, MB, MM, SH, and TM) who used American Sign Language as their primary language at home. Those seven students had native-like ASL skills but were still developing their language production and vocabulary through ASL maintenance classes. Based on the ASL Scale of Development (Herzig, 2002) these students were advanced signers. Four students had hearing, Spanish-speaking parents (AP, BS, EC, and PG),

many of who signed ASL with some proficiency. These students, and the five additional students with hearing, English-speaking parents who signed (AC, BD, ER, RL, and TR), attended ASL immersion classes through pullouts during the day. These pullouts were designed to support the students in their ASL acquisition and development. On the ASL Scale of Development, these nine students would be classified as intermediate to early advanced signers. One student (EC) joined our class while I was interning in the spring, and his ASL skills ranked as beginning or early intermediate.

About half of the students were reading at grade level. Two students (HW and RL) were reading above grade level books and five students (AP, BD, ER, EC, and PG) were reading at the first to second grade reading level. I observed that all of the students enjoyed literacy centers and story time, and that they liked to read books. The students' reading level on the Benchmark Assessment (Nelley and Smith, 2000) ranged from 20-30 points. During math classes, many of them were still learning to read written instructions and word problems in English due to the academic language. The students' written English skills varied based on the 6+1 Writing Trait Assessment (2008) rubric. The majority of the students (ten) were classified as "developing" writers with the exception of two students (BD and EC), who were classified as "emerging" writers, and four students (HW, KD, MM, and TM), who were classified as "capable" writers.

The students' math strengths and weaknesses varied. The majority of them were working on their multiplication and division facts. Four students were memorizing their 3's and 4's facts whereas nine students were working on their 6's,

7's, and 8's facts. One student in the group (SH) was working on multiplying two digit numbers by three digit numbers and another (BD) was still memorizing subtraction and addition facts for single digit numbers as well as committing multiplication facts to memory. All students were still learning English academic vocabulary for math skill instructions, and they were struggling with the language of word problems. During math review work I found that they knew how to read and tally graphs, pictographs, and bar graphs accurately although some students still needed support.

Some of my students were repeating third grade and many of them were newly promoted from second grade, which made for a unique environment. Sometimes they tattled on each other in class and had difficulties solving their personal problems without asking a teacher for help. Three students were particularly quiet and sensitive and were easily upset when they became frustrated, however they interacted well with their peers. One student sometimes intimidated others by putting them down but generally got along with everyone. Most students were relaxed and got along with everyone and were able to ignore inappropriate behavior from some of the other students. They appeared to enjoy helping me write on the SMART Board and enjoyed volunteering to help the teacher. They also participated well during the daily activities. Some students needed additional support from a teacher to stay on task but when they were doing their work and attending, they often performed well.

All in all, this was a great group of students with diverse language and academic strengths. Many of the students were early intermediate or advanced signers

and were generally at grade level for reading and writing. They were energetic, motivated, and ready to learn.

The Implementation

May 11, 2009- Day 1

To start off my curriculum I talked with my cooperating teacher (mentoring teacher) about the students' skills using graphs. She told me that they had already learned about bar graphs, line plots, and pictographs but they would need to review them. She also told me that they had not yet learned about Venn Diagrams, and they would not be able to use pie graphs because they had not been taught the concept of percentages. The students had just been taught fractions several weeks prior, so I decided to start the first day with a modified version of Unit 1, Lesson 1. We did a KWL chart about what the students **K**now, **W**ant to know, and **L**earned about graphs and then I taught them the Venn Diagram. Instead of teaching the exact lesson for Venn Diagrams from my curriculum, I had the students compare one of the classroom teachers and me. I thought the students would enjoy comparing their teachers because it would be more engaging for them than talking about mammals and animals that swim in the ocean, which was the original plan from the curriculum (Unit 1, Lesson 4).

This first day was somewhat hectic because my cooperating teacher was absent and there was a substitute teacher in her place. I instructed her to help where needed during the group lesson. Additionally, there were two people in the room filming for a university research project, which added two more bodies to the room and four

cameras recording the math lesson. Today was their first day of filming but because the students experienced filming when the researchers visited in early March it was not novel to them.

I began by showing a message on the SMART Board saying that we would be doing a KWL about graphs. One student (HW) saw the word graphs and signed the word correctly before I asked for volunteers. I asked if the students knew what a KWL was, and RL said she did because they had done a KWL last year. We reviewed that K stood for what the students Know, W stood for what the students Wanted to know, and L stood for what they Learned during the lesson or unit. I asked the students what they knew about graphs, and MM said she had seen a graph before that displayed the number of people who liked various ice cream flavors. I asked the students what graphs they have used before and told them they could draw it if they did not know its name. RL came up and drew a table of four boxes by three boxes. Because the sign for CHART and GRAPH are the same she was correct in that she used the appropriate sign but she was incorrect because a chart is not the same as a graph. I addressed this issue by explaining that she had drawn a 'chart' and fingerspelling the word.

I showed the students a poster I had made with examples of a bar graph, line plot, pictograph, and Venn Diagram on it (see Figure 9.1). It was titled "Kinds of Graphs", and I covered the four graphs with a sheet of paper. I showed the students the bar graph and asked if they had experienced that graph before. They all signed "yes". I called on RL to come up and draw an example of a bar graph on the KWL chart in the "K" column for what we know about graphs. Then I asked the students

what is usually on a bar graph. TM said it always had a title so I instructed him to write a title on the graph also in the "K" column, and I wrote "title" in the same column in English. MM said we needed numbers on the side as labels, and AP said we needed numbers or colors on the bottom. I wrote "numbers" in English in the K column. AC said we needed the bars for the numbers. She also said that we needed lines. I wrote "lines" in the "K" column.

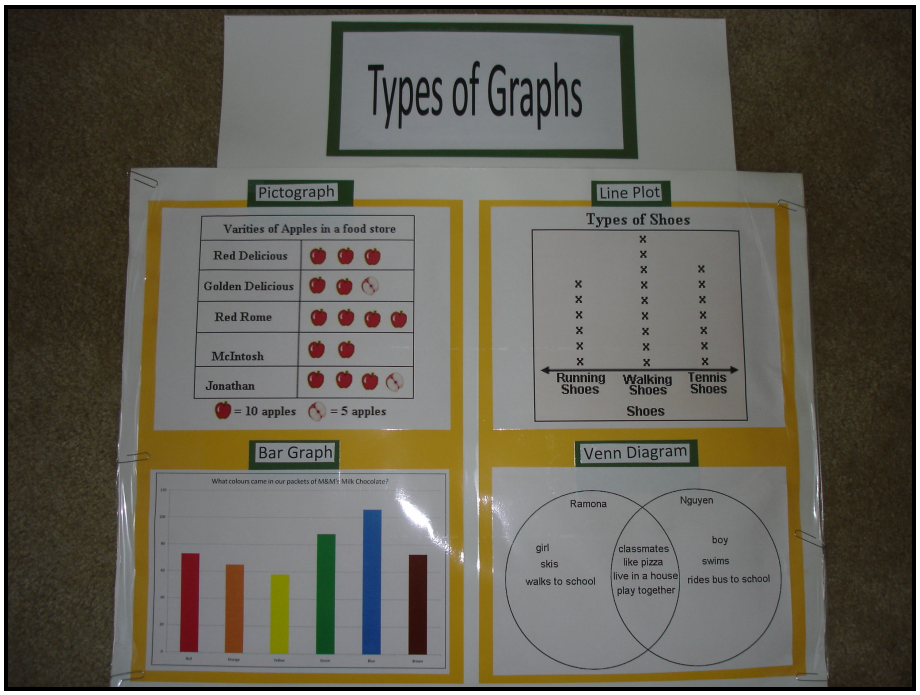


Figure 9.1: "Types of Graphs" poster

Next I asked what the students wanted to know to fill in the "W" in the KWL chart. I said that I was curious about what graphs are for. TM said "if we did not have a graph, from where could we get the information on the graph?" HW asked why we have to learn about graphs. I realized I was losing their attention so I moved on to the next part of the lesson, which was showing the Venn Diagram.

I showed the students my poster of the different types of graphs, with all the graphs still covered except for the bar graph. I told them they would see graphs they had already learned about. I removed the papers covering the examples of each graph one at a time and asked if they knew about each. They said that they did, and lastly, I showed them the Venn Diagram and asked if they had seen a graph like that before. They responded negatively, and I told them that we would learn about this new graph today. I told the students that the Venn Diagram is used to compare two or more people or things. I had another teacher come forward, and I asked for a volunteer to tell me something about this teacher while I recorded their responses on the SMART Board. The students were very enthusiastic about giving responses. Next, I asked them to tell me things they knew about me. Their responses are listed in Figure 9.2.

Teacher 1	Me
Funny	Tall
Good teacher	Funny
Champ!	Serious teacher/ strict
Sweet	Curly hair
Cute/beautiful	Cool
Tall	Sweet
Long hair	Smiles a lot
Strict	New teacher
Rides a motorcycle	Wears glasses
Old teacher	Wears contacts
Smart	Smart

Figure 9.2: Student generated responses for Venn Diagram

Next I asked the students to look at the list and tell me which things the other teacher and I had in common or what traits we both had on our lists. I circled these words on both lists as they named them. Then I posted a Venn Diagram on the SMART Board and told the students that the things that are similar or the same go in the middle circles that overlap and the differences go in the outside circles. Students again told me which traits the other teacher and I had in common, and I wrote these words in the middle circles. Then we listed the 'different' traits in the outside circles (Figure 9.3). I told the students they would make another Venn Diagram the following day with a partner. The students were very engaged by volunteering to

describe the two teachers. In fact, I had to draw popsicle sticks to select students individually because there were so many volunteers, and I wanted to draw names rather than just call on students to be as fair as possible. One thing I would do differently next time is to have the students talk with a partner about the two teachers first so that all of the students were engaged and talking before calling on individuals.

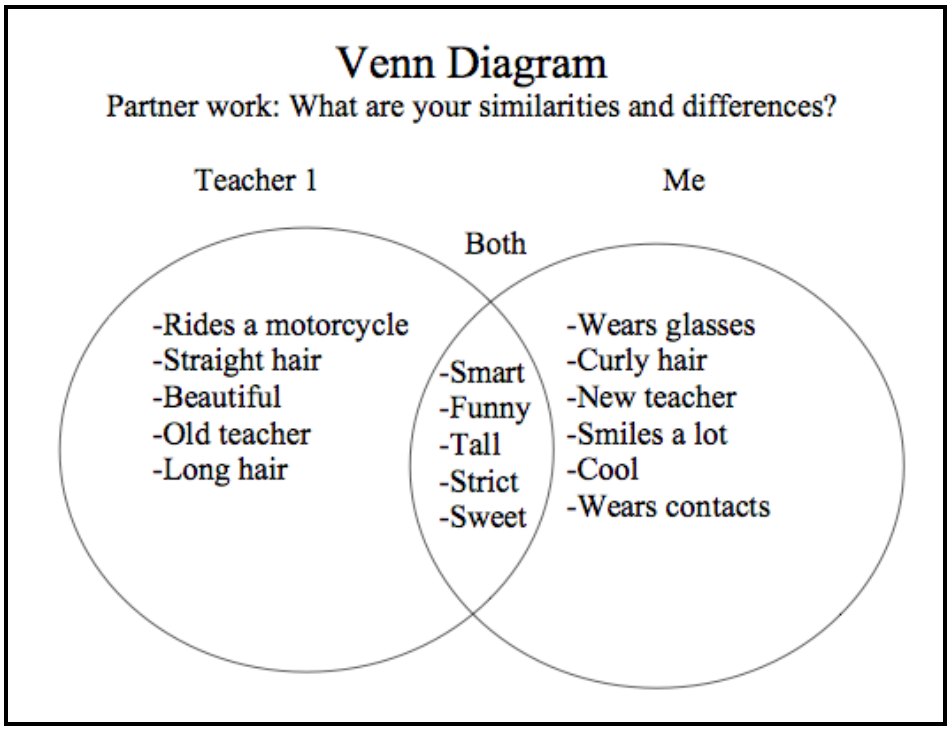
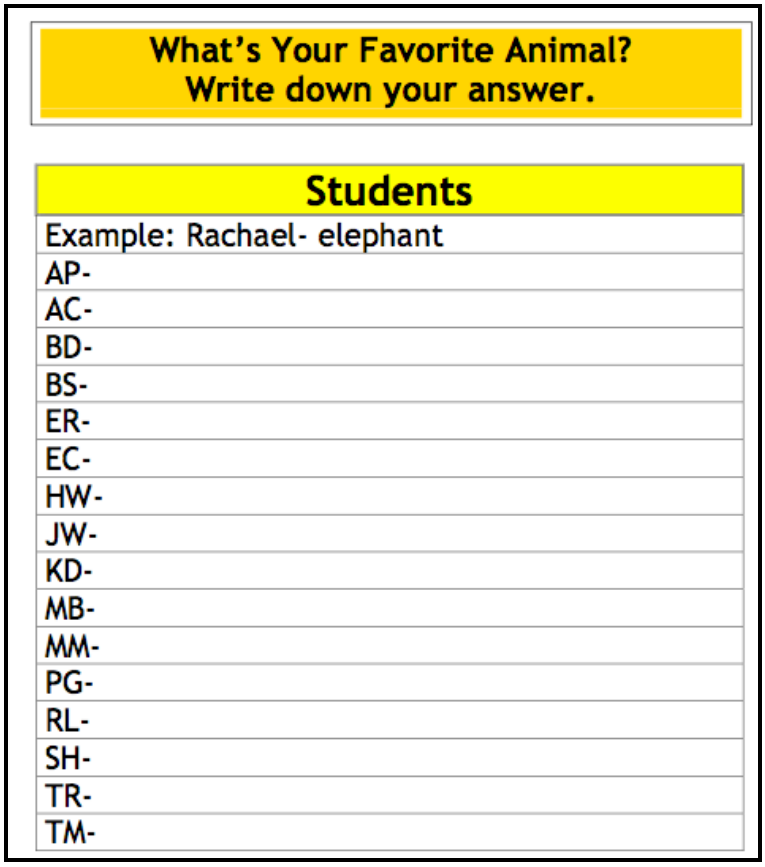


Figure 9.3: Venn Diagram used for group instruction

May 12, 2009- Day 2

During morning meeting on Day 2 I had the students fill out two surveys. For the first survey the students had to write down their favorite animal next to their name (Figure 9.4). These data would be used for the pictograph center later in the day where students would work in small groups with teacher support. This was different from the planned Unit 1, Lesson 1 pictograph activity because I learned that the

students would be doing the pictograph activity individually rather than as a whole class, and they needed data for their pictographs. I thought this modification would be motivating for the students because they would enjoy writing down their favorite animal on the survey and using their own data for the center.



What's Your Favorite Animal?
Write down your answer.

Students
Example: Rachael- elephant
AP-
AC-
BD-
BS-
ER-
EC-
HW-
JW-
KD-
MB-
MM-
PG-
RL-
SH-
TR-
TM-

Figure 9.4: Survey used for the pictograph center

The second survey asked students what time they woke up on weekend mornings (Figure 9.5). Students had to sign their name under the time range matching when they woke up and these data would be used later for the bar graph center. This handout was an addition to Unit 1, Lesson 3 because I did not have the time to do this lesson with the entire group of students and because the students had already learned

about bar graphs. This survey was added to the curriculum during implementation to gather student data for use during the center.

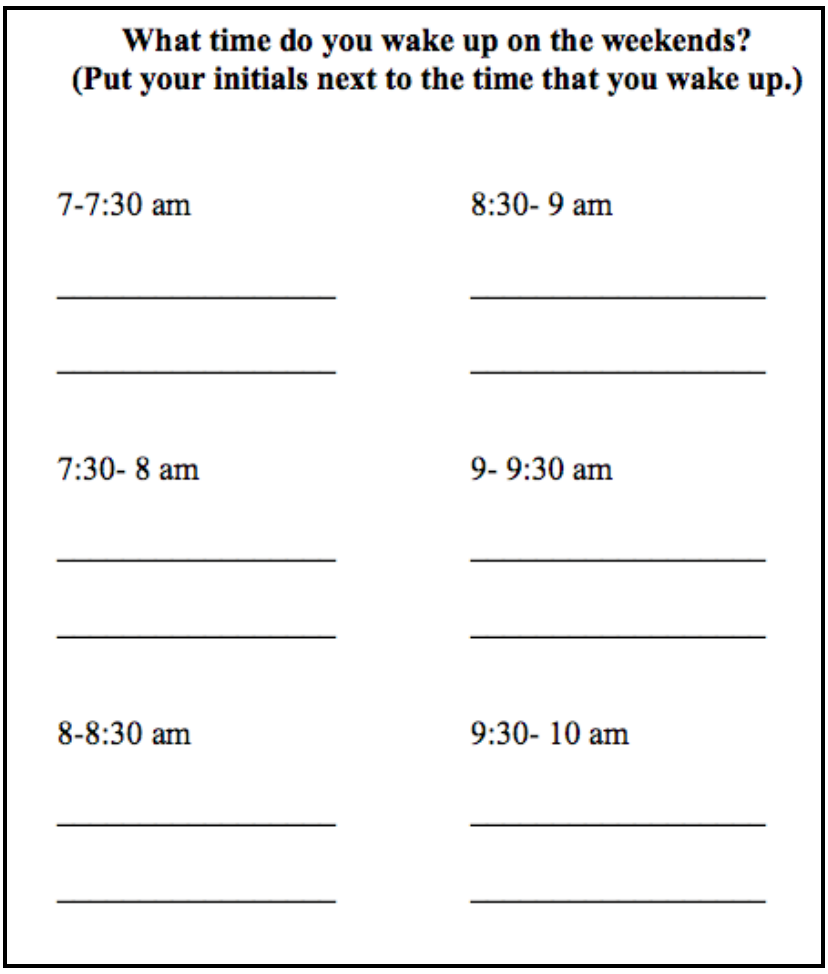


Figure 9.5: Survey used for the bar graph center

The students arrived back from science about 10 minutes late, and they had to sit in the math circle, which is an area of the classroom with chairs set up in a semi circle facing the SMART Board, to talk with a community volunteer. The students had disrespected her earlier in the day by not following her instructions on the way to P.E. class, so she wanted to talk with them about what had happened. After the

discussion I dismissed students to go to the bathroom and get a drink of water like they do during quiet time but they did not get their normal ten minutes of free time to do a favorite activity of their choosing because we were short on time. They returned back to the circle for math time, and I explained that four students would be placed at one of four centers to practice the different types of graphs that I had shown them the previous day on the poster. The students would rotate between the centers with a teacher implementing a different graphing activity at each center, and I informed them that I would flash the lights when I wanted them to rotate to the next center. I also told them that if a group finished early they could work on some of their fix and finish work that was in their math folders, which is their previously graded student work that had errors that needed to be corrected by the student. I dismissed the students and they went to their first center.

Each table had a teacher who explained to the students what they would do at the table and to support those who needed extra help. Students were familiar with the bar and pictographs so those two tables were supervised by a team teacher and the substitute teacher. My cooperating teacher said the students needed review on line plots so I worked with the line plot table. Additionally, the teacher who was involved in the Venn Diagram comparison on the previous day worked with students at that table because she was familiar with that activity.

The students at the Venn Diagram station paired up and compared each other like we had done the day before. They wrote a list of 5-10 things about each other (Figure 9.6), circled the similarities, and then filled in the Venn Diagram (Figure 9.7) with the characteristics they had listed. They put the characteristics that they had in

common in the center of the overlapping circles, and they put their differences in the outer circles.

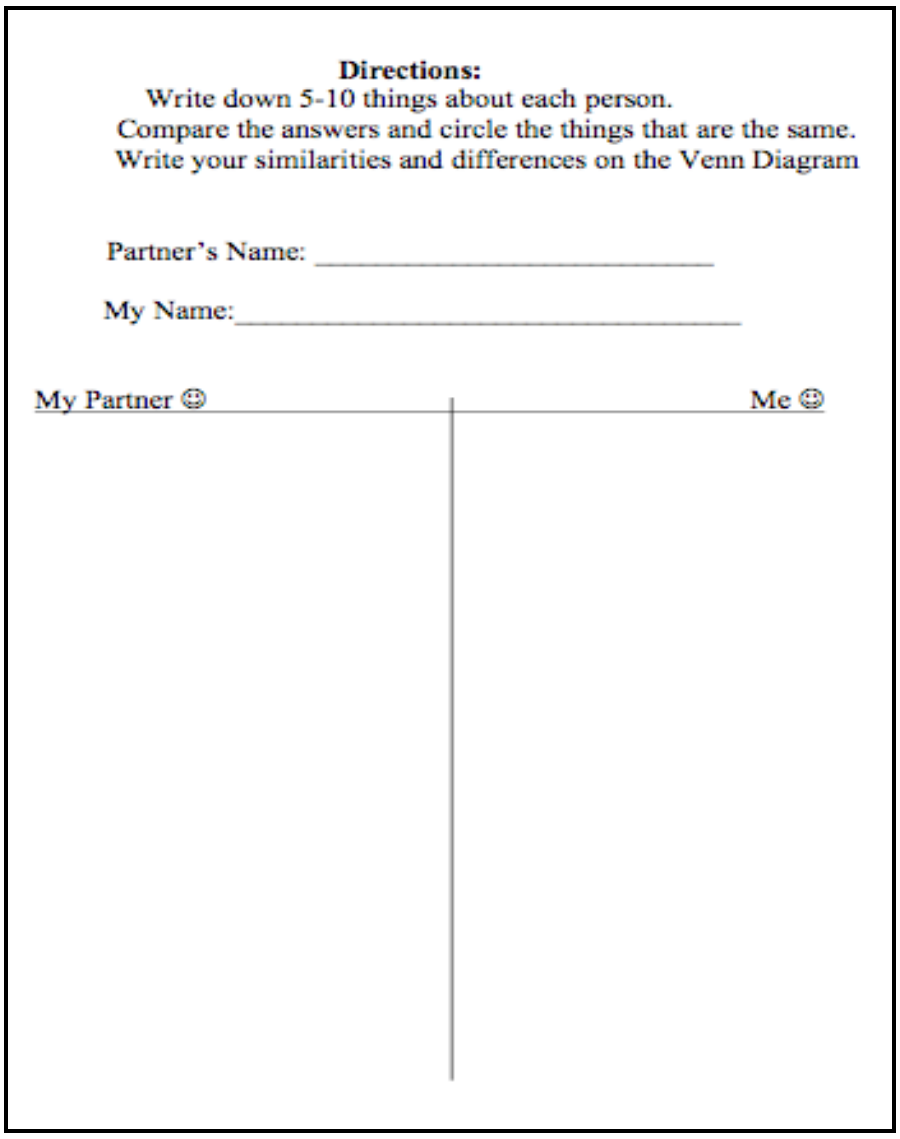


Figure 9.6: Comparison handout for the Venn Diagram center

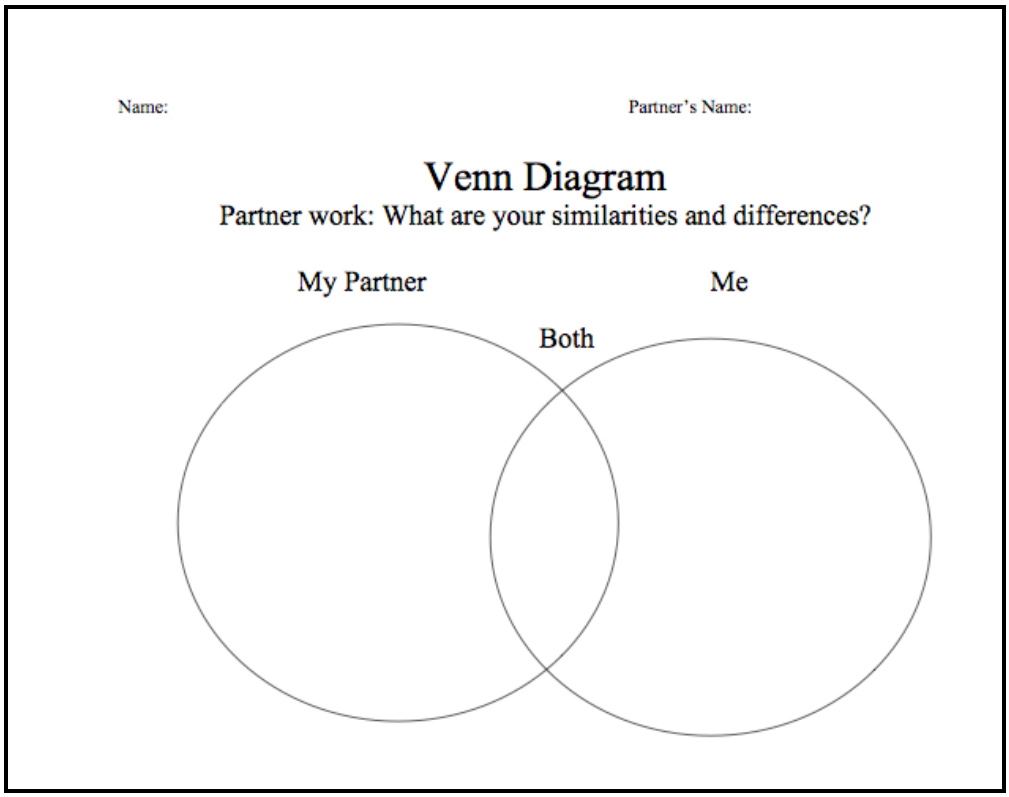


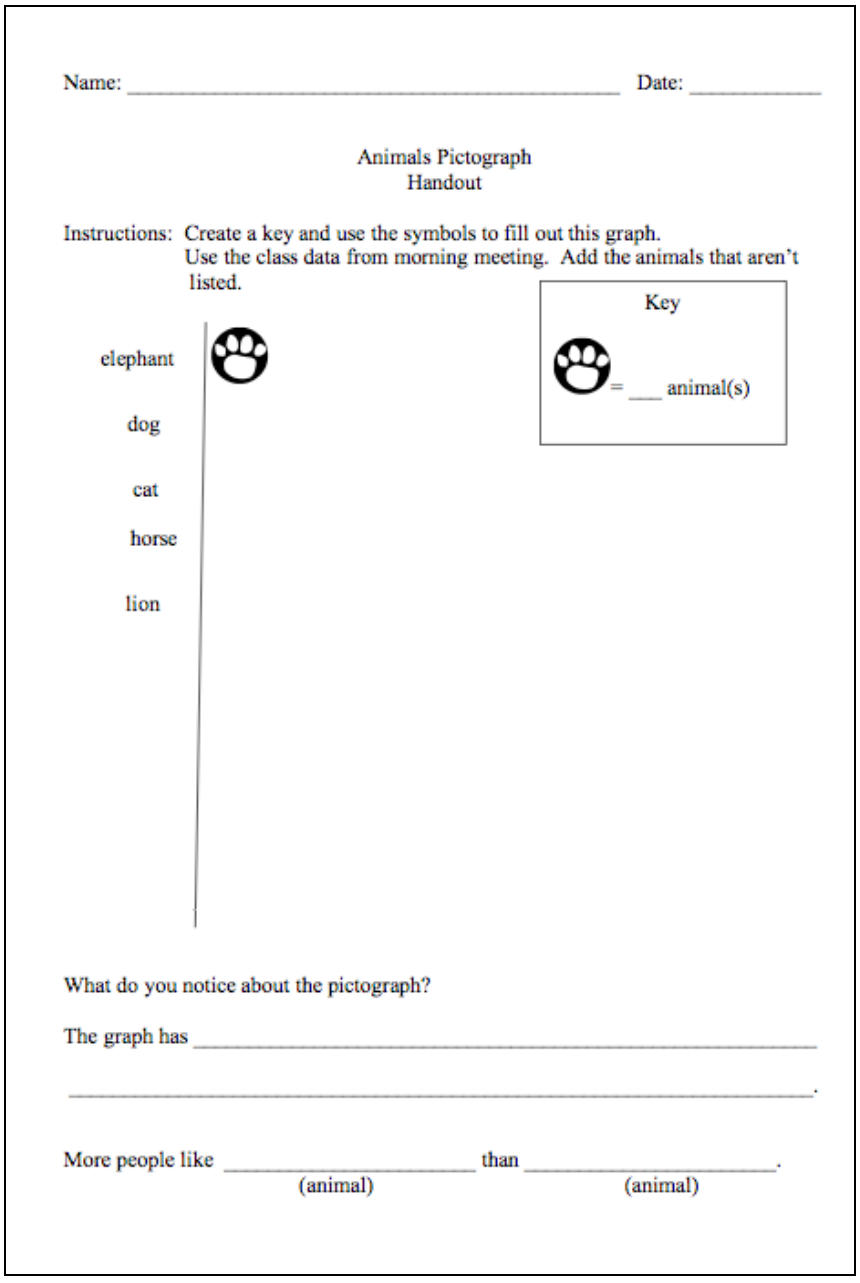
Figure 9.7: Venn Diagram graphic organizer

I talked with the teacher who led the Venn Diagram table, and she said that HW said "not much same" for the characteristics she and her partner (PG) wrote down. They had "girl", "3rd grader", and "likes to swimming" written down as their similarities but had six traits written down for each of the two girls that were different such as "funny", "long hair", "lives in cottage" for one student and "loves soccer", "short hair", and "lives in sweet home" for the other student. Another pair (SH and MM) said they had "a lot same" for their Venn Diagram. They wrote down "curly hair", "pink", "bike", "computer", "sisters", "skateboard", and "Vans" for their similarities but only wrote down "dog", "snake", "meat" for one student and "cats", "coyote", and "vegan" for the other as personal traits that differed.

These students' ASL comments convinced me they understood the purpose of the activity and the academic language of "same as" and "different" that accompanied it. Additionally, there was a pair of students that had nine similarities, and the teacher said, "You two should be best friends". The students laughed because they understood she was saying that because they had a lot of similarities. The students also used the ASL sign with the K handshape "the two of us" often when talking about their Venn Diagrams to refer to the English equivalent of "both of us". Also on their Venn Diagrams the word "Both" was written where the students needed to put similarities and the words "My Partner" and "Me" were written where the students needed to write the respective person's characteristics on the Venn Diagram. These comments and the fact that they filled in their graphs correctly are evidence that the students understand the concept of "both of us" in ASL and English.

At the pictograph center the substitute teacher asked the students what the graph was about by showing them the handout (Figure 9.8). TM, AC and RL were at the table with her. TM and RL said that the graph would show how many people liked each animal. Students counted how many dogs were on the survey that each student had filled out during morning meeting and drew the appropriate number of paw prints on the graph. They continued for cat and drew the paw prints on their graphs. She then asked, "If no one voted for the horse, what do we do?" and TM said to leave it blank. Next, the substitute showed the students the survey again, and they continued for lion. The students then had to identify which animals were not written on the graph and write them in, then they had to draw the corresponding paw prints for the

number of students who voted for that animal as their favorite animal. Wolf was next on the survey.



Name: _____ Date: _____

Animals Pictograph
Handout

Instructions: Create a key and use the symbols to fill out this graph.
Use the class data from morning meeting. Add the animals that aren't listed.

Key
= ___ animal(s)

elephant
dog
cat
horse
lion

What do you notice about the pictograph?

The graph has _____

_____.

More people like _____ than _____.
(animal) (animal)

Figure 9.8: Animal pictograph handout

When the students finished creating their graph from the survey data, the substitute asked, “What do you notice about the graph?”. TM said the names of all the animals on the graph. Then she asked what other things the students noticed. TM said, “Dog had most”. HW said, “Dog has many. One, two, three, four, five, six”. The substitute pointed to the paw print in the key and asked AC what it meant. AC said that it shows one animal. She asked TM, “Which beat others?”, and he said, “Dog”. The students’ responses and interactions with the substitute teacher demonstrated that the students were able to create a graph with the given data and understood the meaning of the graph (e.g. key, labels, etc).

Originally, I planned to have students do each center for ten minutes but there was not enough time for them to rotate through all of the centers due to their late arrival from science and the discussion with the volunteer. Instead, I decided to keep the students at the centers for longer periods of time rather than have them move quickly through all four centers. As a result, the students were only able to complete two of the four centers. I thought this was more beneficial to the students as it gave them a deeper knowledge of the graphs they were exposed to and allowed them to talk with the supervising teacher while at the centers.

I supervised the line plot center where the students counted individual boxes of raisins and created a line plot with the data. I noticed that some students were struggling to count their raisins in the boxes, however. I supported JW and MB when they were counting by having them count while I moved the raisins into a new pile. Some students struggled with understanding the concept of the line plot on their own. I supported AP by asking her pointed questions such as “Where would 108 go on the

line plot?". She found 105 and then counted three marks to the right. I also asked her where 90 would go on the graph. She extended the line to the left on her own and added 90 to the number line and put an "X" above it. This demonstrated her flexibility and understanding of line plots. I gave her a handout that I created for early finishers so that they would have extra data to add to their line plots (Figure 9.9). I had her read the sentence "How many raisins do MOST boxes have?". She signed "MUST" for most. I pointed at the word and she correctly signed "MOST". Her answer of 105 was correct.

Line Plot
Extra Raisin Data

Directions: Add this data to your Line Plot.
What do you notice about the graph?

Student Name	# of Raisins in the Box
Student A	105
Student B	100
Student C	103
Student D	109
Student E	110
Student F	105
Student G	104
Student H	110
Student I	105
Student J	100
Student L	103
Student M	98
Student N	105
Student O	108
Student P	110
Student Q	107

Figure 9.9: Line Plot- Extra raisin data

May 13, 2009- Day 3

On Day 3 there was no substitute teacher for my cooperating teacher who was absent again. During math time I planned to have each teacher or aide work with a group of students on their graphs at a table and lead a conversation about the graphs using the academic language the students were learning. Because we did not have a

substitute teacher, I was planning on having the aide lead the pictograph center. Our aide does not stay in the room throughout the day due to other duties so I was not able to talk to her about the math centers in the morning or during social science. Thus, I changed the fourth center to an activity the students could work on independently. Instead of a discussion about graphs, I had the students do nine different math review problems on a worksheet called "9 a Day" that was in their folders.

On Day 3, I saw students count their raisins in many different ways at my center. BD sorted her raisins in groups of fours and then added up how many she had after sorting. HW counted her whole box one by one whereas PG sorted her raisins out one by one on her paper towel, wrote down the numbers on her napkin underneath each raisin, and then counted them all. AP and ER sorted their raisins into groups of five each and then counted the groups of five. TM put his raisins in groups of 10 and counted by tens to find out the total number of raisins he had. RL put her raisins into random piles, counted how many raisins were in each pile, and wrote down the number next to each group on her napkin. Then she added up the totals for each of the piles. It was interesting to see the different methods that the students used to count their raisins, which demonstrated their understanding of number sense.

I explained the line plot to the students and what to do so they could get started. TM easily figured out where to put the X's on the line plot for the group's data. The worksheet had marks for each number on the number line but only 95, 105, and 115 were written on the graph. The students had to figure out the value of each mark and where to put their X's. TM filled in his graph with ease. I gave him the additional raisin data to fill in, and he was able to complete the graph by himself.

Then, I asked him in ASL, “How many raisins did most of the boxes have?” He correctly answered that most boxes had 105 raisins because five students had 105 raisins in their boxes. He also observed that he and I both had the same amount of raisins in our boxes that we had just counted.

ER was struggling to figure out where to put his mark for 90. The graph started with 95 and went to 115 so the students had to extend the graph to the left and add marks for numbers less that 95. ER correctly counted from 95 to 98 and added the numbers on his graph to the right of the 95 mark. He then wrote 90 next to 98. He did not realize that 90 should come before 95 on the graph. I showed him the graph and asked him if the numbers were getting bigger or smaller from left to right, and he said bigger. Then I asked where 90 goes and he pointed to where he put it on the number line. Then I extended the line plot to the left and added the marks for him and pointed to the one directly next to 95 and asked what number that would be. He answered that it was 94. I then did the same until he got to 90 and understood where to put his X for 90 on the graph.

I saw that most students understand line plots with a bit of support, and were able to fill in their graphs correctly and answer questions about it. On Day 4 we will have small math centers as per the usual schedule. The worksheets the students will complete will include basic math questions and make-up work including any graphs that they did not have time to work on the past two days. Students who were absent on Day 3 will be able to meet with me on Day 4 to catch up on any graphs they missed, and I will work with them one-on-one.

May 14, 2009- Day 4

On Day 4 the students worked on individual work at the centers including doing a "9 a Day" worksheet that had nine different types of review problems on it. The students also did accelerated math, fix and finish work, and subtraction practice. During the subtraction center, another teacher worked with the students and noticed that many of the students had problems 'borrowing' when they were subtracting three digit numbers from three digit numbers.

SH asked me for the data to complete the pictograph that he was unable to complete the day before. I explained to him what to do, and he was able to complete the graph on his own. At the end I asked him to read the question at the bottom of the page, which said: "The students like _____ more than _____." SH was able to fill in the blank with the animal that received the most votes (dog), and he wrote in cheetah for the other animal because it had less votes than dog. I was pleased that he read and comprehended the academic language in English of 'most' and answered the question.

If I had more time to implement my curriculum, I would have gone through the lessons as they were written: introduce the concept via group lessons and then have students do individual or small group activities. I would have liked to do a group activity with the raisins so that the students could have a lot of exposure to line plots. However, materials management was difficult with small groups of four students, so I am glad that I did this activity with smaller rather than a large group.

Next time I use this curriculum I would use a different survey for the time bar graph than the one I gave the students. I learned from the teacher running the bar

graph center that not all of the students understood the concept of weekends or that it meant Saturdays and Sundays. Some students thought the survey was asking them what time they wake up in general rather than on the weekends and they wanted to change their answers when they got to the bar graph center. The survey I gave the students was open ended and some students said they woke up after 10 am, so when the students were filling out the survey I added a category called “other” for students who woke up later than 10 am (Figure 9.10). However, this was problematic when we graphed the data and answered the questions on the worksheet. Next time I would ask a question such as ‘which is your favorite food’ and limit the choices to four or five items rather than make the survey open-ended.

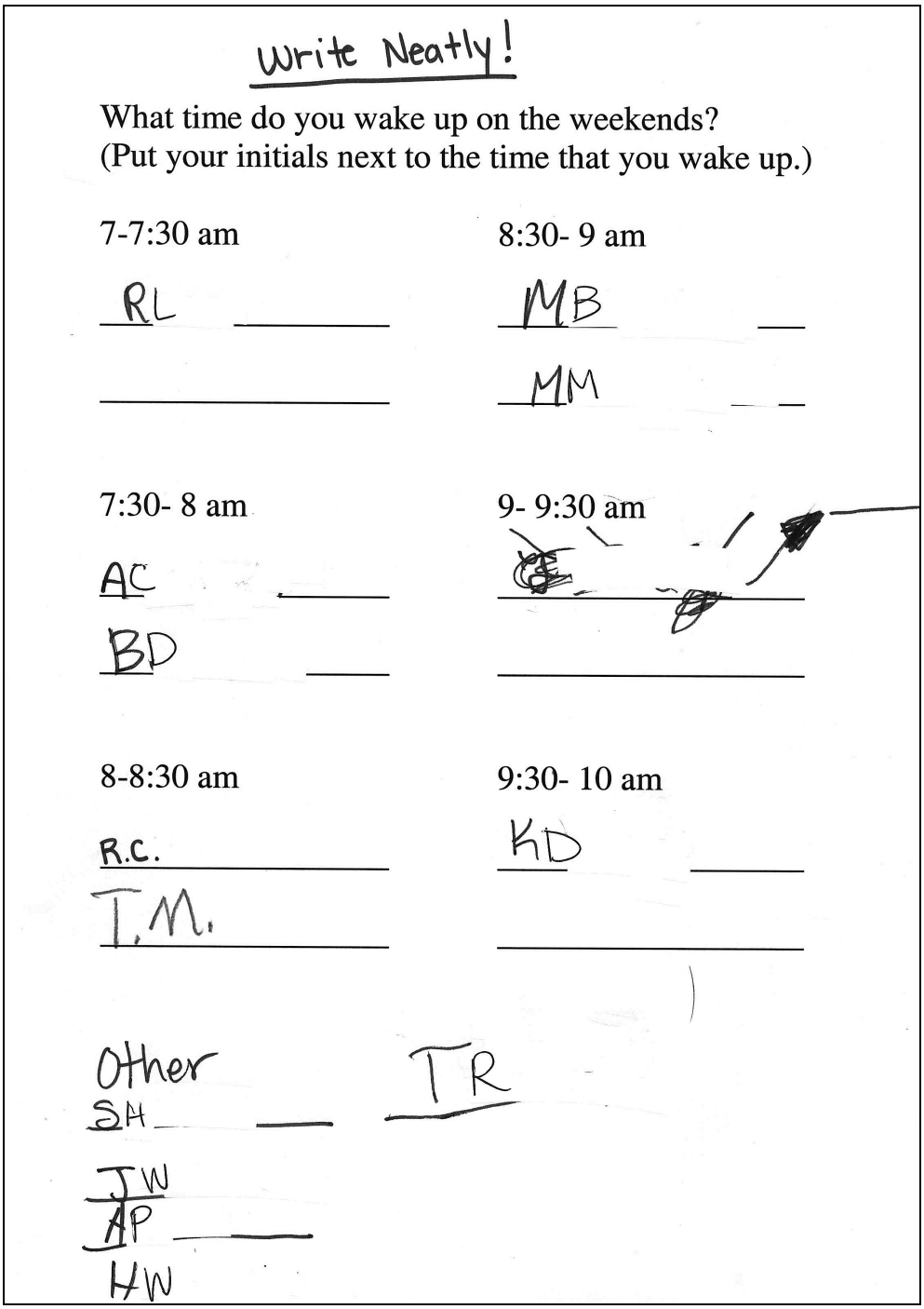


Figure 9.10: What time do you wake up on the weekends sign up sheet

May 18, 2009- Day 5

On Day 5 I deviated from my lesson plans in order to better connect content areas. The students had learned about Egypt in social studies class the previous week, and they were very intrigued by the animals that live in Egypt. I wanted to use their prior knowledge and enthusiasm as a "teachable moment" with graphs. I showed the same power point slide that the students had seen the previous week showing different Egyptian animals that live in the region (Figure 9.11). I circled the Desert Fox, Giant Solpugid, cobra, and baboon, and I set up a poster that said, "Which is your favorite Egyptian animal?" with the above choices that headed four columns. I explained to the students that I wanted to know their favorite animal from among the four choices. The students were instructed to come forward and put a tally mark on the poster for the animal that they like the most. Seven students voted for the Desert Fox, four for the cobra, and two for the baboon. No one voted for the Giant Solpugid (Figure 9.12).

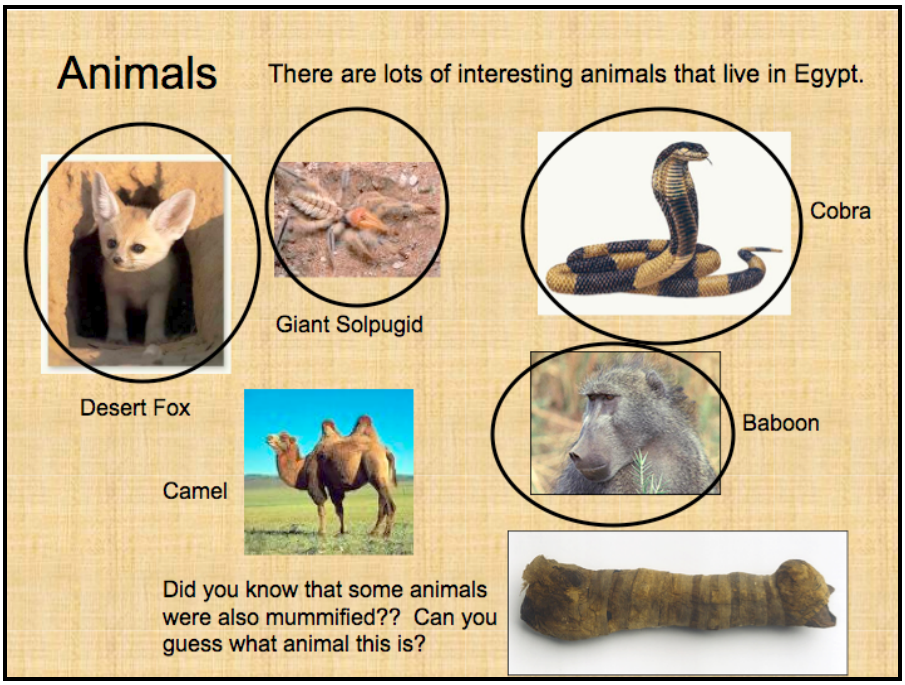


Figure 9.11: Egyptian animals slide used for group lesson on creating graphs

Figure 9.12: Student filling in her answer on the Favorite Egyptian Animals graph

Underneath the graph I wrote, "_____ has the most" and "_____ has the least" (Figure 9.13). I told the students to talk with their partner about what they notice about the graph. The students were using the language of "most" and "least" while talking with their partners about the graph. HW, AP, AC, ER, and KD signed that "Desert Fox most". When I asked who could volunteer to come to the board and write in who had the most votes based on the partner conversations, everyone except for SH raised their hands. TM came up, and I asked him which animal had the most votes. He signed, "Desert Fox because most. Desert Fox has 7, Cobra has 4, and Baboon has 2."

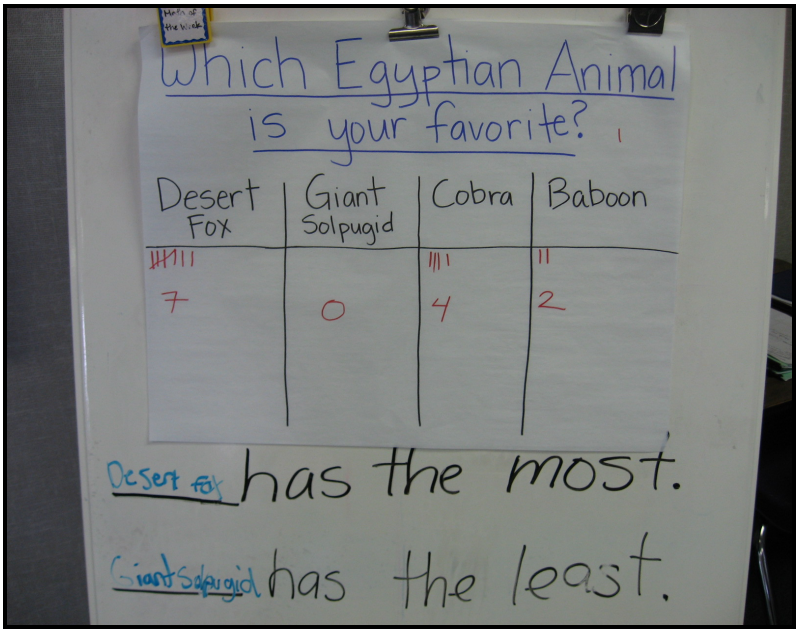


Figure 9.13: Student generated graph used for group lesson

Next I asked for a volunteer to help me figure out which animal had the least votes. Almost all of the students raised their hands to volunteer. I called on KD. She

came up and signed that “Baboon has least because has 2”. This was a common misconception with other students as well. Many of them thought that if an item had zero votes, you could just disregard it. I explained to the students emphasizing that the item with the least is the item with the smallest number. Something close to zero or zero counts as part of the problem. So I asked KD which animal had the least amount of votes, and she correctly said that the Giant Solpugid had the least.

Afterwards, I asked the students how to make a graph from the information on the poster. TR came forward and said we would need numbers on the vertical part and the names of the animals on the horizontal part of the graph. I called on volunteers to come forward and write in the four animal names on the bottom and the numbers one through seven on the vertical part of the graph. Next, JW came forward and helped me make a bar graph with the information on the poster. She drew an arc from the number 7 to the Desert Fox label on the bottom part of the graph. I helped her correct it to make a rectangular bar. Then I asked students what we would do with the Giant Solpugid, and BS responded, “Nothing because 0 votes”. I called on TR to come forward and draw the bar for the cobra, and when asked how many votes the cobra had, he responded “4”. Lastly, RL correctly created the bar for the baboon (Figure 9.14).

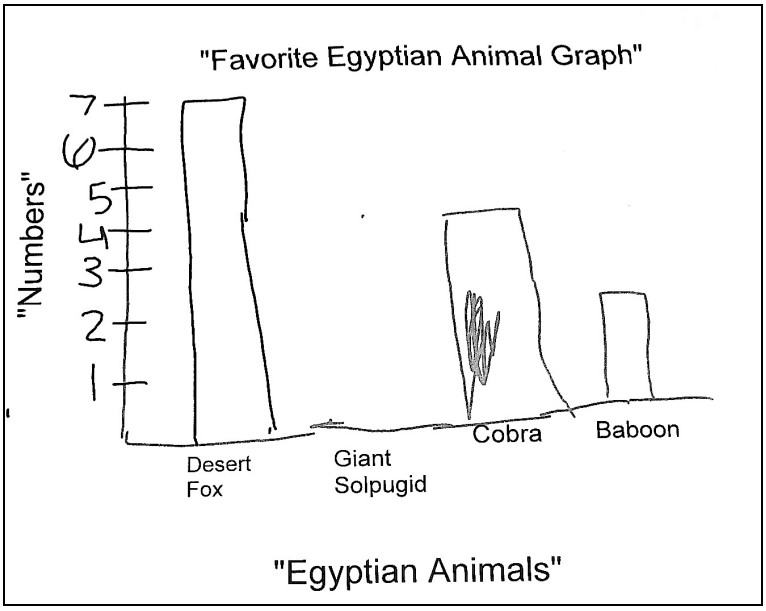


Figure 9.14: Student drawn class graph of their favorite Egyptian animals

After we created the graph I asked the students why we needed graphs. ER said that we know the information about how many students like which graph. JW said that we put in how many people like which animal. All of the students' responses were similar to this, but they did not tell me what graphs are for or why we use them. I explained that it takes a long time to ask each student about their favorite animal, however, we can learn that same information in just a few minutes by looking at a graph.

Lastly, for our daily activity I implemented a variation of Unit 2, Lesson 5 in which I had the students think of questions they wanted to ask each other to learn more about the other, for example finding out each other's favorite colors. After

allowing two minutes to brainstorm with their partners I got their attention and had them tell me their responses. At first the students thought they needed to tell their partner their own favorite color. They did not understand that they were supposed to brainstorm ideas for questions that we could ask each other. After calling on a few students for their question ideas, all of them raised their hands to give their questions. This is the list the students came up with:

What is your favorite sport?- KD
What is your favorite restaurant?- RL
What is your favorite pet?- MM
What is your favorite country?- TR
What is your favorite candy? –TM
What is your favorite cookie?- KD
What is your favorite store?- MB
What is your favorite animal?- BS
What is your favorite picture?- JW
What is your favorite movie?- ER
What is your favorite food?- AC
What is your favorite drawing?- AP
What is your favorite game?- BD

I closed the lesson by telling them that we would start a new project the next day and reviewed what they had learned about the purpose of graphs. HW came to the front and shared that we need graphs because they give us the information in one page and it is easy to read the information. I was pleased that she remembered, and I will ask the students again after the curriculum is finished to see if they have internalized the purpose graphs.

On Day 6 the students will break up into groups and either generate their own question to survey each other with, or use one of the questions from Day 5's brainstorming session. They will gather data from their peers and work as a group to create a graph. The lesson plan for Unit 3, Lesson 1 was for students to work with a

partner but I decided, due to our time constraint, to have the students work with students they are partnered with during story time called color groups. With four students per group, they will work together to generate a question to use to survey their peers in class. My team teachers suggested having each group draw a different type of graph instead of letting the students choose so that rather than multiple examples of the same graph, we would have a variety of graphs represented.

May 19, 2009- Day 6

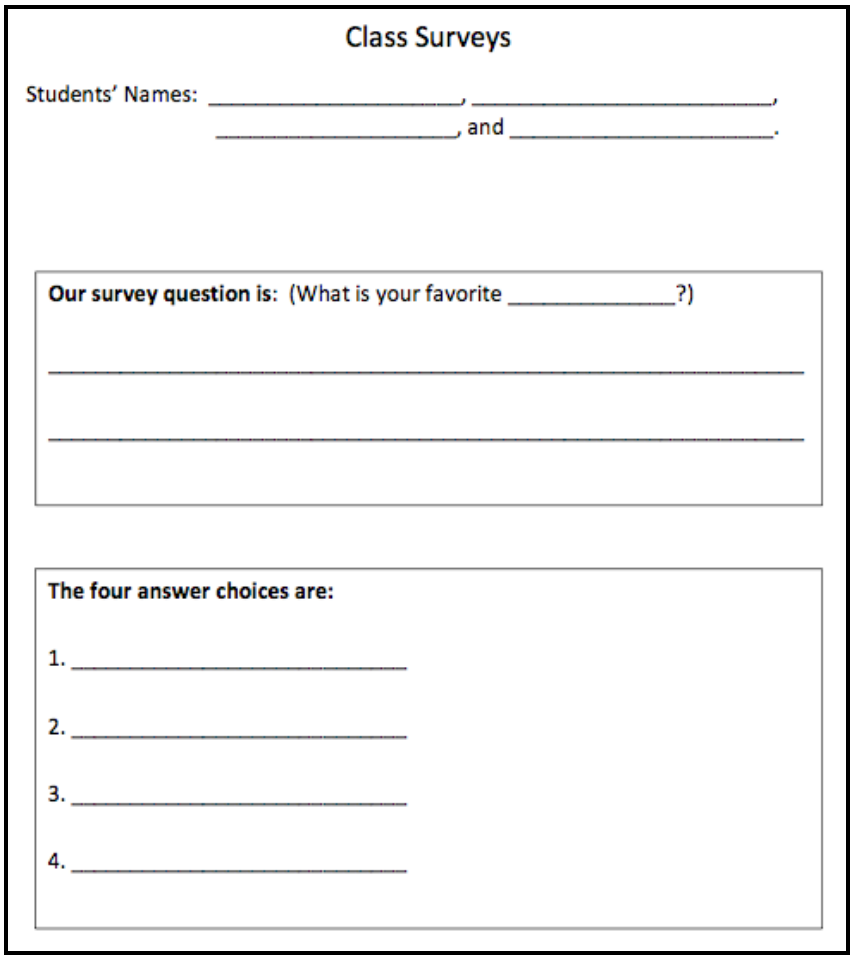
On Day 6 I reviewed with the students what we did the day before and told them that we would be modeling an example of a graph from yesterday (See Figure 9.14 above). I showed the students the worksheet and explained to them that they each as a color group would choose a question for a survey of their peers. The students were excited choose a question, and they enjoyed working with their classmates. It was a challenge for the yellow group of students (TR, HW, AP, and KD) because TR was adamant about choosing one question while the three other students wanted to choose a different question. It was a good opportunity for a lesson about compromising and how to choose a question that all of the students could agree on.

After giving them five minutes to make their decisions, I regained students' attention. Then I drew names from four popsicle sticks that each had one name of a member from each group written on them. Those students told me which question their group had decided on, and I wrote the color name next to the question on the SMART Board so all of the students could see which group was using each question.

TM asked me what I would do if two groups wanted the same question, and I told him they would choose in the order their names were chosen. Once another group had already decided on a question, it could not be chosen again. The groups picked the following questions:

What is your favorite game?- Green group
What is your favorite animal?- Pink group
What is your favorite cookie?- Yellow group
What is your favorite sport?- Blue group

The students were then instructed to work with their groups to come up with four response choices for their survey. Additionally, I explained that each group would survey the other groups, and handed out the worksheet guides to each group before dismissing them to their tables (Figure 9.15). A teacher was on hand to support each group as needed. My group's question was "What is your favorite sport?", and they decided that each member of the group would suggest one sport for the survey. MB said soccer, EC said basketball, and AC said baseball. This sparked a discussion about the difference between softball and baseball by MB. She said that softball uses a bigger ball that is generally softer and baseball uses a small, harder ball. AC confirmed that she meant baseball. Lastly, SH offered track as his sport. I told him that track usually encompasses many different sports such as shot put, hurdles, triple jump, etc. He picked football as an alternative.



Class Surveys

Students' Names: _____, _____,
_____, and _____.

Our survey question is: (What is your favorite _____?)

_____

_____

The four answer choices are:

1. _____
2. _____
3. _____
4. _____

Figure 9.15: Class surveys used for student surveying

The first group to survey the other students was the yellow group whose question was "What is your favorite cookie?". Their four response options were: ginger cookies, Oreos, chocolate chip cookies, and M&M's cookies. Two students out of the four in their group surveyed one table while the remaining two students surveyed a group each on their own. Each student said, "Which is your favorite cookie?" and gave the four options for their question. It was a good way for the students to practice signing a list in ASL on their non dominant hand by holding out their four fingers, pointing to a finger and giving the first option, and repeating this for

each of the three remaining options. It was also a good measure of ASL receptive skills because the surveyor had to perceive his peers' responses and vice versa. When each group finished they met back at their table and the next group sent out its surveyors.

The next group was the pink group, and their question was: "What is your favorite animal?". Their four response options were: white tiger, bald eagle, dolphin, and panda bear. Some students did not know what a panda bear was in my group so ER had to explain that it had a white face with black spots on their eyes and ears. Following that group was the blue group (What's your favorite sport?) and the green group (What's your favorite game?). The green group's four response options were: Wii, DS, Xbox360, and PSP. All four groups rotated through gathering data from their peers in the same way as described above.

HW noticed that there were only 13 responses on her survey when she added up all of the responses but there were 16 students in the classroom. She discovered it was because the students did not survey themselves on their own questions, and she asked me if I wanted the groups to survey themselves so there were 16 responses. I told her that we would just survey each other instead.

When my group came back from collecting responses I had them each share how many students preferred each sport so that we could fill in a collective worksheet with all of the tallies on it showing the class data. SH and AC said that soccer had the most votes. They also noted that baseball had the fewest votes. I instructed the other tables to do the same: report the results of the survey, put all of the tallies onto one

paper so that the group collectively had the information on a master worksheet, and then have each student make sure his/her paper matched the master copy.

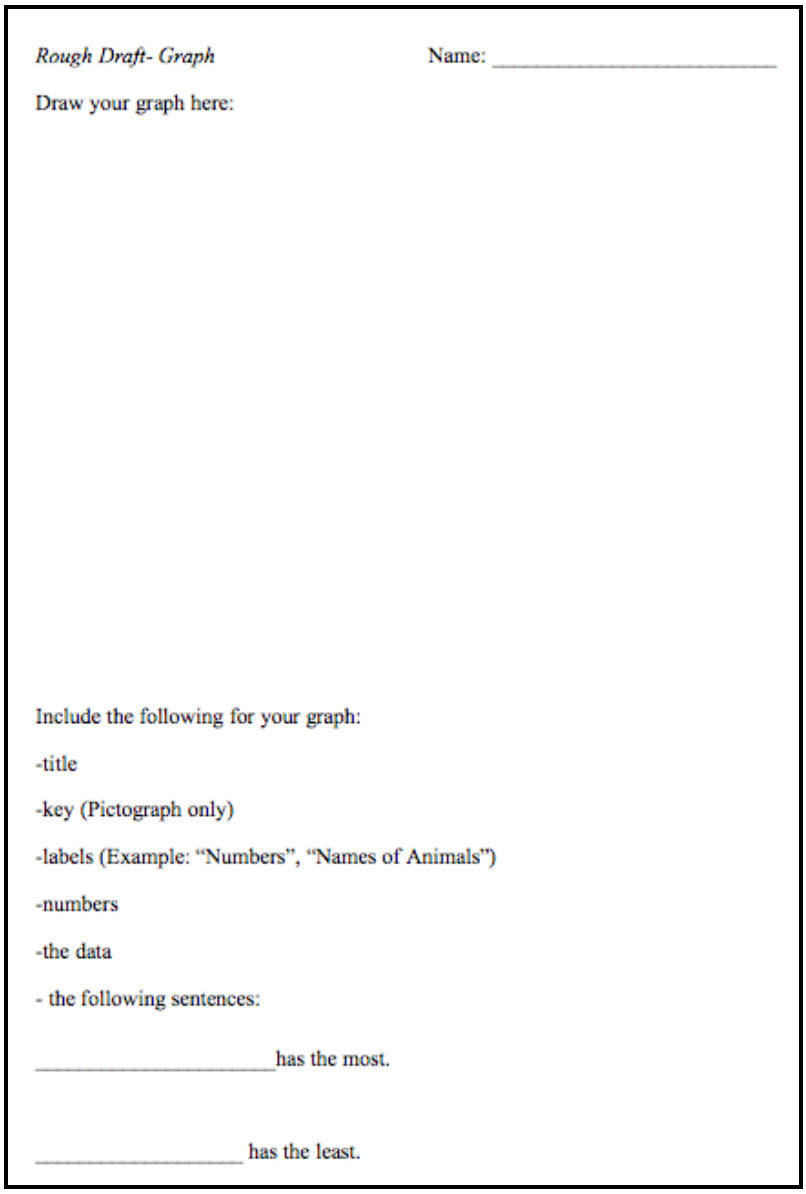
On Day 7 the students will work with their team to create a graph of the data that they collected in class. They will make a rough draft of their graph that includes a title, labels, numbers, and the information (data) from their peers. After I have checked the graph with the students to make sure that the math is correct and everything has been included the students will get a piece of poster paper on which to draw their graph. Additionally, the students will include these English sentences at the bottom of their poster: "_____ has the most" and "_____ has the least". This will reinforce the ASL academic vocabulary related to their graph because they will discuss the data with their group members in ASL. Likewise the students will write the English sentences, which will reinforce the English academic vocabulary needed to describe their graphs. Two students will work on transferring the graph to poster paper while the two other group members practice for a presentation that will take place the following day (Thursday-Day 8).

May 20, 2009- Day 7

On Day 7 during math I reviewed the four types of graphs with the students and explained that they would be drawing their graphs individually using the data they collected the previous day. I told them all the elements they needed to have on their graphs by reviewing the items on the worksheet including vocabulary, and told them they would fill in some sentences about which category of their graph had the most or least votes. Additionally, I assigned each color group a type of graph to draw and

reviewed what it looked like using my poster as a model; the blue group was assigned the line plot, yellow and green groups the bar graph, and the pink group was assigned the pictograph. I told the students that I would give them poster paper after they checked in with me and that two members of the group would draw the graph onto the poster and the other two would practice the presentation for the following day.

The students dispersed into their groups, and I handed out the worksheets for them to use as a guide (Figure 9.16). The worksheets had a list of things to include on the graph as well as space for them to draw their own graph and complete the most/least sentences. I encouraged the students to ask each other for help before asking me. One of the three team teachers was out of the classroom today due to a family emergency. She was involved in the activities the previous day so I explained the lesson to the substitute teacher. Also two other teachers had to leave the class for about 15 minutes to get some materials for the following week, so I monitored all four groups with the support of the substitute teacher.



Rough Draft- Graph Name: _____

Draw your graph here:

Include the following for your graph:

-title

-key (Pictograph only)

-labels (Example: "Numbers", "Names of Animals")

-numbers

-the data

- the following sentences:

_____has the most.

_____ has the least.

Figure 9.16: Handout for students to draw a rough draft of their graphs

The blue group was assigned the line plot to graph responses to the question "What is your favorite sport?". I observed that SH did a great job drawing his line plot. He needed prompting to add the label for the items on the line plot, he outlined the names of the sports with boxes, and he did not have a clear line at the bottom of

the graph with arrows in opposite directions. I prompted him by showing him the line plot example on my poster with the different kinds of graphs and asked him if he saw boxes and labels on the graph. This prompted him to fix his mistakes himself.

EC was absent today so he was not in the group. MB looked at my poster example and started drawing the exact graph from the poster, the subject of which was different types of shoes. I asked her what she was doing, and she replied she was drawing a line plot. Then I prompted her to use the information from yesterday's survey activity to draw a line plot. She erased her shoe line plot and replaced it with the sports line plot, however she and AC added numbers up the side of the graph. I asked them both if the example line plot had numbers anywhere on it. They responded negatively and erased the numbers.

Next I asked who from the group would be drawing the graph and who would be presenting on the following day. SH wanted to draw the graph and AC and MB wanted to practice for the presentation. I gave them their poster paper so they could begin. SH drew the graph in pencil and checked with me to get approval. I gave him some feedback of how he could improve the graph (write larger, add the most/least sentences, and outline in black marker). Additionally, I checked in with MB later, and she was practicing the presentation. I gave her some feedback (instead of just saying "sports" say "Our group's question was 'What is your favorite sport?'" and name the members of the group).

I checked in with the yellow group whose question was, "What is your favorite cookie?". The students were creating their bar graphs and had some issues with TR because he was not cooperating with them. I had the aide work with TR while the

other three moved on to drawing their graphs and answering the questions. When one teacher came back from getting supplies, she worked with the group to find the "most" and "least" votes for their data. Many of the students still struggled with "zero" representing the least. The group wanted to discount the two choices with zero votes when they were considering which option had the least votes. I was glad to have the opportunity to clarify that concept with this group of students one-on-one.

I checked their individual graphs with the list of items that needed to be included. HW, AP, and JW had forgotten to include the labels, and the title of their graph was "Cookies". I suggested they name their graph "Favorite Cookies" so as not to confuse the labels for the types of cookies on the bottom and the number of students who liked each kind on the side. I asked the students what was on the vertical axis of the bar graph, and they responded numbers 1, 2, 3, 4, 5, etc. I asked them what they could write as a label on that side, and they said, "Numbers". The horizontal axis of the bar graph named different types of cookies so they suggested "Cookies" as a label. AP, HW, and JW wrote their labels and corrected the title, and I gave them their poster paper. HW said she would present, and JW and AP would create the graph of the poster.

Next I checked on the pink group whose question was, "What is your favorite animal?". This group was doing a pictograph. ER had just returned to his seat after being absent from class for reading when I got to their table. He was drawing a bar graph of his information from the previous day, however his group members were all drawing pictographs. I pointed to the other students' papers and told ER that their group was assigned to draw a pictograph. He erased his graph and started again.

TM was drawing lines with a ruler for a table on his graph. When I returned to the table he had written in all of the animal names and used tally marks to represent the number of votes each animal got. I showed him my poster and asked if the pictograph had any tally marks. He responded negatively and erased his tallies and then drew a Key using a paw print to represent one animal. He also listed the number of votes each animal had next to the corresponding lines. When he was finished I asked him if he saw any numbers on my example, and then he erased the numbers and answered the questions on the graph.

MM was drawing her pictograph and also had numbers written to the right of each animal. She erased the numbers and completed her graph. Her pictures were beautifully drawn, and she had answered all of the questions correctly on her worksheet. BD was working on her graph, and the teacher asked her how many tally marks she had to be sure that she understood the tally system. BD first answered three when asked how many tallies there were for the white tiger (answer 5) then she self-corrected to five. When all of the students in their group finished their graphing worksheets I gave MM and BD the poster paper to begin working on the graph. TM said he and ER would present the information the following day.

The last group (green group) was working with the substitute teacher so I did not check on them as much as the other groups who did not have any support. Their question was, “What is your favorite game?”. I came to their group at the very end of class right before the day was over. One student had gotten the poster paper on her own without checking with me first so I did not get a chance to approve her graph. I looked at her graph and saw that she had drawn a bar graph with 16 people preferring

the game Wii. Since only 13 students were surveyed during the day I was alarmed immediately that there was an error on her graph. She had 16 people for Wii, 3 for PS3, and others. I asked her where her original paper was, and she showed me. It only had six responses for Wii and had a total of 13 tallies altogether. She said the substitute gave her the additional information to add. I should not have assumed that the substitute understood the assignment nor should I have assumed that the students would figure it out. This was a big error on my part, and I should have worked with this group to make sure they understood. It was good, though, that I was able to check in with them and catch the errors.

On Day 8 all of the groups will continue working on their graphs, and they will all present them towards the end of math class. I will work with this fourth group to help them fix their graphs and help them draw a correct bar graph on their poster paper. For their presentations the students were instructed to include a title for their graph, the type of graph they drew, the most/least questions, and who was in their group.

May 21, 2009- Day 8

On Day 8 I gathered the students into a circle in the meeting area. After another teacher announced the end of the year field trip I announced to the students that their multiplication test scheduled for the following day would be moved to Tuesday. These few announcements set us back in time a little bit, but I explained to the students that they would keep working on their graphs and add color if they were finished. I told the two students who were presenting from each group to stay in the

circle so I could show them the rubric that I would use to evaluate their presentations. I dismissed the other students to get started, and I asked another teacher to work with the green group on fixing their graphs while I worked with the presenters.

The students who were doing the presentations wanted to start practicing right away. MB was supposed to present with AC for the blue group but MB was absent. The blue group only had two members present today (SH and AC) so both members had to finish the graph and present the information. I showed the students who were presenting the rubric I had created for them. I told them they needed to include five elements in their presentations: introduce the title of the graph, list the four options that the students were given to choose from, present the data, identify which type of graph they used, and which choices had the most/least votes.

The students were eager to begin practicing their presentations. They found music stands, podiums, and tables to prop their worksheets up on. ER and TM practiced close to the door and wrote down on their worksheets who would say what and then practiced as the substitute teacher watched and gave feedback. HW practiced in the front corner of the classroom and then asked me for feedback. I went through the rubric and asked if she had all five elements. She forgot to include the type of graph she was presenting so she went through her presentation again and added that her group had drawn a bar graph.

RL was a part of the group whose data needed to be fixed. She needed her worksheet to practice for the presentation but the graph she had made the day before was incorrect. I helped her fix it and then watched as she went through her presentation. She asked me what “data” meant, and I responded that it is what you

collected yesterday (who likes each type of game and how many people you surveyed). The second presenter from her group, PG, decided she did not want to be a part of the presentation even though I told her she could just help RL hold the graph so I watched RL practice her presentation by herself. PG did not even want to hold the poster, so I told her she could help draw the graph on the poster paper, but she did not want to do that either. Eventually she decided she would help draw the graph.

SH and AC added color to their graph, and I checked in with them before they presented. I asked them if they included all five elements when they practiced their presentation. I listed off each criterion and when I asked which type of graph they made SH said it was sports. I told him that was what their survey was about and asked again which type of graph they were using, referencing my poster with the four types of graphs on it. He said, "The one with the X's on it". I asked him the name in English, and he said he did not know. I told him it was called a "Line Plot" and had him fingerspell it several times to practice.

I checked in with the other groups to make sure they were still working. The yellow group (favorite cookie) was doing a bar graph and added designs inside their bars. The pink group was adding color to their graph, and I did not notice that they did not include the most/least sentences on their poster until they were presenting but they did include the information in their presentation. The green group was working with a teacher while one student drew the graph and the other student colored in its bars. I flashed the lights when I saw that everyone was ready to move on and instructed the students to come to the circle after cleaning up their areas.

I kept the evaluation sheets on a clipboard so I could evaluate the group presenters as they were presenting, and I asked the volunteer to take pictures of the students as they presented their graphs. Before we began I told the students that I expected them to pay attention to each presenter because when it was their turn the students would want their peers to pay attention to their presentations. The blue group presented first (Figure 9.17). They included everything except explicitly stating the four response choices. At the end, I had them state the four choices, and I made sure that all of the students applauded when they finished.

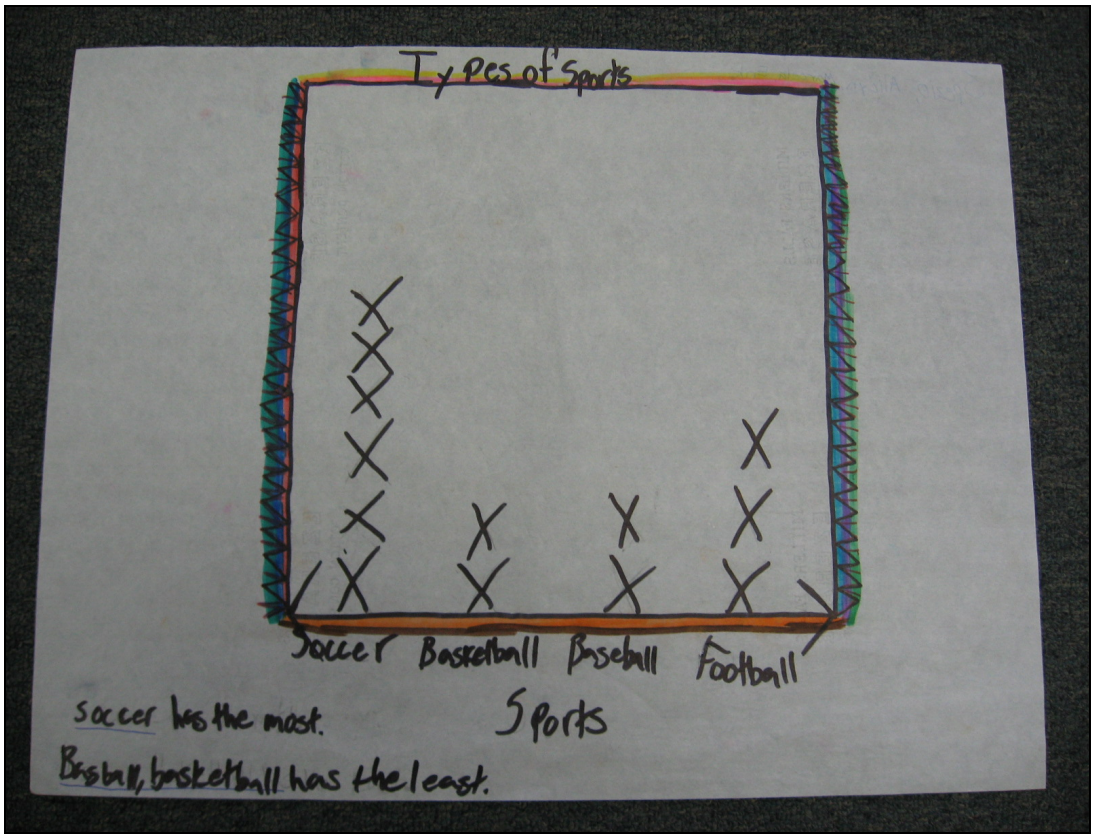


Figure 9.17: The blue group's line plot-"Favorite Sports"

Next, I called on HW to present because she initially said she wanted to go first, but I let SH go first because he asked me before HW did. Two group members

held the poster for her while she presented (Figure 9.18). She explained that their group's question was, "What is your favorite cookie?" and said there were four options. She set up an ASL list pointing to each of her four fingers as she spelled each of the following: Oreo, ginger, M&M, chocolate chip cookies.

Yellow Group's Graph

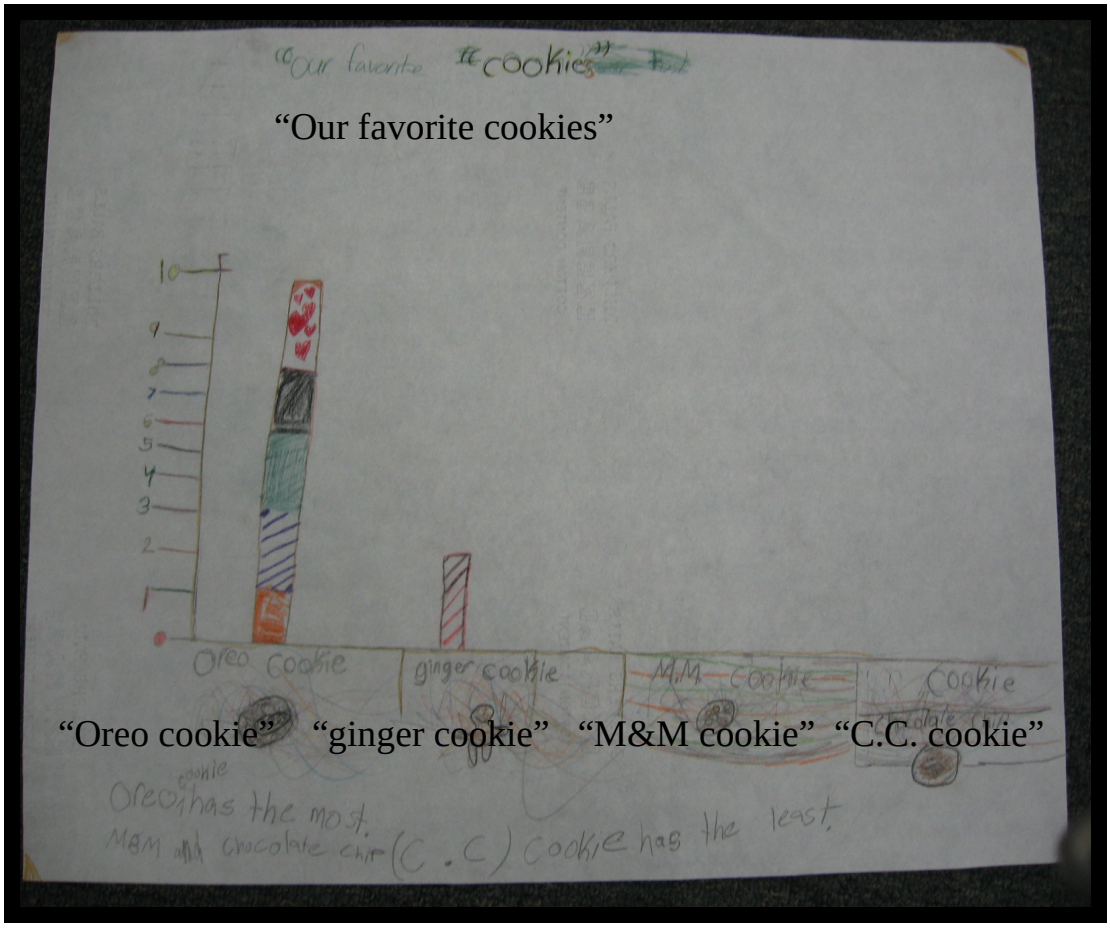


Figure 9.18: The yellow group's bar graph-"Favorite Cookie"

Then she said she asked all of the students their favorite cookie, tallied their responses, and made a bar graph. She told us that Oreo had the most with ten votes and ginger had three votes. M&M's and chocolate chip cookies had the least votes with zero for each. The students all applauded her group, and the yellow group sat down.

The green group jumped up next to present. RL presented the info while two other students held the poster for her (Figure 9.19). This was the group whose data had errors and their graph needed to be redone earlier in the day. The graph looked great! It was clean, colored nicely, and was mathematically correct in that it matched the data. It only lacked labels for the horizontal and vertical axis. I was not able to check the graph over before we went ahead with the presentations so I addressed this omission during their presentation.

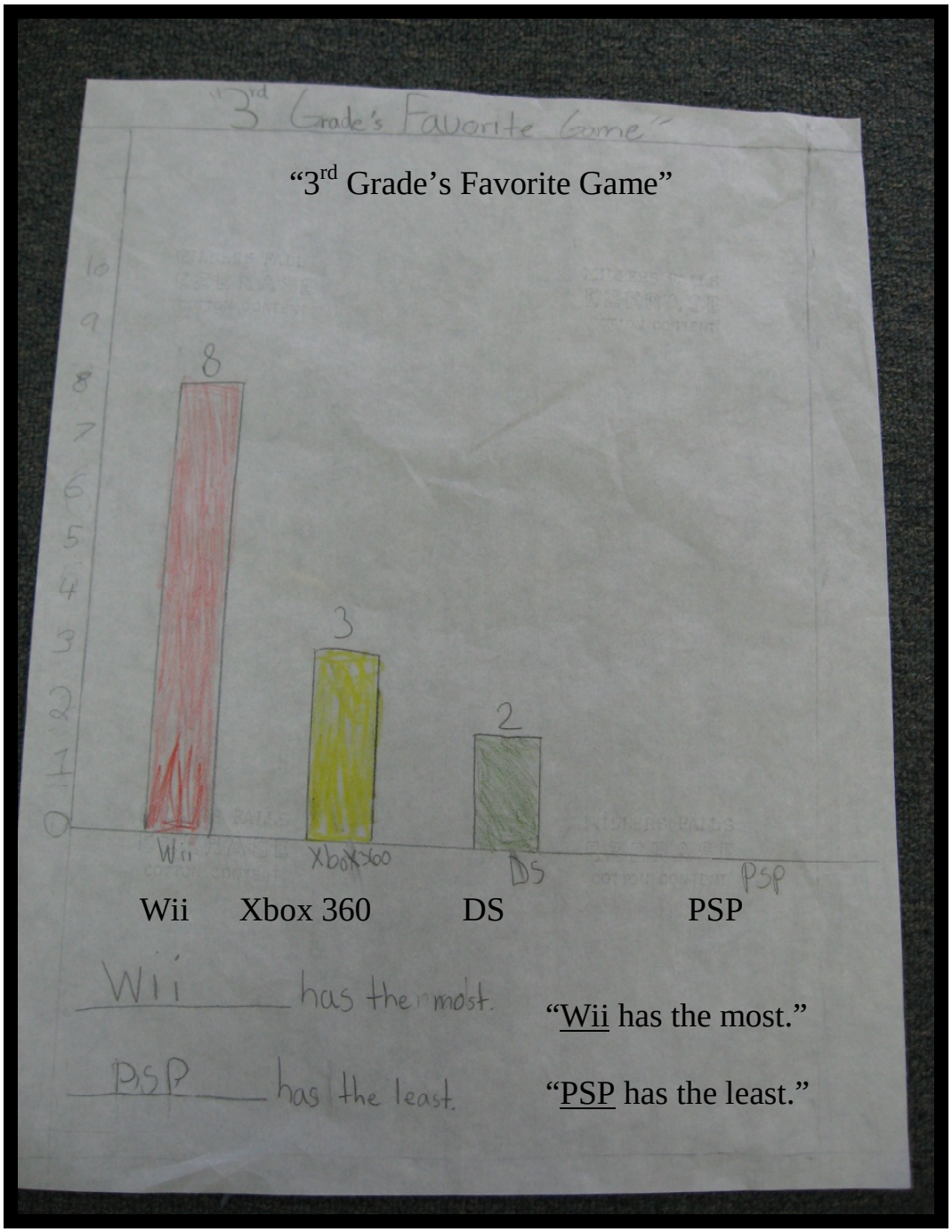


Figure 9.19: The green group's bar graph-"Favorite Game"

RL did a good job presenting the information. Her signing was clear, and she included all of the criteria from the rubric. She started by saying the type of graph

(bar graph) and then introduced the title of the graph, which was “Favorite Game”. She listed the four options: Wii, PSP, Xbox360, and DS. Next she said how many people voted for each option, and she ended by saying which of the four games had the most and least votes.

The last group to present was the pink group. TM and ER presented together while MM and BD held their poster (Figure 9.20). TM introduced the group’s question and held out his four fingers to make an ASL list. ER pointed to the first finger and signed the first animal: white tiger; pointed to the second, third, and fourth fingers and signed bald eagle, dolphin, and panda bear, respectively. It was a creative way to present the information using two people and ASL. Next TM explained the data and said the graph was a pictograph. Lastly, ER told the group which animal had the most and least amount of votes. At the end of their presentation I commented on how the two students took turns presenting and how they used a creative and unique way to present the information. We applauded this group like we had done with all of the groups.

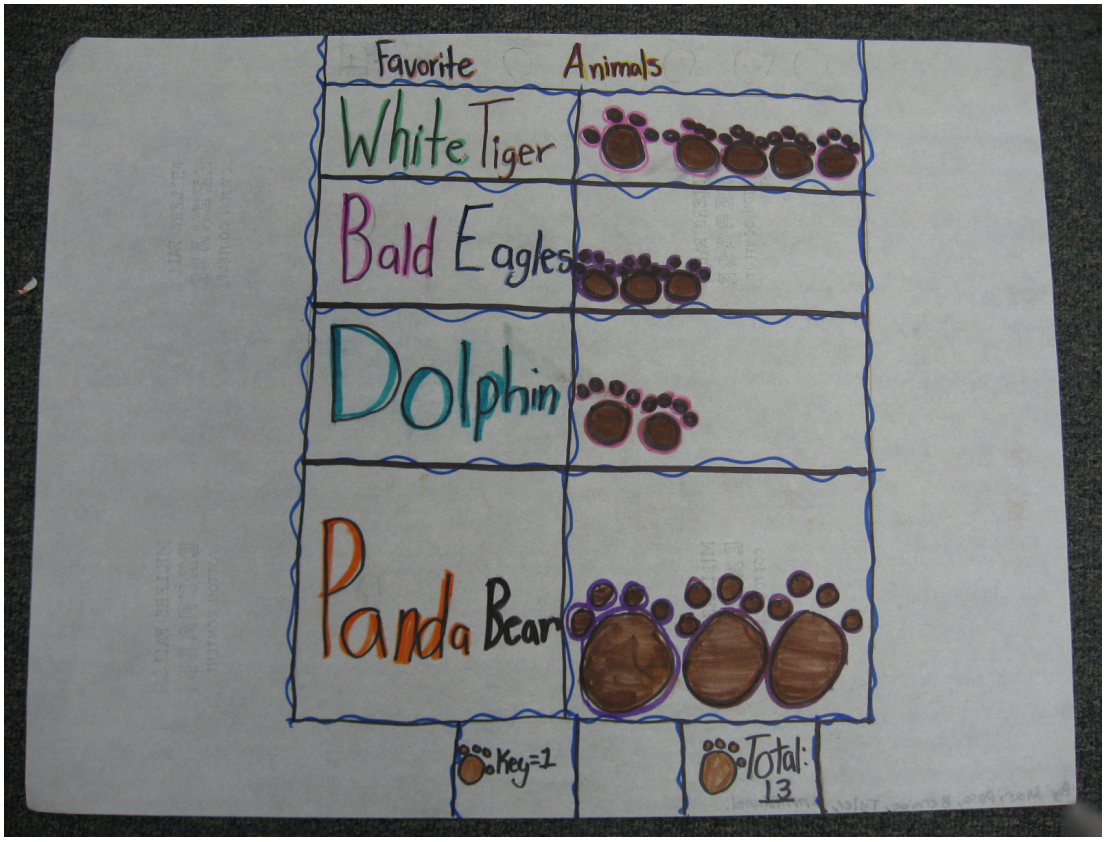


Figure 9.20: The pink group's pictograph-"Favorite Animal"

Following the final presentation we had five minutes to talk about graphs and wrap up the curriculum. I asked the students to name one kind of graph for me. TM used the poster and signed "pictograph, bar graph, Venn Diagram, and XXX". I asked SH to tell us the English name for the graph with the X's. He came forward to the front of the circle and fingerspelled "line plot".

Next I asked the students what graphs are for, and MM said it helps you so you do not have to remember all of the information yourself. SH said you could ask people what they like, tally it up, and make a graph so it is easy to read. AC said if you forget while you are presenting you can use a graph to help you remember the information. The students learned so much about graphs that they had not known

before. Mainly, they had not known what purpose graphs serve, and I think they worked with graphs in a fun way, which enabled them to internalize the purpose of graphs.

X. Results of Curriculum Evaluation

Using the methods of data collection and analysis mentioned in the Evaluation Plan (Section VII), the following student and teacher artifacts, observations, and rubrics were used to determine if the five overall curriculum goals were successfully met. An analysis of the data suggests that the students were successful in meeting four of the five goals in a variety of ways.

The first goal of the curriculum was for students *to experience different types of graphs*. Throughout the eight days that I implemented the math graphing curriculum students created a variety of graphs including: bar graphs, pictographs, line plots, and Venn Diagrams demonstrating that they met this first goal. They participated in creating surveys and generated answers for these graphs. The table below (10.1) shows the type of graph in the curriculum, the data source for the graph, and the activity in which the students participated for each graph. After talking with my cooperating teacher and determining it was too difficult for the students, I decided not to teach the circle graph; it is the only graph from my curriculum that was not implemented.

Table 10.1: Types of graphs

Type of Graph	Data Source	Student Activity
Tally Graph	Discussion of Students' Favorite Egyptian Animal	Group Tally Graph
Bar Graph	Group Tally Graph	Group Bar Graph
Bar Graph	Survey: Weekend Wake Up Times	Individual Bar Graph
Pictograph	Survey: Favorite Animal	Individual Pictograph
Line Plot	Students Count Raisin Boxes with Groups	Individual Line Plot
Venn Diagram	Group discussion about Two Teachers	Group Created Venn Diagram
Venn Diagram	Student Discussions with a Partner	Individual Venn Diagram
Final Project	Student-collected Data	Group Graphs-Various

For the tally graph I used the students' excitement about the Egyptian animals that we had learned about in class the previous week. I showed the same power point slide that the students had seen the previous week showing different Egyptian animals: Desert Fox, Giant Solpugid, cobra, and baboon, and I set up a poster that said, "Which is your favorite Egyptian animal?" with the above choices that headed four columns. I explained to the students that I wanted to know their favorite animal from among the four choices. The students were instructed to come forward and put a tally mark on the poster for the animal that they like the most. Seven students voted for the Desert Fox, four for the cobra, and two for the baboon. No one voted for the Giant Solpugid (Figure 10.1).

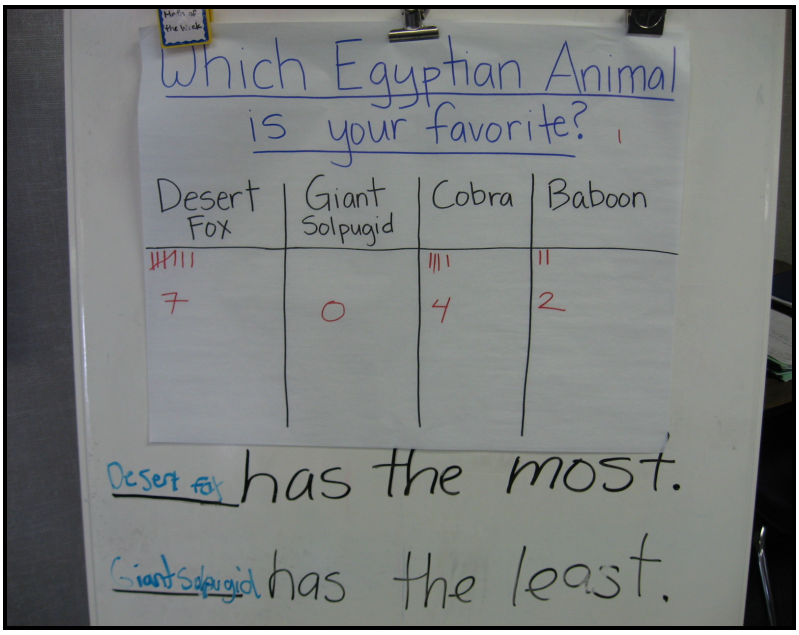


Figure 10.1: Student generated graph used for group lesson

We had a discussion about which animal was liked the most and which one was liked the least after doing the tally graph. A common misconception came up during this time. Many students thought that if an item had zero votes, you could just disregard it. I talked with the students emphasizing that the item with the least is the item with the smallest number. Something close to zero or zero counts as part of the problem. After this discussion I asked the students which animal was liked the least again and KD correctly said that it was the Giant Solpugid.

Afterwards, we made a bar graph from the tally graph information. TR came forward helped to set up the graph saying we would need numbers on the vertical part and the names of the animals on the horizontal part of the graph. Volunteers came forward to create the graph. JW drew an arc from the number 7 to the Desert Fox label on the bottom part of the graph. I helped her correct it to make a rectangular bar.

Then I asked students what we would do with the Giant Solpugid, and BS responded, "Nothing because 0 votes". I called on TR to come forward and draw the bar for the cobra, and when asked how many votes the cobra had, he responded "4". Lastly, RL correctly created the bar for the baboon (Figure 10.2).

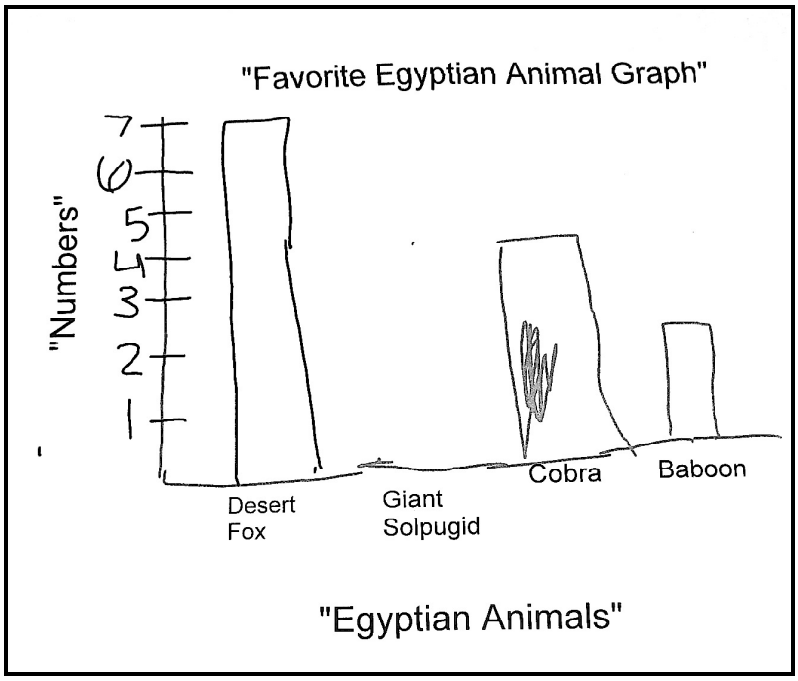


Figure 10.2: Student created bar graph

For the individual bar graph activity the students used a survey of student responses from the morning meeting. The survey asked students the question "What time do you wake up on the weekends". Working in small groups with a teacher as a guide, students created bar graphs using the survey information. On the vertical axis were the numbers 0 to 10 and the label "Number of Students". On the horizontal axis were time frames in half hour increments starting with 7-7:30am through 9:30-10am and the label "Time". The student example from AC (Figure 10.3) shows she

understood how to accurately graph the data onto the bar graph. Additionally, she answered the questions below the graph. For the first question “What do you notice about this bar graph” she replied, “Lot of number is other 5 most”. That shows me that she recognized that the majority of the students (5 of them) woke up later than 10 am and she graphed this as “Other” in the final column.

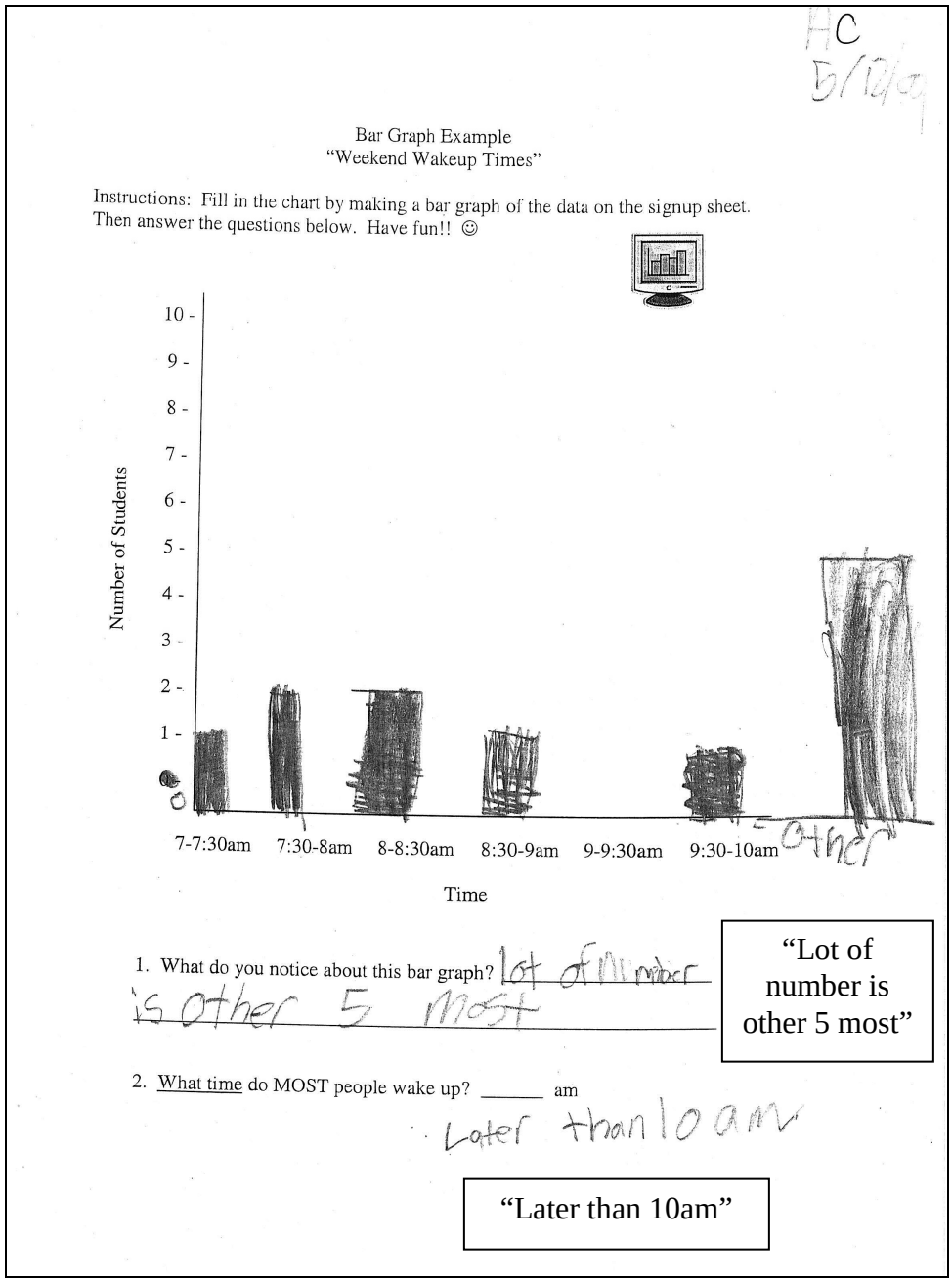


Figure 10.3: AC's bar graph

The pictographs were made during implementation with a substitute teacher at one of the centers using the survey from morning meeting. The survey asked students to write down their favorite animal next to their name. One paw print represented one animal on the graph. Students counted how many of each animal was on the survey

and drew the appropriate number of paw prints for that animal on the pictograph. The students then had to identify which animals were not written on the graph and write them in, then they had to draw the corresponding paw prints for the number of students who voted for that animal as their favorite animal. Figure 10.4 shows AP's pictograph. She used the data from the survey to create her pictograph and was able to accurately answer the questions underneath the graph. The first question asked what was on the graph. Students could write in the animals that were mentioned on the graph. The next question said "More students liked _____ than _____". AP correctly responded that students favored dogs more than cheetahs as dogs had 6 votes and cheetahs had 3 votes.

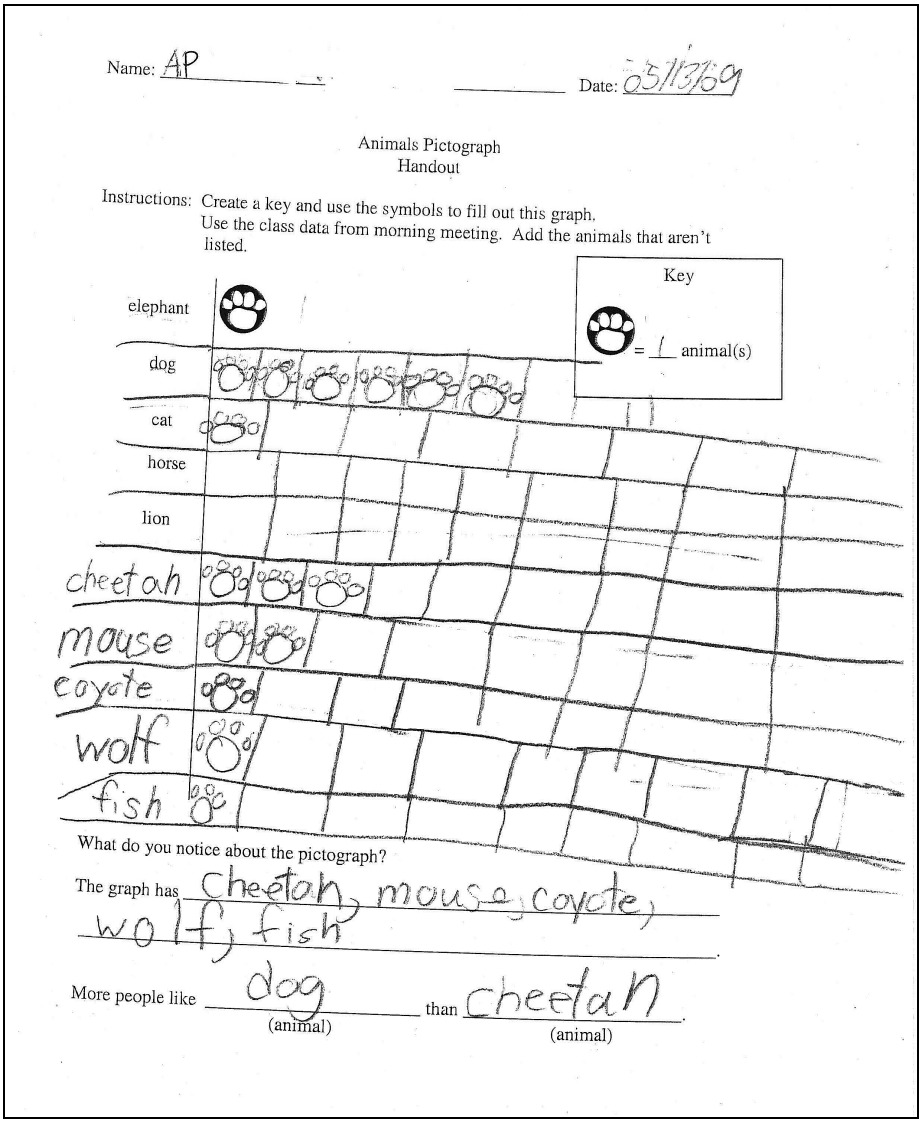


Figure 10.4: AP's pictograph

The next graph that the students created was the line plot. During the center activity each student was given a small box of raisins and were asked to count how many they had in their own box. Then they had to write down how many they had and how many each member of the group had and then graph the information. Lastly they were given some additional data to graph to add more data points to the line plot.

KD's graph is below in Figure 10.5. She was able to accurately graph her own data and the additional data on the graph. Some students struggled to count their raisins and one student struggled to graph the data. Next time I do this activity I would have students work with a partner or do the graph as a whole class.

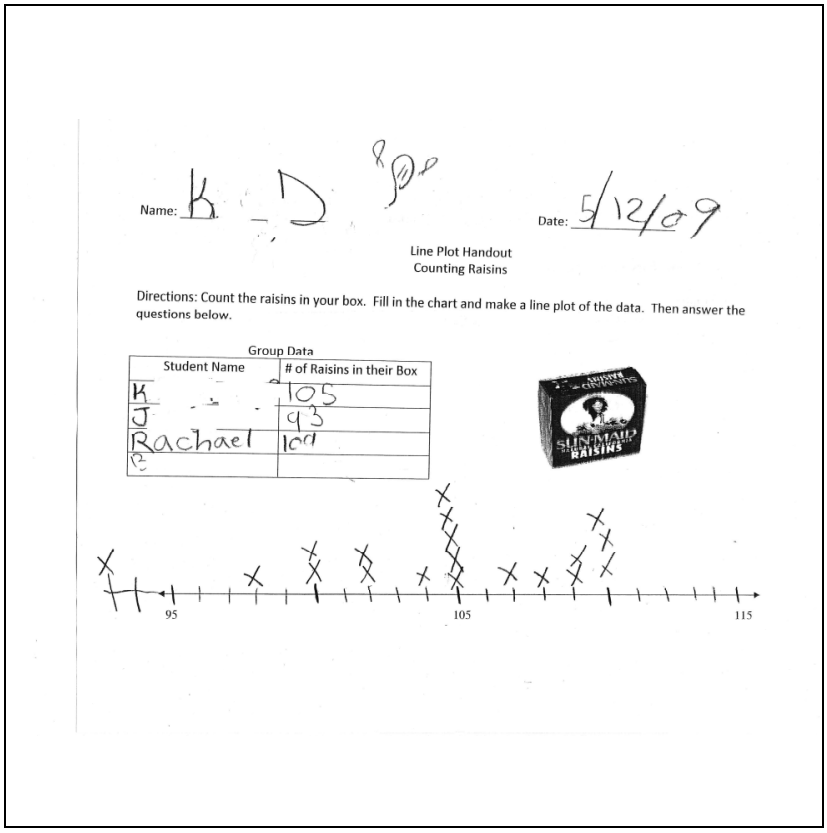


Figure 10.5: KD's line plot

Students also participated in creating a group Venn Diagram by comparing two of their teachers. They were very enthusiastic about giving characteristics about one teacher and about me. Their responses are listed in Table 10.2 below.

Table 10.2: Student generated responses for Venn Diagram

Teacher 1	**Me**
Funny	Tall
Good teacher	Funny
Champ!	Serious teacher/ strict
Sweet	Curly hair
Cute/beautiful	Cool
Tall	Sweet
Long hair	Smiles a lot
Strict	New teacher
Rides a motorcycle	Wears glasses
Old teacher	Wears contacts
Smart	Smart

I asked the students to look at the list and tell me which things the other teacher and I had in common or what traits we both had on our lists. We circled these words on both lists as they named them. Then we created a Venn Diagram with the information on the SMART Board, and I explained that the things that are the same go in the middle circles that overlap and the differences go in the outside circles. Students again told me which traits the other teacher and I had in common, and I wrote these words in the middle circles. Then we listed the 'different' traits in the outside circles (Figure 10.6).

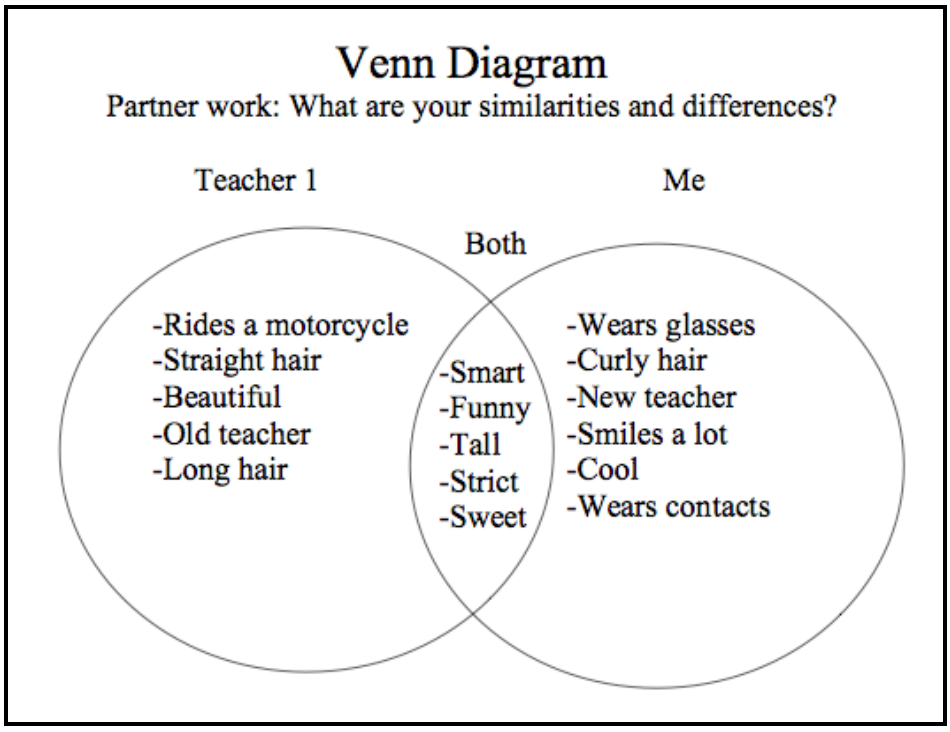


Figure 10.6: Venn Diagram used for group instruction

The next day in class students created their own Venn Diagrams with a partner. They first listed characteristics about their partner and themselves on a piece of paper and then circled the similarities. Then they transferred the characteristics to the Venn Diagram. In Figure 10.7 below MM created her Venn Diagram with partner SH. They had most things in common: "curly hair, pink, bike, computer, sisters, skateboard, and Vans". Their differences were that SH liked dogs, snakes, and ate meat whereas MM liked cats, coyotes, and is a vegan.

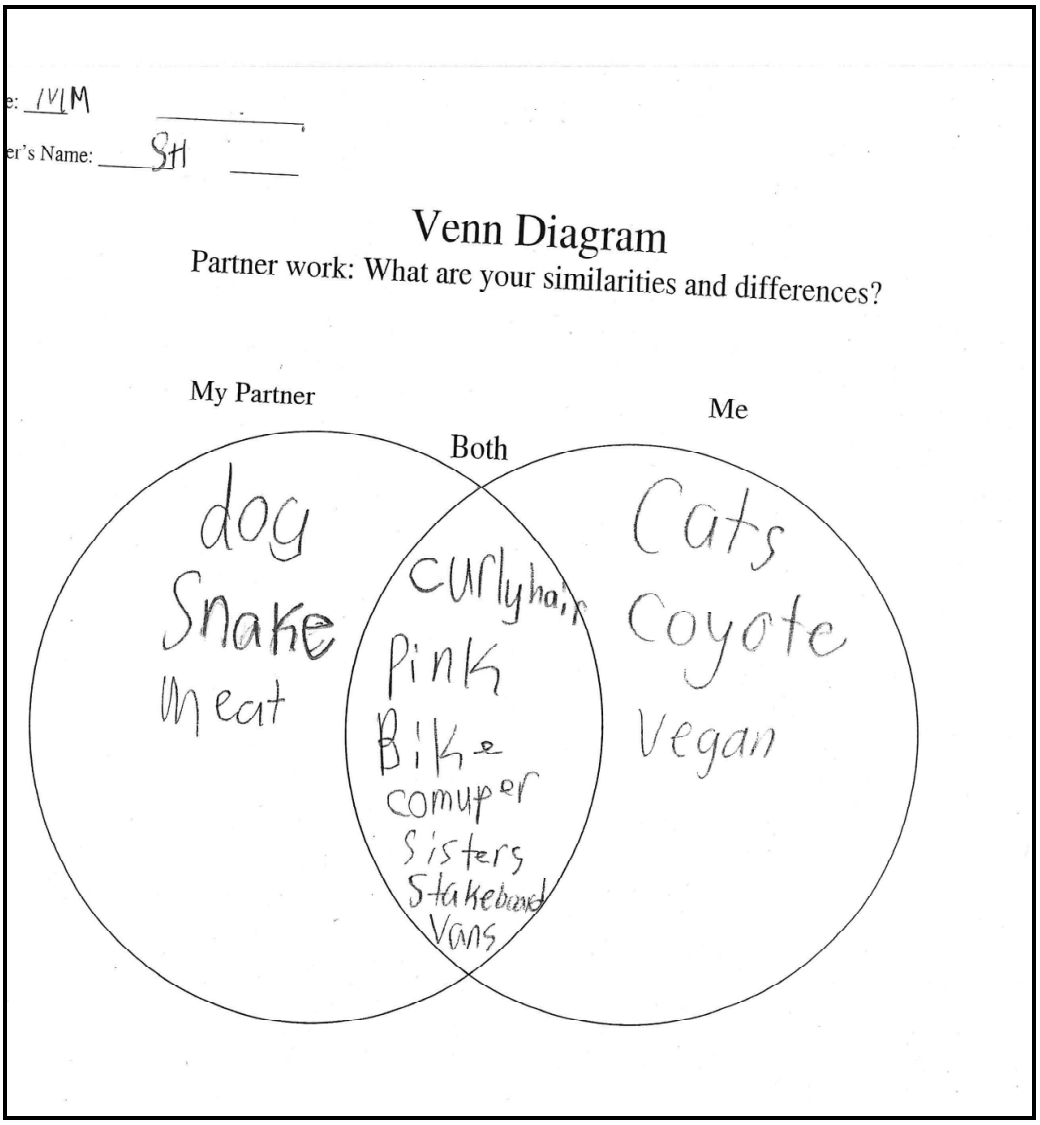


Figure 10.7: MM's Venn Diagram

Additionally, a teacher-produced poster on the various types of graphs used in the curriculum was presented to the students initially and then posted on the wall throughout the implementation process so students could refer to it if needed (see Figure 10.8). The students referred to this poster at times during the curriculum. For the final project the students created their own survey questions and collected data

from their peers. The students then graphed the data onto one of four graphs. During this time they often referred to the poster to help them make their respective graphs.

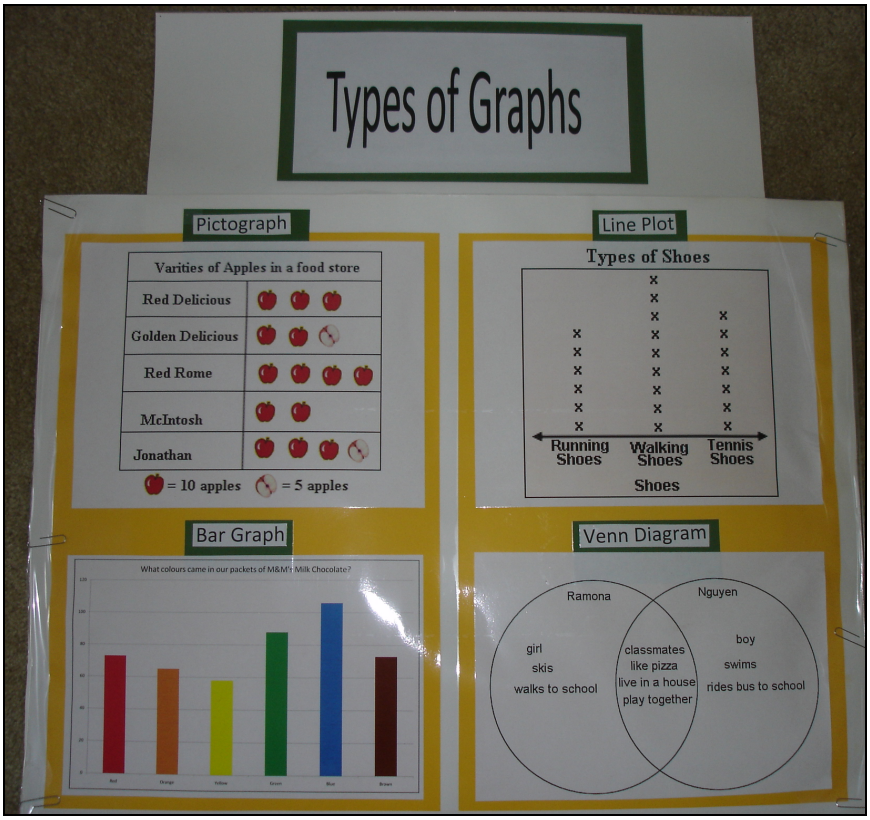


Figure 10.8: "Types of Graphs" poster

The final project tested students' abilities to create their own graphs from data they collected themselves. Students brainstormed question ideas with a partner first and then I called on them to give their ideas. This is the list the students came up with:

What is your favorite sport?- KD
What is your favorite restaurant?- RL
What is your favorite pet?- MM
What is your favorite country?- TR
What is your favorite candy? –TM
What is your favorite cookie?- KD
What is your favorite store?- MB
What is your favorite animal?- BS

What is your favorite picture?- JW
What is your favorite movie?- ER
What is your favorite food?- AC
What is your favorite drawing?- AP
What is your favorite game?- BD

The students were grouped with their reading groups or color groups and chose a question to use to survey their peers. The yellow group of students (TR, HW, AP, and KD) faced a challenge; TR was adamant about choosing one question while the three other students wanted to choose a different question. The experience of working as a group was a good opportunity for a lesson about compromising and how to choose a question that all of the students could agree on. After about five minutes the groups chose their question. This list shows the final choices:

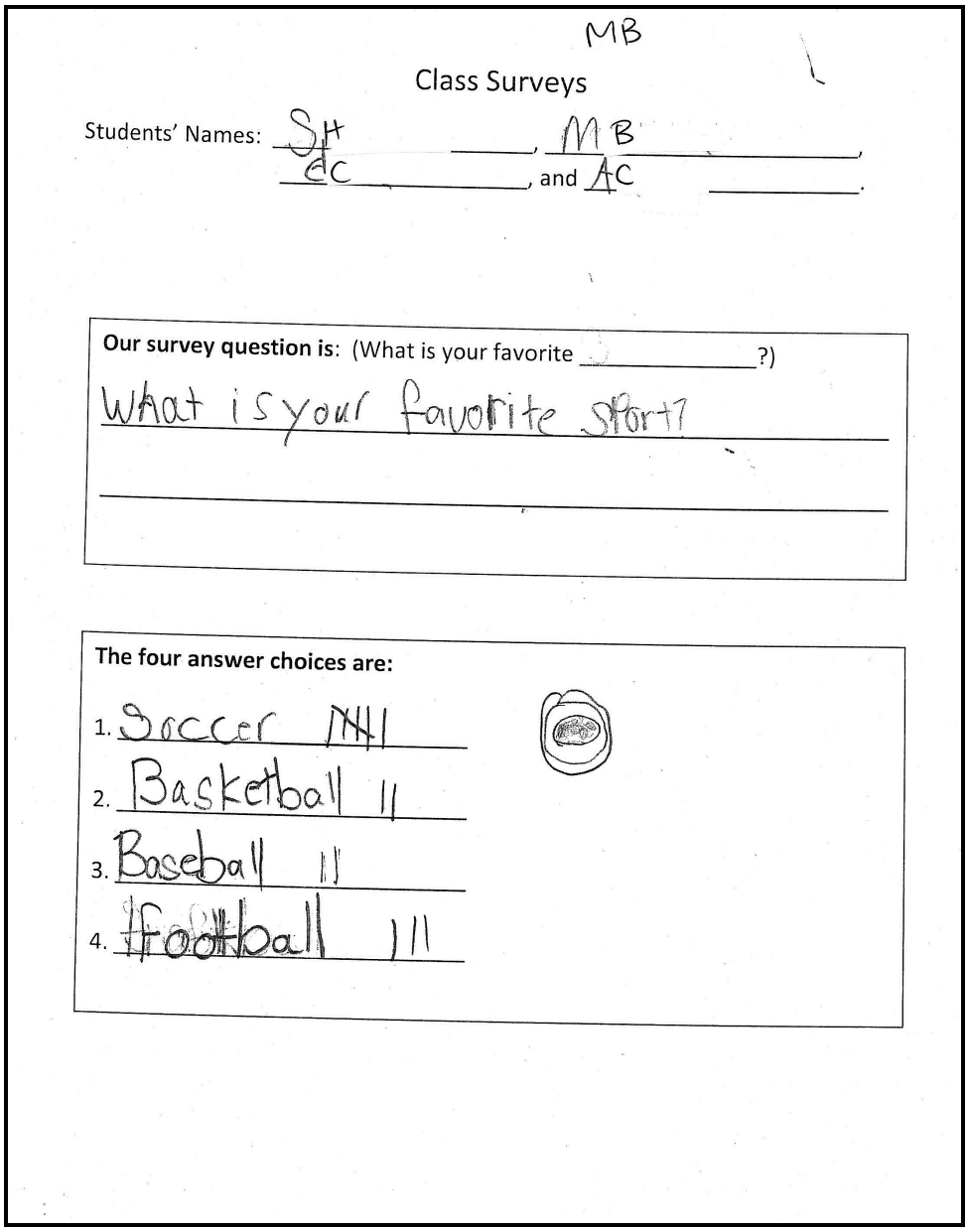
What is your favorite game?- Green group
What is your favorite animal?- Pink group
What is your favorite cookie?- Yellow group
What is your favorite sport?- Blue group

The students worked with their groups to come up with four response choices for their survey. Additionally, each group surveyed the other groups by sending one member of their team to survey the other three teams and write down their responses. A teacher was on hand to support each group as needed. Here is a table that shows the four groups' questions, and four answer options (Table 10.3).

Table 10.3: Four groups' survey questions with answer options

Color Group	Question	Four Answer Options
Blue	What is your favorite sport?	Soccer Basketball Baseball Football
Green	What is your favorite game?	Wii DS Play Station P X box 360
Pink	What is your favorite animal?	White Tiger Bald Eagle Dolphin Panda Bear
Yellow	What is your favorite cookie?	M&M Cookie Chocolate Chip Cookie Oreo Cookie Ginger Cookie

Below is MB's survey sheet (Figure 10.9) that shows her group, the blue group's, four answer choices.


MB

Class Surveys

Students' Names: SH _____, MB _____,
_____, and AC _____.

Our survey question is: (What is your favorite _____?)

What is your favorite sport?

The four answer choices are:

1. Soccer IIII
2. Basketball II
3. Baseball II
4. Football III

Figure 10.9: MB's survey page

From their survey pages, the students shared information and were assigned one of three graphs: bar graph, pictograph, or line plot. The final project culminated with students graphing their data onto a large poster paper and then giving a final presentation. The students learned so much through this process. They learned how

to work in a group, to compromise, collect data from a survey, to survey their peers, to ask questions and explain the four answer options using appropriate ASL (setting up the list of four options on one hand and explaining it using the other hand), to graph the data and check their answers, and they learned to follow the style of graph (not putting numbers on the line plot or the pictograph). Lastly, the students showed their ASL presentation abilities and showed that they could work with a group of their peers. They decided who would present the information to the class and who would draw the graph, and then they proceeding to either practice the presentation or draw the graph itself.

The second goal was for students *to experience methods of collecting data*. During implementation of my curriculum, I modeled a variety of ways to collect data for the students through making lists, having students complete surveys, and interview their peers, which shows that this goal was met. In our first lesson, I asked the students to name some similarities and differences between me and another teacher, and we created a list for our Venn Diagram (Figure 10.10). During this period I gave students an opportunity to raise their hands, provide a characteristic about each teacher, and I wrote their responses down on the SMART Board.

Teacher 1	Me
Funny	Tall
Good teacher	Funny
Champ!	Serious teacher/ strict
Sweet	Curly hair
Cute/beautiful	Cool
Tall	Sweet
Long hair	Smiles a lot
Strict	New teacher
Rides a motorcycle	Wears glasses
Old teacher	Wears contacts
Smart	Smart

Figure 10.10: Student generated list for a Venn Diagram

During Day 2 of implementation, the students completed two surveys to use later during math centers. One survey had a list of students' names and asked them their favorite animal (Figure 10.11). The students wrote down their favorite animal next to their name. The second survey listed several time frames and asked the students what time they woke up on weekends (Figure 10.12), and they wrote their initials next to the time frame that matched when they woke up.

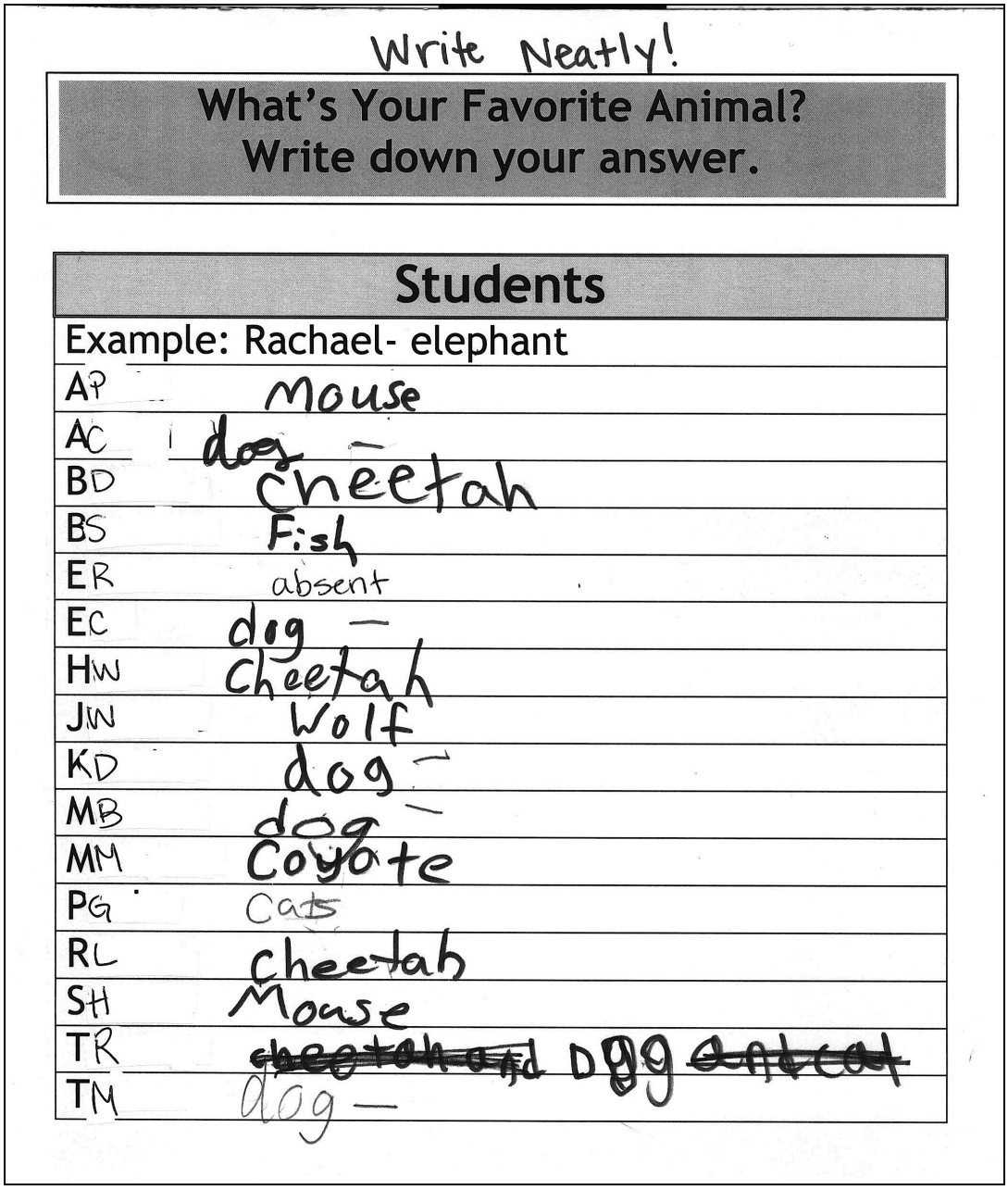


Figure 10.11: Completed student favorite animal survey

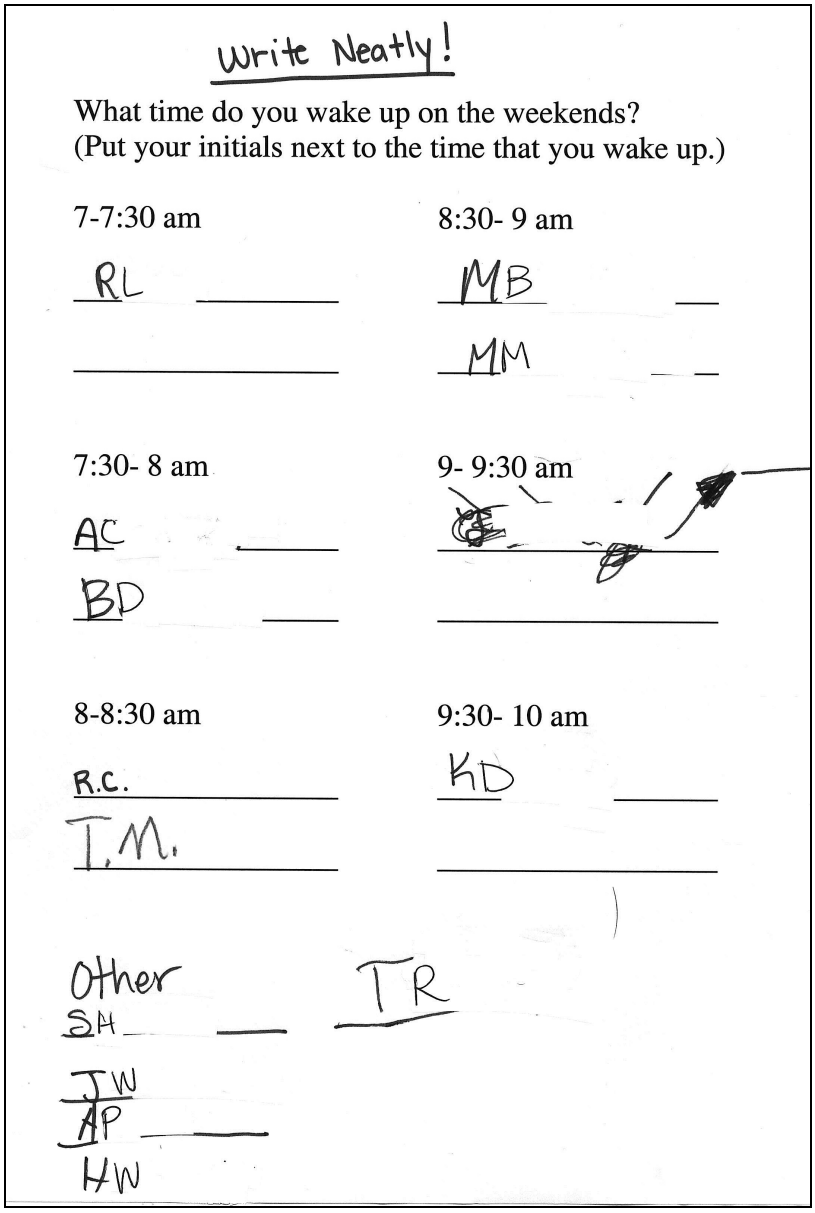


Figure 10.12: Completed student "wake up time" survey

For their final projects the students brainstormed questions they would like to ask each other. They worked with a partner to generate questions. I gave them an example: "What's your favorite color?" and told them to come up with more questions

that they want to know about each other and gave them time to talk with their partner. When I regained their attention and asked for new questions many of the students gave me their favorite color as an answer. I explained to them that I wanted them to brainstorm questions that they could ask their peers. After calling on several volunteers other students understood what I was asking and we created a list of possible questions together. Here is the list that we created:

What is your favorite sport?- KD
What is your favorite restaurant?- RL
What is your favorite pet?- MM
What is your favorite country?- TR
What is your favorite candy? –TM
What is your favorite cookie?- KD
What is your favorite store?- MB
What is your favorite animal?- BS
What is your favorite picture?- JW
What is your favorite movie?- ER
What is your favorite food?- AC
What is your favorite drawing?- AP
What is your favorite game?- BD

Next the students picked a question from the list above with their color group. The students were excited to choose a question, and they enjoyed working with their classmates. It was a challenge for the yellow group of students (TR, HW, AP, and KD) because TR was adamant about choosing one question while the three other students wanted to choose a different question. It was a good opportunity for a lesson about compromising and how to choose a question that all of the students could agree on.

After giving them five minutes to make their decisions, I regained students' attention. Then I drew names from four popsicle sticks that had one name of a member from each group written on them. The students who were selected told me

which question their group had decided on, and I wrote the color name next to the question on the SMART Board so all of the students could see which group was using each question. TM asked me what I would do if two groups wanted the same question, and I told him they would choose in the order their names were chosen. Once another group had already decided on a question, it could not be chosen again. The groups picked the following questions:

What is your favorite game?- Green group
What is your favorite animal?- Pink group
What is your favorite cookie?- Yellow group
What is your favorite sport?- Blue group

The students were then instructed to work with their groups to come up with four response choices for their survey. A teacher was on hand to support each group as needed. My group's question was "What is your favorite sport?", and they decided that each member of the group would suggest one sport for the survey. MB said soccer, EC said basketball, and AC said baseball. This sparked a discussion about the difference between softball and baseball by MB. She said that softball uses a bigger ball that is generally softer and baseball uses a small, harder ball. AC confirmed that she meant baseball. Lastly, SH offered track as his sport. I told him that track usually encompasses many different sports such as shot put, hurdles, triple jump, etc. He picked football as an alternative. Table 4 shows the four groups' survey questions and the four answer options created by the students.

Table 10.4: Four groups' survey questions with answer options

Color Group	Question	Four Answer Options
Blue	What is your favorite sport?	Soccer Basketball Baseball Football
Green	What is your favorite game?	Wii DS Play Station P X box 360
Pink	What is your favorite animal?	White Tiger Bald Eagle Dolphin Panda Bear
Yellow	What is your favorite cookie?	M&M Cookie Chocolate Chip Cookie Oreo Cookie Ginger Cookie

Through creating class lists during circle time as a group, students participated in collecting data using one method. During morning meeting students completed two surveys: Weekend Wake-up Time survey and the Favorite Animal survey. The weekend wake-up survey was a little problematic for students because after explaining to them what to do, students started coming forward to put their name down. I realized I did not make sure that they all completely understood the assignment. Some students (HW, BD, AP, and TM) later said they did not know what *weekend* meant and that they put down the time they wake up daily. They told me they would have put down a later time if they knew it meant the time they woke up on Saturdays and Sundays.

The favorite animal survey was easy for the students. Later the students made pictographs from the favorite animal survey, and they did a good job with the data and correctly graphed the information. If I were to do that survey again, I would pick four or five different animals and ask the students which animal is their favorite of the ones I chose because it is easier for the students to answer the questions which animal was liked the most and the least based on four or five options rather than an unlimited amount.

Lastly, the students interviewed their peers during the final project to collect data on their survey sheets. Each group had a different question and therefore had different data results. The students went individually to the four members of the remaining three groups to ask them the question and recorded the data as tally marks on their survey sheets. Below is BD's survey for favorite animals (Figure 10.13).

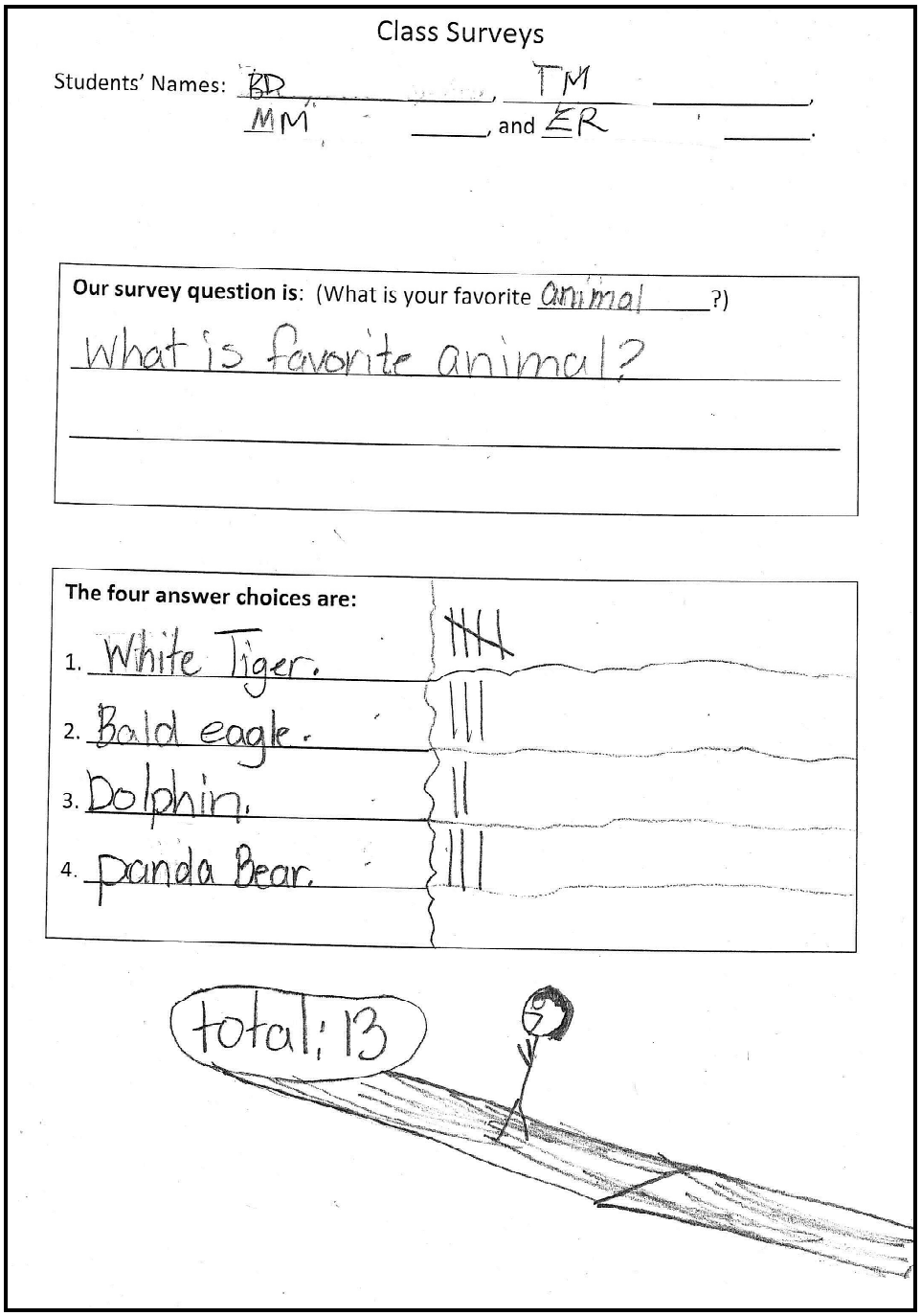


Figure 10.13: BD's class survey

The third goal of the curriculum was *to develop skills needed to create and analyze mathematical graphs from a data set*. This goal was met based on my

analysis of the students' final projects (see Appendix, page 201). The students created questions for a survey of their peers and as a group decided which question and four answer options related to their question to use. Next, they interviewed their peers and made a list with tallies on it to keep the data organized. From the data they made a rough draft of their graph and included vital information such as the title, a key if they were making a pictograph, the labels for the horizontal and vertical axes if they were making a bar graph, the data, and they completed the sentence strips: _____ has the most and _____ has the least. Lastly, they transferred their graph to a poster for their presentation to the class. The table below shows a detailed analysis of students' work (10.5).

Table 10.5: Analysis of students' final projects

Note: 16 students for all activities except the group poster.			Characteristics of Student Work		
Criterion Number	Criterion Description	**Did Not Complete**	**Below** Standards/ Learning Objectives	**Meets** Standards/ Learning Objectives	**Exceeds** Standards/ Learning Objectives
Final Project- Class Surveys					
1	Wrote down the survey question in the space provided.	4/16		12/16	
2	Wrote the four answer options for their group's question.			16/16	
3	Collected data from classmates and recorded tally marks for responses.		4/16	12/16	
Rough Draft Graph					
4	Drew a picture of their graph.	3/16	2/16	11/16	
5	Included a title for your graph.	5/16		11/16	
6	Drew a key for their graph. (Pictograph only= 4 students)	1/4	1/4	2/4	
7	Wrote the labels for the vertical and horizontal axes. (Bar graph only= 8 students)	4/8	1/8	3/8	
8	Wrote the label for the line plot. (Line plot only= 4 students)	2/4		2/4	
9	Included the data accurately on their graphs.	4/16	2/16	10/16	
10	Finished the sentence frame: _____ has the most.	4/16		12/16	
11	Finished the sentence frame: _____ has the least.	5/16	1/16	10/16	
Final Graph Poster- Based on four group graphs					
12	Groups drew their graph.			4/4	
13	Group graph included a title.			4/4	
14	Group graph included a key. (Pictograph only= 1 group)		1/1		
15	Group graph included the labels for the vertical and horizontal axes. (Bar graph only= 2 groups)	2/2			
16	Group graph included the label for the line plot. (Line plot only= 1 group)			1/1	
17	Group graph accurately included the data.		1/4	3/4	
18	Group graph included the sentence: _____ has the most.	1/4		3/4	
19	Group graph included the sentence: _____ has the least.	1/4		3/4	
20	Group graph included color and was bold so classmates could see it from far away.		2/4	2/4	

A teacher guided the students through the process of the final project but it was largely student-centered and student-driven. The data above for criteria 1-3 for the class surveys show that most students (12 out of 16) wrote down the survey question in the space provided, wrote down the four answer options for their group's question (16 out of 16), and collected data from their classmates by recording tally marks (12 out of 16). Four of the sixteen students did not write down their survey question on the space provided and four of the sixteen students' data was recorded incorrectly on their surveys. Those students' work is marked as "Did Not Complete" and "Below Standard" respectively.

Criteria 4-11 refer to the students' rough draft sketch of their graphs. The criterion were clearly marked on the rough draft paper detailing what the students needed to include on their rough draft graph. Eleven of sixteen students' work met the standards/learning objectives for drawing a picture of their graph. Most students included a title (11 out of 16), half drew a key for their pictograph correctly (2 out of 4), only three out of eight students drew the labels for their bar graphs, half wrote the label for their line plot (2 out of 4), most (10 out of 16) included the data accurately on their graphs, and most completed the two sentence frames at the bottom of the page for the most and least votes (12 out of 16; 10 out of 16 respectively).

Lastly, the students created a poster for their final presentation from the data they collected. Most groups met the standard/learning objective for each of the criterion. All four groups drew their graph and included a title. The one group that did a pictograph included a key for their graph but it was not completely correct. It said that the Key= 1 when it should have said, "Key: (Paw print)=1" with the picture

of the paw print in lieu of the writing. The two groups that did a bar graph did not include the labels for the horizontal and vertical axes. The line plot group did include their label underneath the names of the different sports (basketball, baseball, soccer, and football) they wrote "Sports". Three of the four groups accurately graphed their data. One group was given "Below Standards/Learning objectives" because their graph did not accurately show the number of votes per category. The yellow groups' graph should have shown 3 votes for the ginger cookie but the graph showed just 2 votes (see Figure 10.14 below).

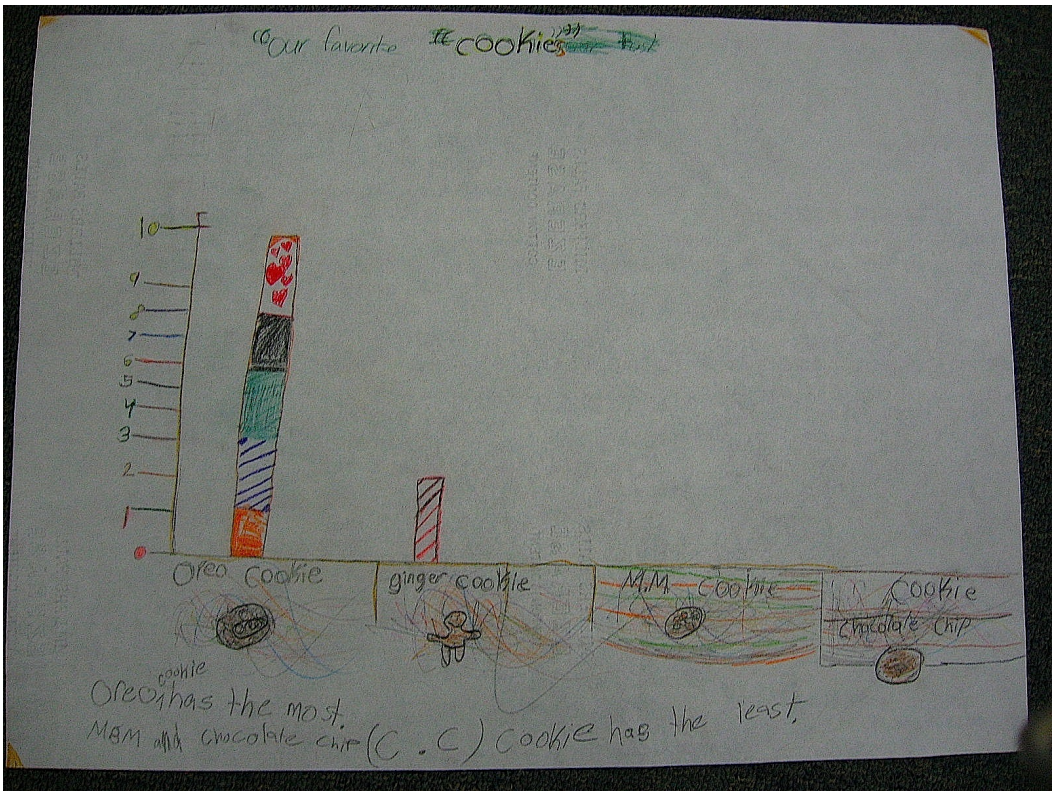


Figure 10.14: Yellow group's graph of favorite cookies

Three out of four groups (blue, yellow, and green) included the sentences for the most and least votes on their poster. One group, the pink group, did not include

those sentences. Lastly, two out of the four groups included color and outlined the information and sentences in black marker so that their data was bold enough for their classmates to see while they presented the information. Two groups used colored pencils and pencil to draw their graph and data and it was difficult to see the graph from the circle area where the students were seated. Overall, most students succeeded with the final project, which tells me that this goal was met.

Additionally, the presentation rubrics showed that the groups met the criteria for the final project presentation which were to present the group's question and four answer choices, talk about the data, identify the type of graph they used, and tell the class which choice had the most and least votes. Students were rated in their color groups for the presentation (See Appendix, p. 201).

The fourth goal was *to develop the academic language necessary to discuss graphs in ASL and written/spoken English using higher level thinking skills*. The students partially met this goal based on my anecdotal notes of students' comments and teacher observations. Because I did not implement the entire curriculum the way I originally wrote it, I did not do the student math journals, which would have shown a lot of their academic language use and were designed to promote higher order thinking skills. Similarly, I did not have the opportunity to implement several lessons that would have had the students talk with their partner to explain their graphs. However, I did collect evidence to show students' academic language use and Cognitive Academic Language Proficiency (CALP). Examples are explained in the next few paragraphs.

The students at the Venn Diagram table used the higher order thinking skill of comparison to talk about the characteristics they had in common and the characteristics that they did not share with each other. The teacher overseeing the Venn Diagram table said that HW and her partner (PG) looked at their Venn Diagram and said "not much same" for the characteristics they wrote down. They had "girl", "3rd grader", and "likes to swimming" written down as their similarities but had six traits written down for each of the two girls that were different such as "funny", "long hair", "lives in cottage" for one student and "loves soccer", "short hair", and "lives in sweet home" for the other student. Another pair (SH and MM) said they had "a lot same" for their Venn Diagram. They wrote down "curly hair", "pink", "bike", "computer", "sisters", "skateboard", and "Vans" for their similarities but only wrote down "dog", "snake", "meat" for one student and "cats", "coyote", and "vegan" for the other as their personal traits that were different.

These students' ASL comments demonstrated that they understood the purpose of the activity and the academic language of "same as" and "different" that accompanied it. As they were using that language they were comparing themselves to each other and looking for characteristics that were similar or different. Additionally, there was a pair of students that had nine similarities, and the teacher said, "You two should be best friends". The students laughed because they understood she was saying that because they had a lot of similarities. The students also used the ASL sign with the K handshape "the two of us" often when talking about their Venn Diagrams to refer to the English equivalent of "both of us". On their Venn Diagrams the word "Both" was written down where the students needed to put similarities and the words

"My Partner" and "Me" were written down where the students needed to write the respective person's characteristics on the Venn Diagram. These comments and the fact that they filled out their graphs correctly showed that the students understood the concept of "both of us" in ASL and English.

At the pictograph center the substitute teacher worked with the students to complete their graphs. When the students finished creating their graph from the survey data, the substitute asked, "What do you notice about the graph?". TM said, "Dog had most". The teacher asked him, "How do you know that?" and HW said, "Because dog has many. One, two, three, four, five, six". These students were engaged in the comprehension level of Bloom's Taxonomy (Bloom's Taxonomy, 2009). The teacher wanted to know *how* they knew that the dog was liked the most. She asked them another way to get their knowledge by saying, "Which beat others?", and TM said, "Dog". The students' responses and interactions with the substitute teacher demonstrated that they could create a graph from the given data and understood what the parts of the graph meant (key, labels, etc) as well as know what the word "most" means. They were able to read the English sentence on the worksheet and accurately fill in their responses to which animal was liked the most. Additionally, students were able to respond to ASL questioning using the sign "MOST", which signaled that they understood what it meant. The students incorporated the academic language of "MOST" into their comments about the graph.

During the final project preparation and throughout my internship with the students, I noticed a big misconception about what "least" means for a graph. While I was interning with the students in the spring, I completed my Performance Assessment

for California Teachers (PACT) assignment, which is a project that California teachers must complete in order to get their credential. The math PACT involved writing a background commentary on the students, creating a sequence of three to five math lesson plans for one concept, teaching and filming the sequence in the classroom. Afterwards, I analyzed student work samples for common understandings and common misunderstandings across students and wrote a commentary on my analysis including suggestions for changes if I were to teach this sequence again. Lastly, I included my daily reflections and a reflection commentary on my teaching.

While doing the PACT with the students I first noticed a misconception emerge. If we did a tally graph and a category had zero votes, the students disregarded this category in their idea of which had the most and which had the least. They would look at the category that has at least one vote and include that in the comparison. I am not sure where this misconception started but it was a difficult one to expunge. The yellow group was having a discussion with another teacher about the choice that had the least number of votes for their graph so they could write their English sentences. I was happy to talk with the yellow group and to explain again that the item that had zero votes or close to zero that that item had the least votes. I had the yellow group students determine which cookie was liked the most and the least. After they decided on their own I asked them to turn to their partner and explain how they knew which cookie was liked the least and the most. While the students were explaining to their partner I observed their responses. JW signed, “M&M and chocolate chip cookies both had zero votes so they tied for the least number of votes”. HW signed, “The most was Oreo cookies because it had 10 votes and ginger cookies

only had three votes." I was happy that the students were able to determine the most and the least with their new understanding. The other three groups were able to figure out which choices had the most and least votes for their data.

The final project encompassed many higher order thinking skills in that the project itself was not static. Each group chose a different question, had to interview their peers and collect data. Then the students took the data and created a graph that applied what they had learned from the math stations. Students had to first make a graph individually and then create a larger poster after I had checked their individual graphs. I noticed that my group, the blue group, started creating their line plots using the example line plot from the reference chart of graphs that was in the room. Instead of using the data they had just collected about their classmates' favorite sports my group was creating graphs of different shoe types. I redirected the students to look at the data they had just collected. Then they began to create a line plot with their data, however, many of them included numbers on the line plot. Again, I redirected them to the poster and asked if the line plot had numbers on it. They responded negatively and erased the numbers they had added. The project incorporated application of graphing knowledge and analysis of the data.

The students partially met the fourth goal of my curriculum based on the evidence above. However, if I did this curriculum again, I would have the students keep a journal where they would write down vocabulary, definitions, drawings of each type of graph, and I would have them do assignments where they would have to draw a graph and then explain through written English to a friend how to draw them. By having a journal I would be able to assess students' understanding of the graphs

through their writing and it would promote more application of what they had learned. I would also have students do ASL Video Logs (VLogs) of their favorite type of graph. The students would pick a graph and explain how to read and interpret the graph through ASL. Additionally, I would follow my original curriculum closely because I embedded activities designed to promote application, analysis, comprehension, and synthesis in those lessons. These are four of the six levels of Bloom's Taxonomy that describe higher order thinking skills (Blooms Taxonomy, 2009).

The fifth goal of the curriculum was *to improve students' understanding of the use of graphs in real world situations*. Based on questioning before and after during the curriculum, the students successfully met this goal. Before I implemented the curriculum I talked with my cooperating teacher about what the students had already learned previously in math this year. She said that the students had learned about some graphs (bar graph, line plot, pictograph) but they had not learned the purpose of graphs because she and the other team teachers did not teach that to them. My cooperating teacher encouraged me to teach the students the purpose of graphs.

When I started the curriculum, I did a KWL chart with the students where I asked them what they knew and what they wanted to know about graphs (Figure 10.15). After we discussed what the students knew about graphs, I started the next discussion, what they wanted to know, with my own question "What are graphs for?", and I asked the students if they knew what they were for. No one responded to the question about the purpose of graphs. This demonstrated that they did not know the purpose of graphs. HW wanted to know "Why we learn graphs?" and TM asked

"How will we learn info on graphs (if we did not have them)?" Throughout the implementation of my curriculum I taught the students the purpose of graphs in the real world, and I reinforced it several times.

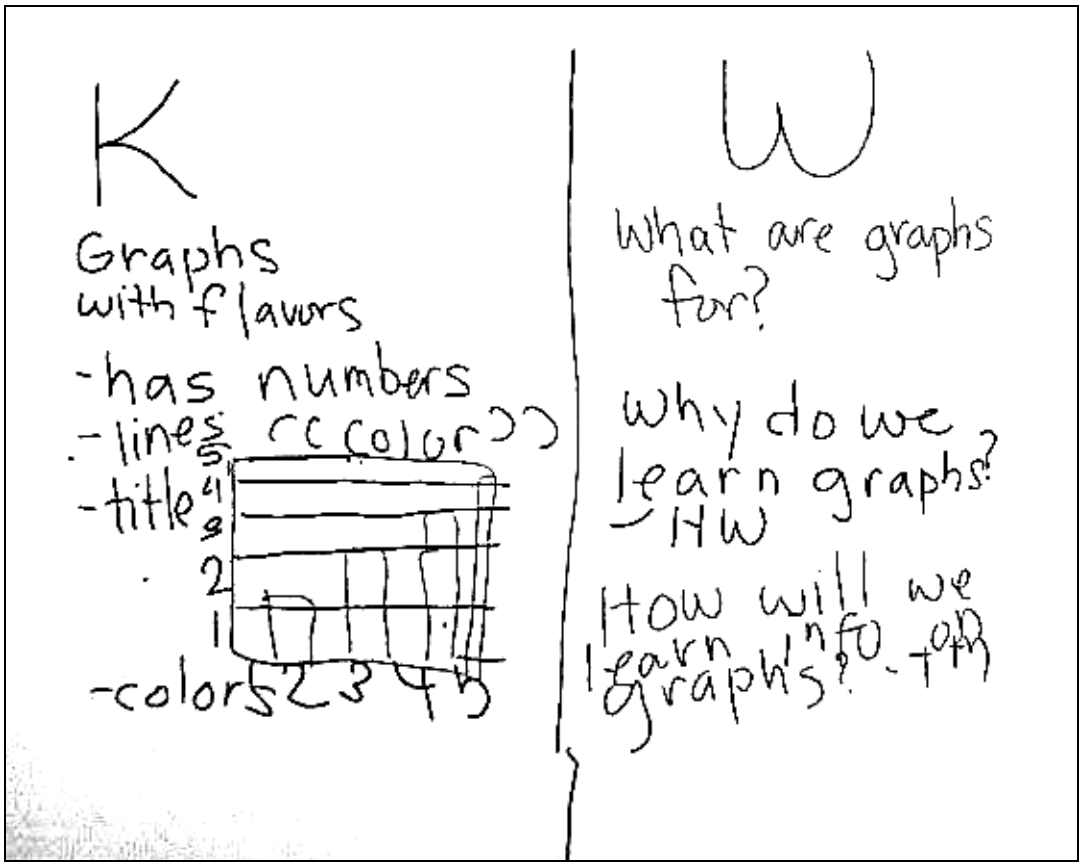


Figure 10.15: KWL from class about graphs

At the end of implementation, I wrapped up the curriculum by asking the students the purpose of graphs to see what they had learned. MM signed, "Graphs help you so you do not have to remember all of the information yourself". SH signed, "You could ask what people like, tally up their responses, and make a graph of the information so it is easy to read rather than ask all of them again when you want to know their answers". AC stated, "If you forget something while you are doing a

presentation you can use a graph to help you remember the information". When I started this curriculum the students had not yet learned the purpose of graphs and upon finishing it they were able to tell me why graphs are important in our lives. This underscored that they met this goal.

XI. Conclusion

The curriculum in this thesis was a compilation of bilingual teaching methods and theory, experience working with Deaf students, and input from my supervisor and classroom teachers who helped make implementation possible. An evaluation of teacher observations, student and teacher artifacts, and rubrics indicated that it was successful, and that the students met its goals. The students learned how to use data to create a line plot, bar graph, and pictograph, and they learned how to make a Venn Diagram by comparing themselves to a partner. They also created a survey of four choices to collect data from their peers and used the data to create a graph. Lastly, the students successfully presented their graphs to their peers and teachers and were able to talk about the graph using academic ASL and English.

The curriculum was implemented over a span of eight days in a bilingual ASL-English classroom. The school at which I was working had a lot of holidays and spring break occurred when I was interning so the students were absent from school a lot. Additionally, I had another assignment for my credential, the PACT, that needed to be completed and written towards the beginning of my internship. During implementation of my curriculum I adapted and shortened lessons for the students due to the limited time frame with which I was working and to fit my students' abilities, needs, and interests. I initially designed some of the lessons to start with a group lesson so I could model the graph, and I could gauge student understanding before they did the planned individual activity. My classroom had three team teachers so I was lucky to be able to use them and an aide to provide extra support when needed.

Given the time frame that I was working with to implement this curriculum in my classroom it proved invaluable to have extra teachers there to support the small group activities.

Classroom management is one area where I will continue to build my skills through more confidence and experience in the classroom. It was challenging coming into an established classroom with its own teachers and routines with which the students were very familiar. They were used to working individually in math centers where they could work at their own pace on worksheets tailored to their ability levels. A big part of my curriculum was incorporating partner work and doing whole group lessons, and I wanted my students to work in small groups or partnerships but I realized I needed to set up my rules and expectations with them from the beginning so that the activities would be a success. Additionally, I needed to teach them the appropriate social skills that were required to make the activities successful. We discussed how to dialogue and work with a partner. Teaching social skills is very important and teachers cannot assume that the students already know how to work with a partner or group even at the middle or high school stage.

The experience of writing curriculum for use in the classroom was challenging at first because I did not know for which grade I was developing the curriculum. I started to hone down on one area, math, and then started to pull ideas for what I wanted the students to learn: critical thinking skills, analysis and interpreting skills. I am amazed that I was able to create the whole curriculum, implement it in a classroom, and write a thesis about it in less than a year but it is completed, and the process was very rewarding.

References

6+1 Trait writing. (2008). Portland, OR: Northwest Regional Educational Laboratory.

Armstrong, T. (2000). Multiple intelligences. Retrieved November 18, 2008, from http://www.thomasarmstrong.com/multiple_intelligences.htm

Bilingual education act. (2009). Retrieved August 10, 2009, from http://en.wikipedia.org/wiki/Bilingual_Education_Act

Blooms taxonomy. (2009). Retrieved November 26, 2009, from http://www.ves.wpsb.org/focus/bloomstaxonomy.html

Bluestein, D. (2007). *Ready, set, solve! A bilingual approach to solving math word problems for elementary deaf students.* University of California, San Diego, La Jolla, CA.

Casado, M. (1990). *Bringing life to math: A mathematical problem solving curriculum.* University of California, San Diego, La Jolla, CA.

Chen, K. (2006). Math in motion: Origami math for students who are deaf and hard of hearing. *Journal of Deaf Studies and Deaf Education, 11*(2), 262-266.

Cohen, E. G. (1986). *Designing groupwork: Strategies for the heterogeneous classroom*. New York: Teachers College Press.

Corwin, R. B., & Friel, S. N. (1990). Statistics: Prediction and sampling, a unit of study for grades 5-6, *Used Numbers: Real Data in the Classroom*. Palo Alto, CA: Dale Seymour Publications.

Crawford, J. (2004). *Educating English learners: Language diversity in the classroom* (5th ed.). Los Angeles: Bilingual Educational Services, Inc.

Cummins, J. (1986). Empowering minority students: A framework for intervention. *Harvard Educational Review, 56*(1), 18-56.

Cummins, J. (1996). The two faces of language proficiency. In *Negotiating identities: Education for empowerment in a diverse society* (pp. 51-70). Ontario, CA: California Association for Bilingual Education.

Cummins, J., & Swain, M. (1986). *Bilingualism in education: Aspects of theory, research, and practice*. New York: Longman Group Limited.

Easterbrooks, S. R., & Stephenson, B. (2006). An examination of twenty literacy, science, and mathematics practices used to educate students who are deaf or

hard of hearing. *American Annals of the Deaf, 151*(4), 385–397.

Friel, S. N., Mokros, J. R., & Russell, S. J. (1992). Statistics: Middles, means, and in-betweens, a unit of study for grades 5-6, *Used Numbers: Real Data in the Classroom*. Palo Alto, CA: Dale Seymour Publications.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: Basic Books.

Gibbons, P. (1991). *Learning to learn in a second language*. Sydney: Primary English Teaching Association.

Hamers, J. F. (1998). Cognitive and language development of bilingual children. In I. Parasnis (Ed.), *Cultural and language diversity and the deaf experience*. New York: Cambridge University Press.

Herzig, M. (2002). The ASL scale of development, from the *UCSD thesis entitled: Creating the Narrative Stories: The Development of the Students' ASL and English Literacy Skills.* (Revised from 2006 ed.).

Hoffmeister, R. J., DeVilliers, P. A., Engen, E., & Topol, D. (1997). English reading achievement and ASL skills in deaf students. *Proceedings of the Annual Boston University Conference on Language Development, 21*, 307-318.

Livingstone, S. (1997). *Rethinking the education of deaf students: Theory and practice from a teacher's perspective*. Portsmouth, NH: Heinemann.

Mahshie, S. (1995). *Educating deaf children bilingually*. Washington, D.C.: Gallaudet University Press.

Mann, S. (2004). *Beyond the book: Improving number sense at home and in the classroom.* University of California, San Diego, La Jolla, CA.

Math graphing. (2008). *Folklife Curriculum* Retrieved 12/8/2008, from http://www.riversofsteel.com/pdf/Folklife_MathGraphing.pdf

Mayer, C., & Wells, G. (1996). Can the linguistic interdependence theory support a bilingual-bicultural model of literacy education for deaf students? *The Journal of Deaf Studies and Deaf Education, 1*(2), 93-107.

Meadow, K. (1968). Early manual communication in relation to the deaf child's intellectual, social, and communicative functioning. *American Annals of the Deaf, 113*, 29-41.

National Council of Teachers of the Deaf Research Committee. (1957). The teaching

of arithmetic in schools for the deaf. *Teacher of the Deaf, 152*, 165-172.

Nelley, E., & Smith, A. (2000). *Rigby PM benchmark kit*. Barrington, IL: Rigby Publishers.

Newmann, F. M., & Wehlage, G. G. (April 1993). Five standards of authentic instruction [Electronic Version]. *Educational Leadership, 50*, 8-12. Retrieved November 18, 2008 from http://pdonline.ascd.org/pd_online/diffinstr/el199304_newmann.html

Nunes, T., & Moreno, C. (2002). An intervention program for promoting deaf pupils' achievement in mathematics. *Journal of Deaf Studies and Deaf Education, 7*(2), 120-133.

Ong, F., Lucia, B., & Yee, K. (1997). Mathematics content standards for California public schools: Kindergarten through grade twelve [Electronic Version] from http://www.cde.ca.gov/be/st/ss/documents/mathstandard.pdf

Padden, C., & Ramsey, C. (2000). American Sign Language and reading ability in deaf children. In C. Chamberlain, J. P. Morford & R. I. Mayberry (Eds.), *Language acquisition by eye*. Mahwah, NJ: Lawrence Erlbaum Associates.

Peal, E., & Lambert, W. E. (1962). The relation of bilingualism to intelligence. *Psychological Monographs, 76*, 1-23.

Peregoy, S. F., & Boyle, O. F. (2005). *Reading, writing, and learning in ESL: A resource book for K-12 teachers* (4th ed.). Boston, MA: Pearson Education Inc.

Principles and standards for school mathematics. (2000). Retrieved November 19, 2008, from http://standards.nctm.org/document/chapter3/data.htm

Quigley, S., & Frisina, R. (1961). Institutionalization and psychoeducational development of deaf children, *CEC Research Monograph*. Washington DC: Council on Exceptional Children.

Ramsey, C. (2004). What does culture have to do with the educatin of students who are deaf or hard of hearing? In B. J. Brueggemann (Ed.), *Literacy and deaf people: Cultural and contextual perspectives*. Washington DC: Gallaudet University Press.

Russell, S. J., & Corwin, R. B. (1989). Statistics: The shape of the data, a unit of study for grades 4-6, *Used Numbers: Real Data in the Classroom*. Palo Alto, CA Dale Seymour Publications.

Russell, S. J., & Corwin, R. B. (1990). Sorting: Groups and graphs, a unit of study for grades 2-3, *Used Numbers: Real Data in the Classroom*. Palo Alto, CA: Dale Seymour Publications.

Schmidt, W., Houang, R., & Cogan, L. (2002). A coherent curriculum: The case of mathematics [Electronic Version]. *American Educator, Summer 2002*. Retrieved November 18, 2008 from http://www.aft.org/pubs-reports/american_educator/summer2002/curriculum.pdf

Singleton, J. L., Supalla, S., Litchfield, S., & Schley, S. (1998). From sign to word: Considering modality constraints in ASL/English bilingual education. *Topics in Language Disorders, 18*(4), 16-29.

Stevenson, E. (1964). A study of the educational achievement of deaf children of deaf parents. *California News, 80*, 143.

Stokoe, W. C., Casterline, D. C., & Croneberg, C. G. (1965). *A dictionary of American Sign Language on linguistic principles*. Silver Spring: Linstok Press.

Strong, M., & Prinz, P. M. (1997). A study of the relationship between American Sign Language and English literacy. *Journal of Deaf Studies and Deaf Education., 2*(1), 37-46.

Stuckless, R., & Birch, J. (1966). The influence of early manual comunication on the linguistic development of deaf children. *American Annals of the Deaf, 106*, 436-480.

Traxler, C. B. (2000). The Stanford Achievement Test, 9th edition: National norming and performance standards for deaf and hard-of-hearing students. *The Journal of Deaf Studies and Deaf Education, 5*(4), 337-348.

Vrbancic, M. (2000). *Reading math: Making connections between math and language.* University of California, San Diego, La Jolla, CA.

Washington State K-12 mathematics standards. (July 2008). Retrieved November 12, 2008, from http://www.k12.wa.us/curriculumInstruct/mathematics/RevisedStandards/FullWAK-highschool.pdf

Wollman, D. C. (1965). The attainments in English and arithmetic of secondary school pupils with impaired hearing. *Teacher of the Deaf, 159*, 121-129.

Wood, D., Wood, H., & Howarth, P. (1983). The mathematical achievements of deaf children from different educational environments. *British Journal of Educational Psychology, 54*, 254-264.

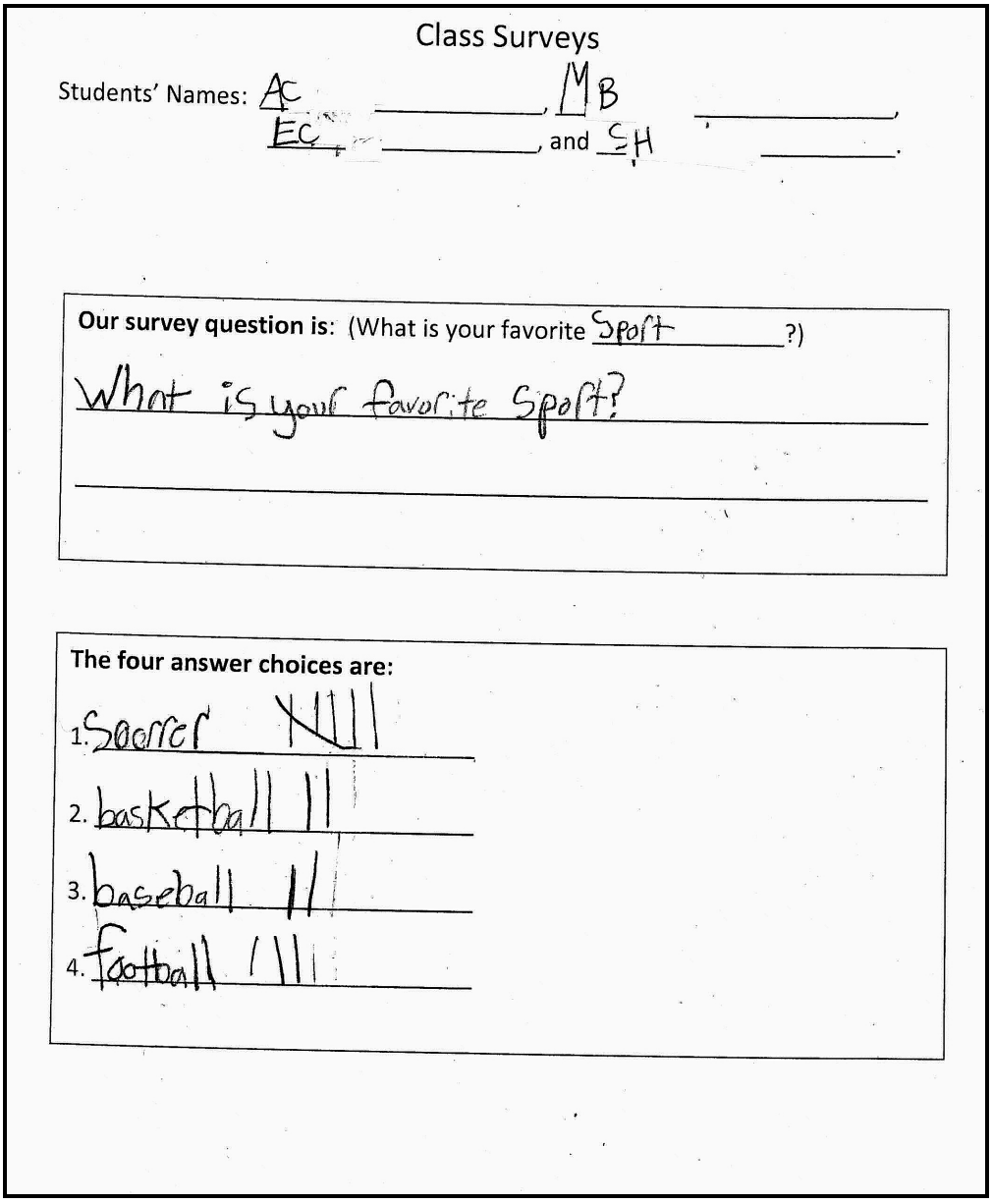
Zernovoj, A. (2005). *Telling, writing, and reading number tales in ASL and English academic languages: Acquisition and maintenance of mathematical word problem solving skills.* University of California, San Diego, La Jolla, CA.

Appendix

Student Artifacts
Final Project and Rubrics

Blue Group's Final Project

AC's Class Survey



Class Surveys

Students' Names: AC _____, MB _____, EC _____, and SH _____.

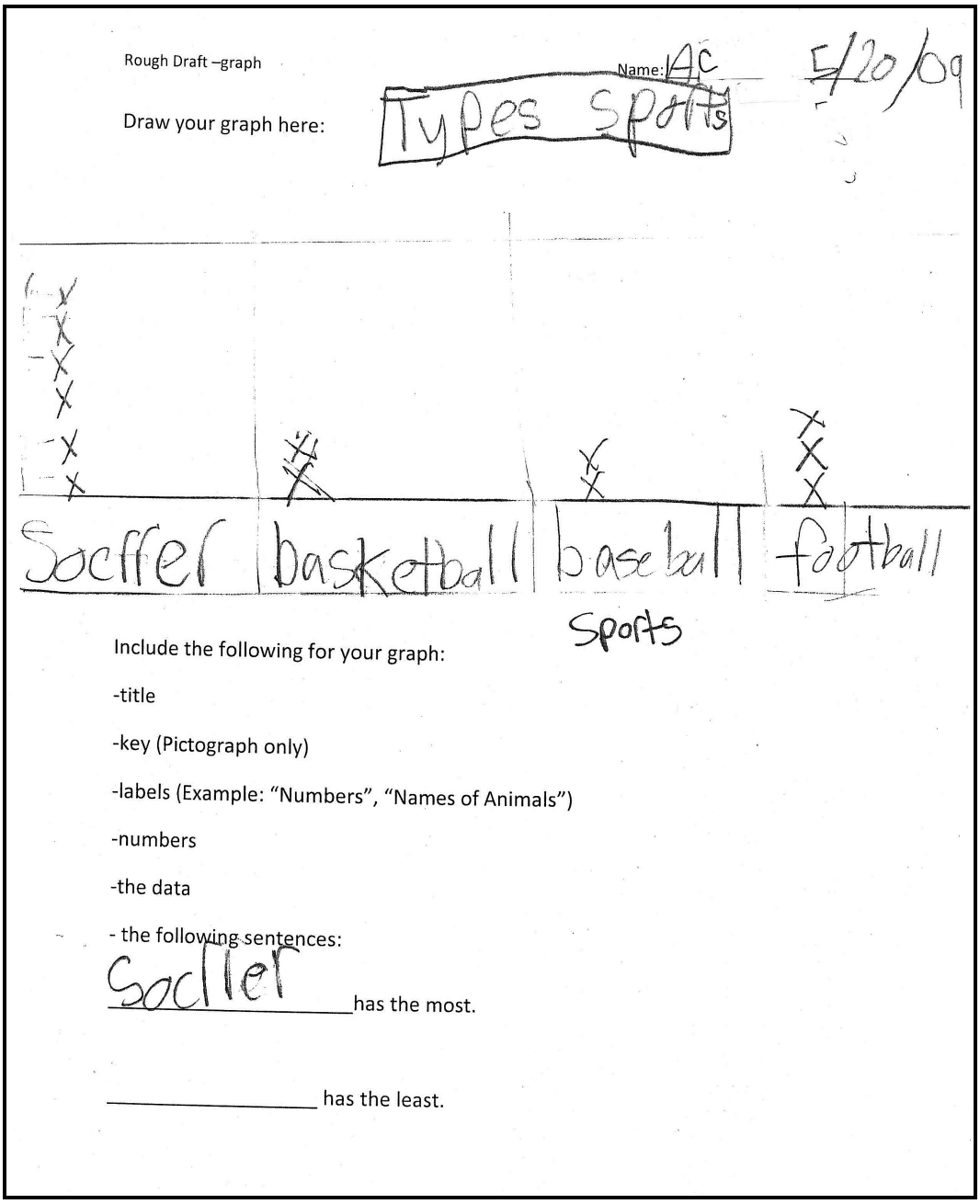
Our survey question is: (What is your favorite Sport?)

What is your favorite Sport?

The four answer choices are:

1. Soccer IIII
2. basketball II
3. baseball II
4. football III

AC's Rough Draft Graph



Rough Draft –graph

Name: AC

5/20/09

Draw your graph here:

Types Sports

Soccer | basketball | baseball | football

Sports

Include the following for your graph:

-title

-key (Pictograph only)

-labels (Example: "Numbers", "Names of Animals")

-numbers

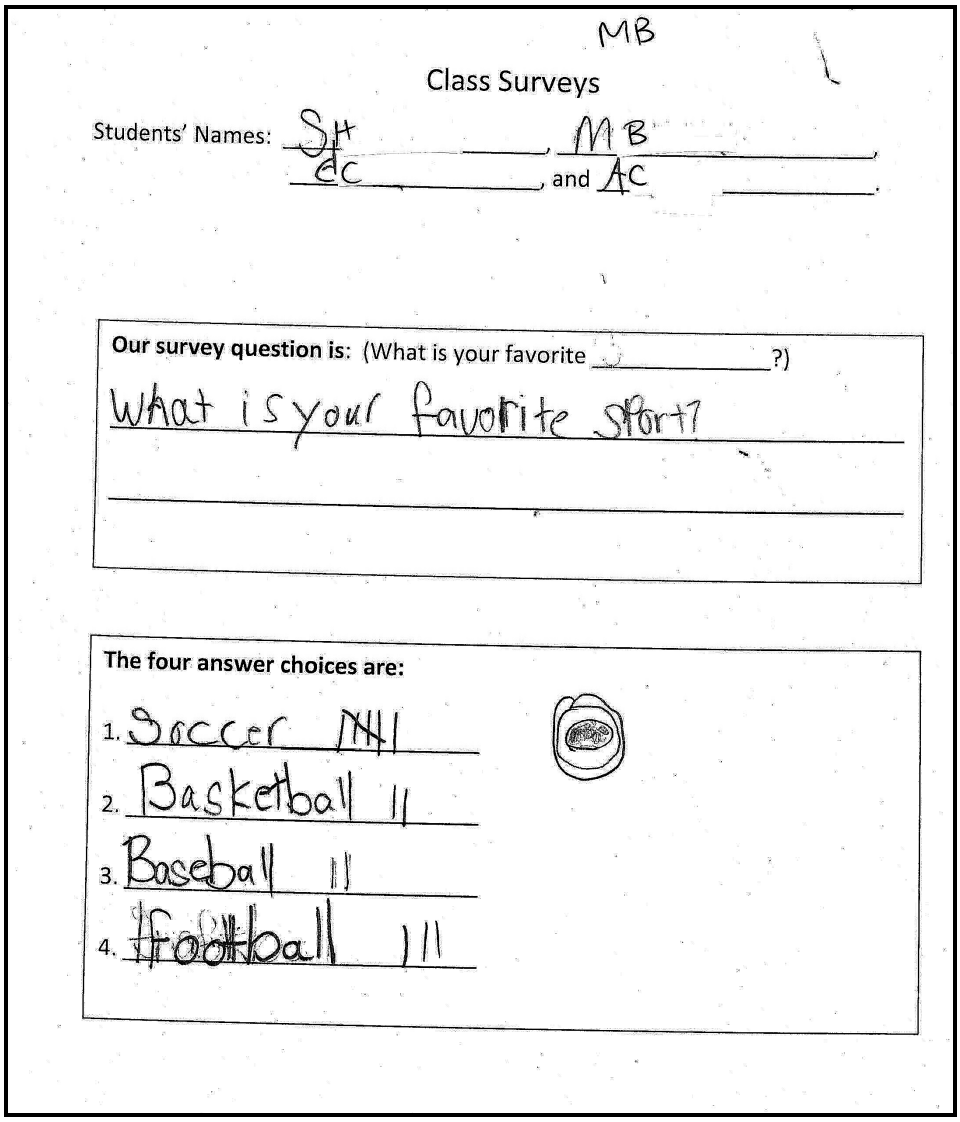
-the data

- the following sentences:

Soccer has the most.

_____ has the least.

MB's Class Survey



MB

Class Surveys

Students' Names: Sft, MB, dc, and AC.

Our survey question is: (What is your favorite ____?)

What is your favorite sport?

The four answer choices are:

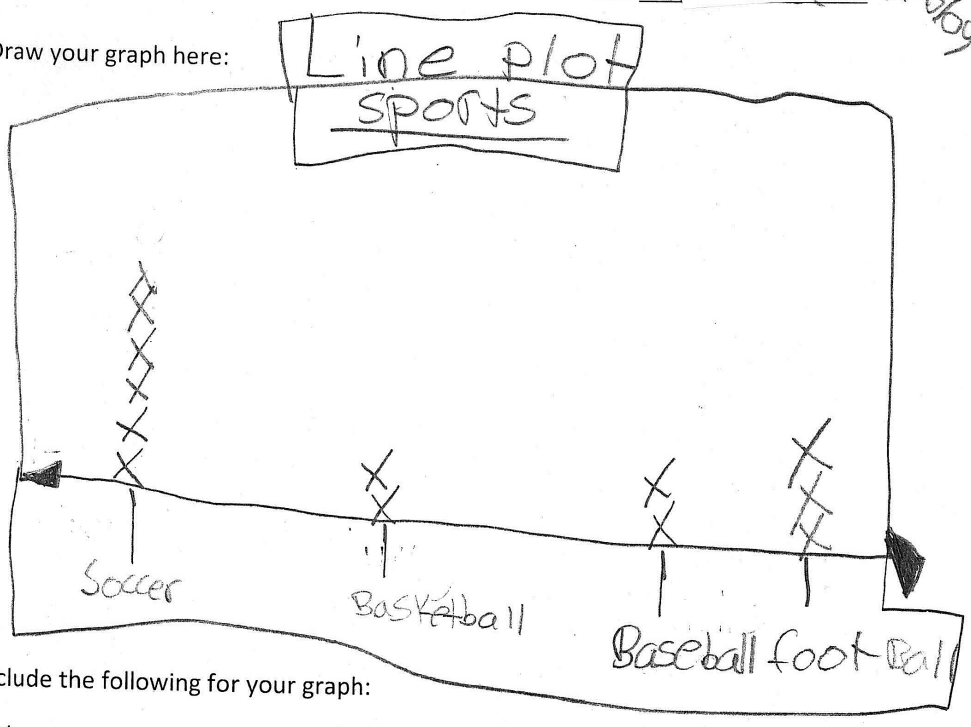
1. Soccer IIII
2. Basketball II
3. Baseball II
4. Football III

MB's Rough Draft Graph

Rough Draft –graph

Name: MB 5/20/09

Draw your graph here:



Include the following for your graph:

-title

-key (Pictograph only)

-labels (Example: "Numbers", "Names of Animals")

-numbers

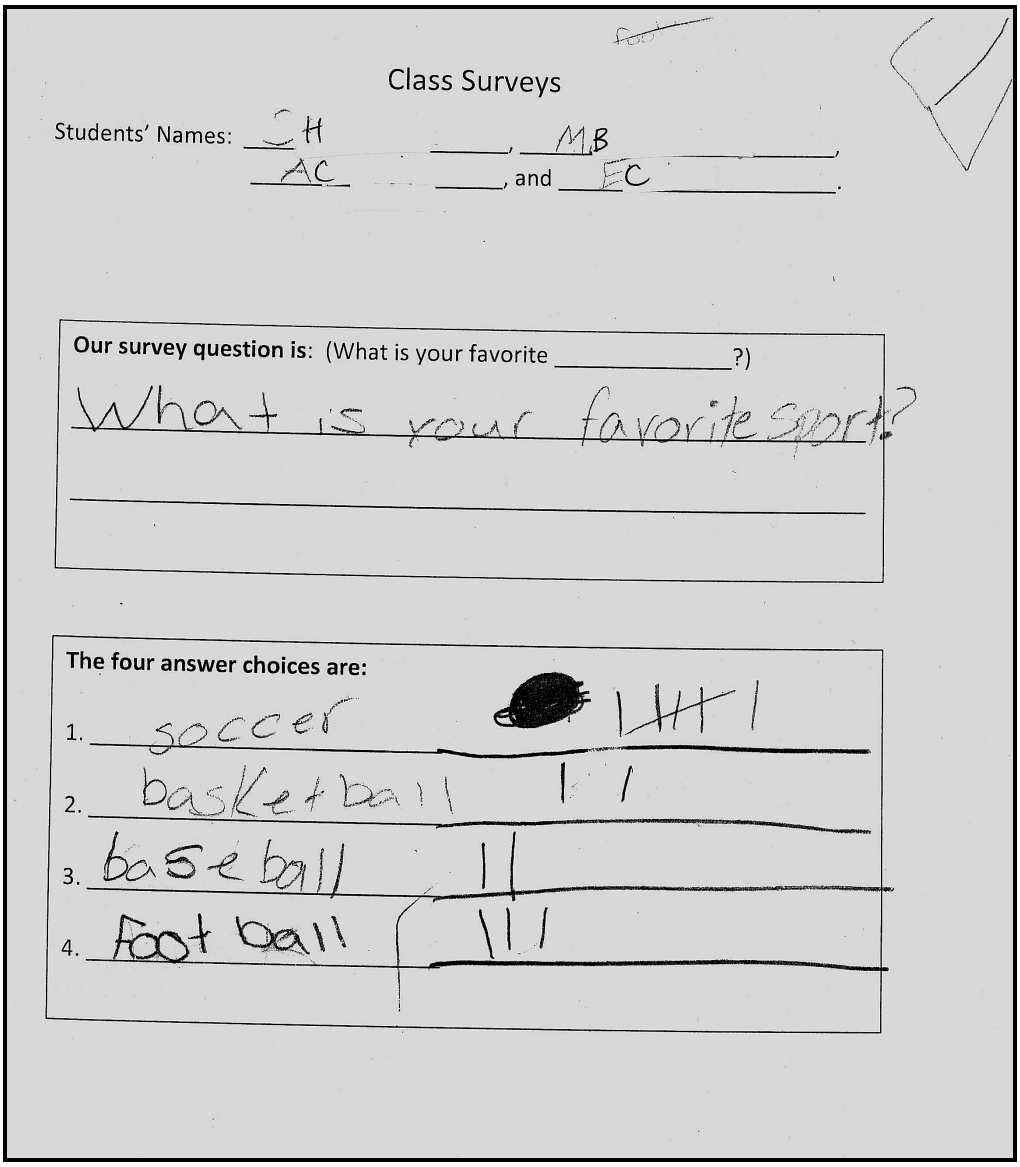
-the data

- the following sentences:

Soccer has the most.

Basketball
Baseball has the least.

SH's Class Survey



Class Surveys

Students' Names: SH _____, MB _____,
AC _____, and EC _____.

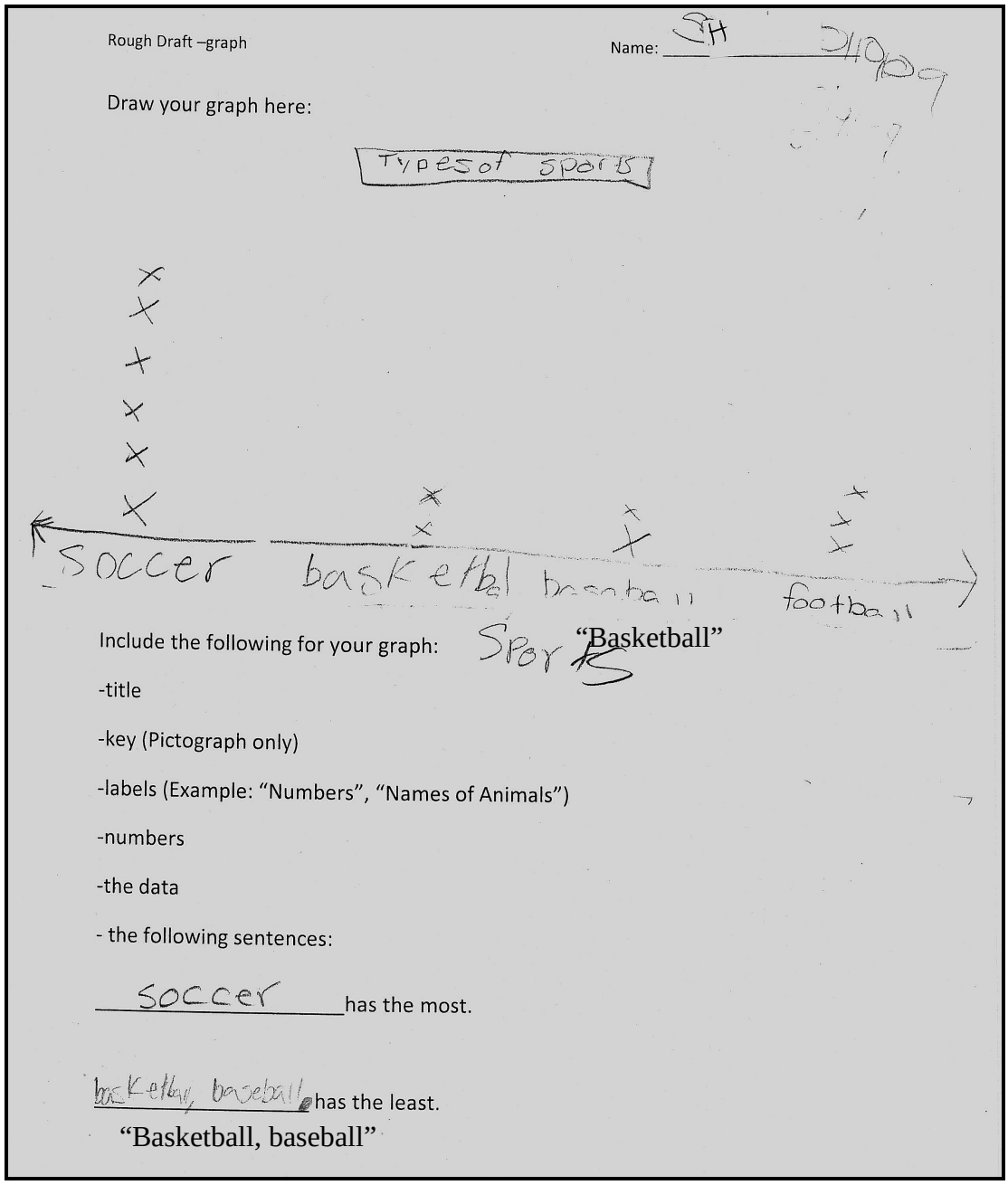
Our survey question is: (What is your favorite _____?)

What is your favorite sport?

The four answer choices are:

1. soccer — |HH|
2. basketball — | |
3. baseball — ||
4. Football — |||

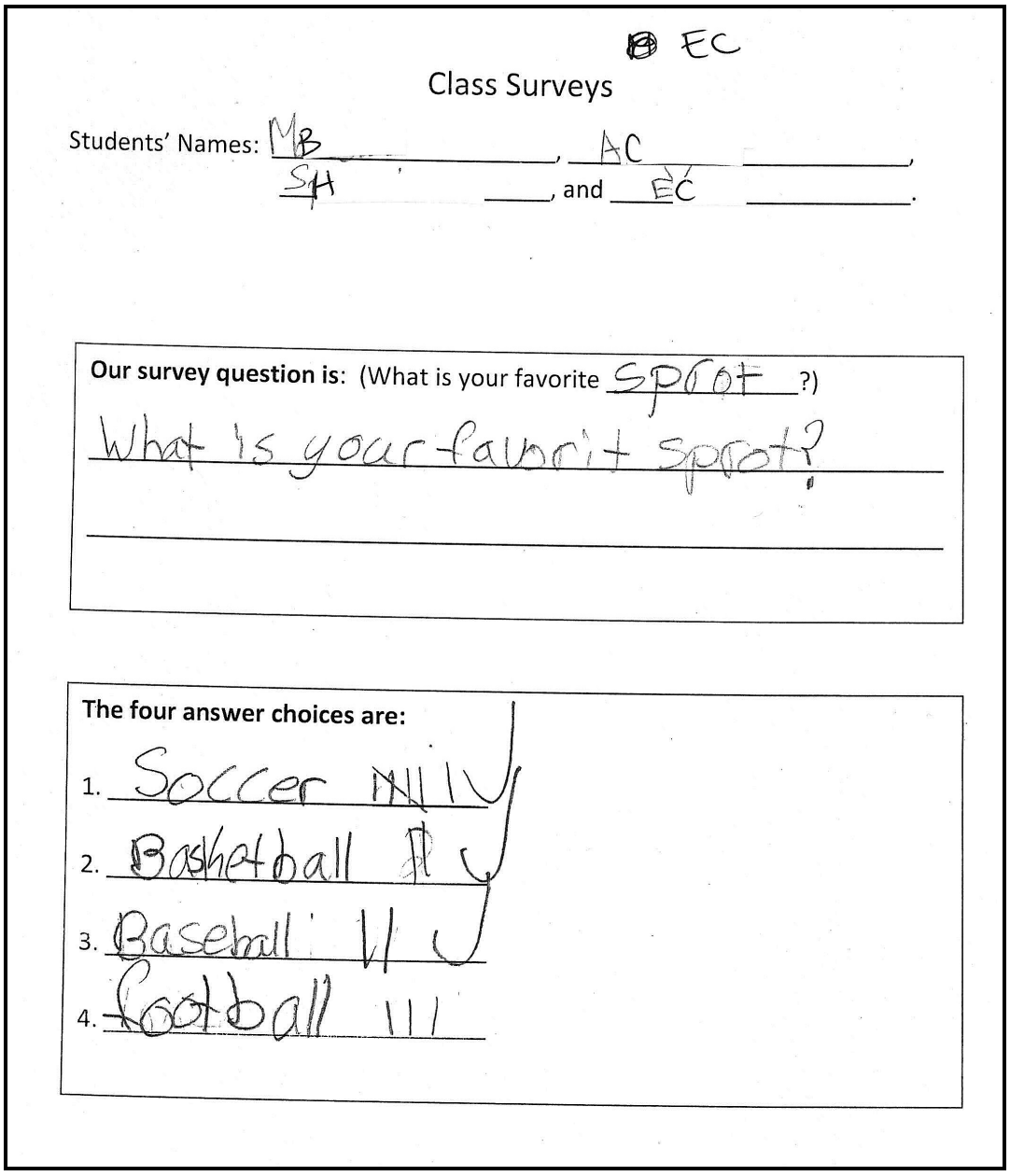
SH's Rough Draft Graph



"Basketball"

"Basketball, baseball"

EC's Class Survey



EC

Class Surveys

Students' Names: MB, AC, SH, and EC.

Our survey question is: (What is your favorite SPORT?)

What is your favorit sport?

The four answer choices are:

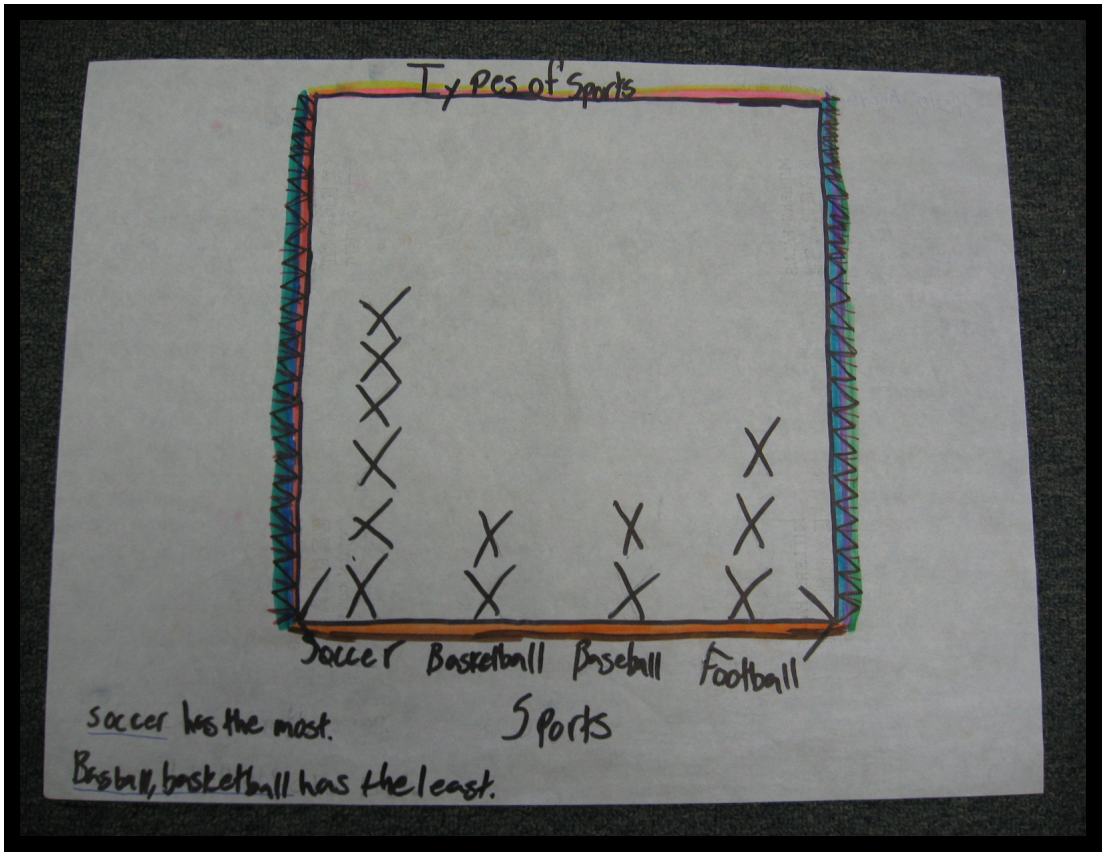
1. Soccer IIII
2. Basketball II
3. Baseball III
4. Football III

EC's Rough Draft Graph

Data Not Available-

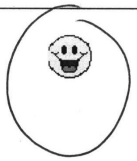
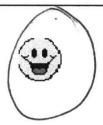
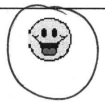
Student was out sick for the remainder of the final project.

Blue Group's Graph



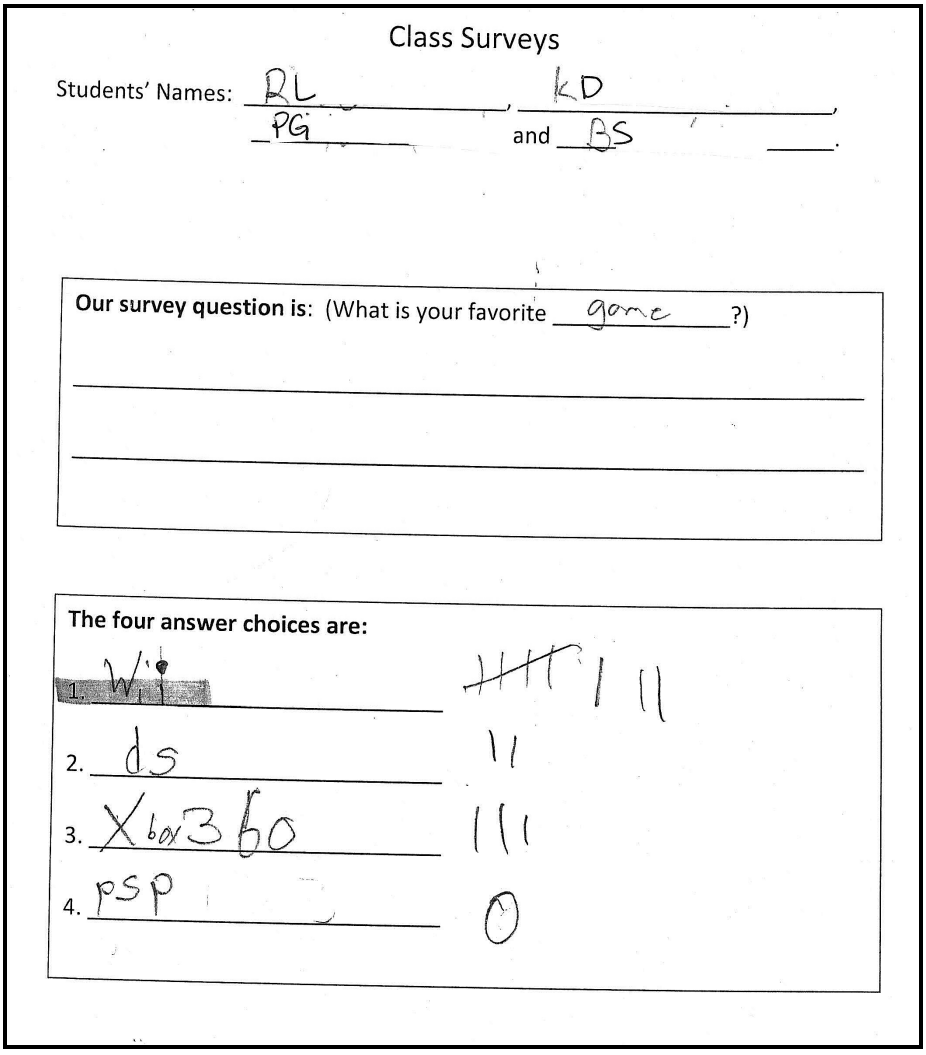
Blue Group's Rubric

Name: Blue

Math Presentation Rubric		
Skill	**Great Job!**	**Need Practice**
1. I signed my group's question.		
2. I identified the four choices.		
3. I included the data.		
4. I identified which kind of graph we drew.		
5. I explained the most/least for my graph.		

Green Group's Final Project

RL's Class Survey



Class Surveys

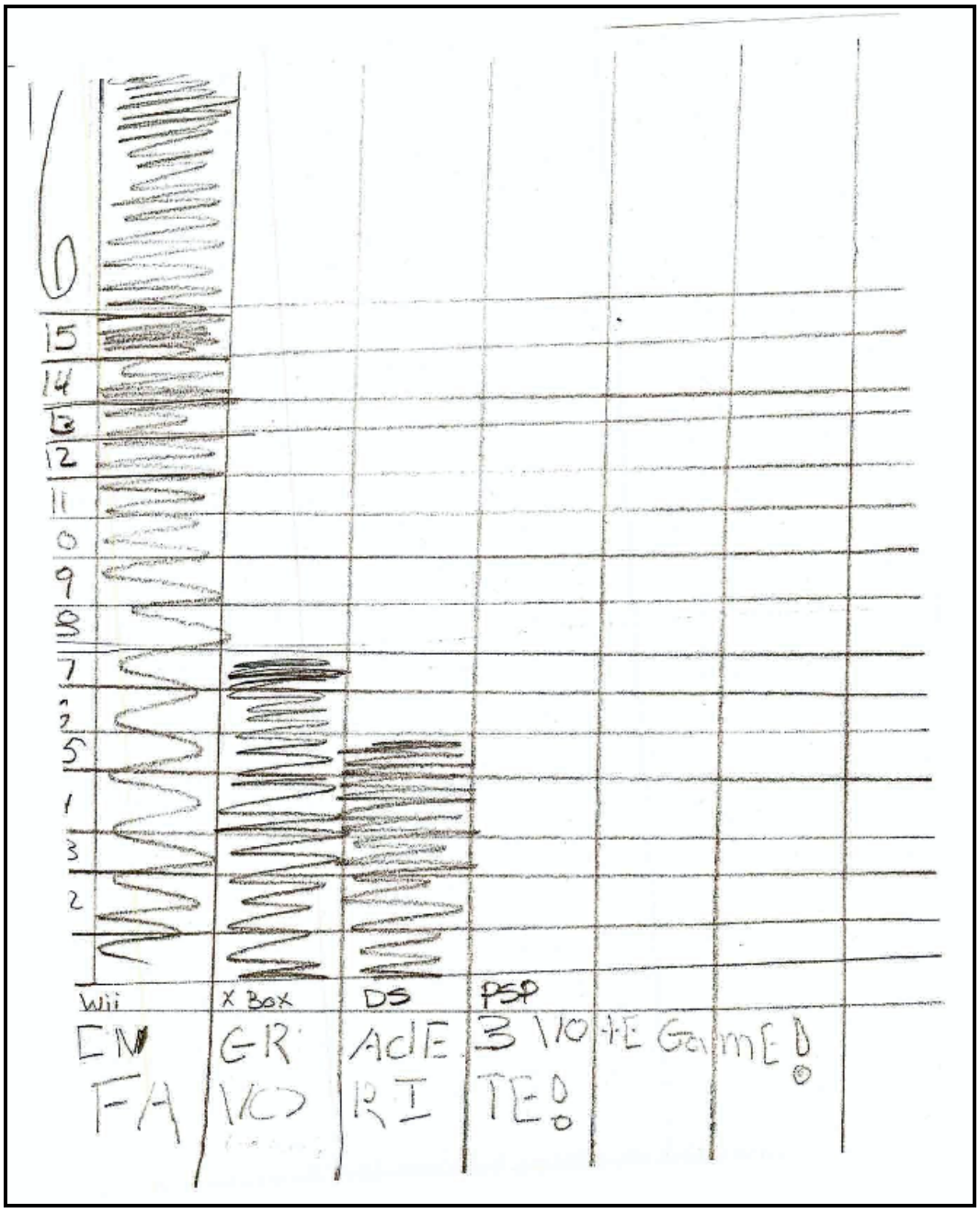
Students' Names: RL, KD, PG and BS.

Our survey question is: (What is your favorite game?)

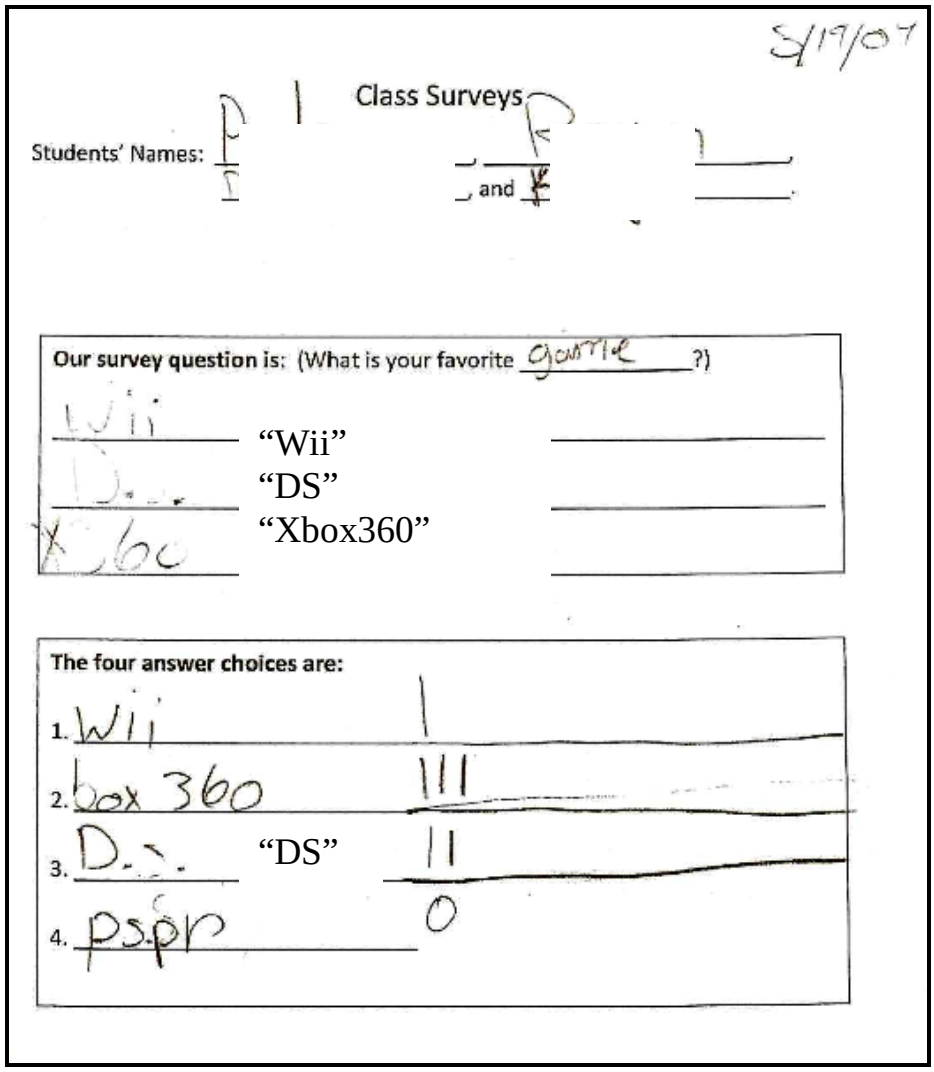
The four answer choices are:

1. Wii — ||||/ ||
2. ds — ||
3. Xbox360 — |||
4. psp — 0

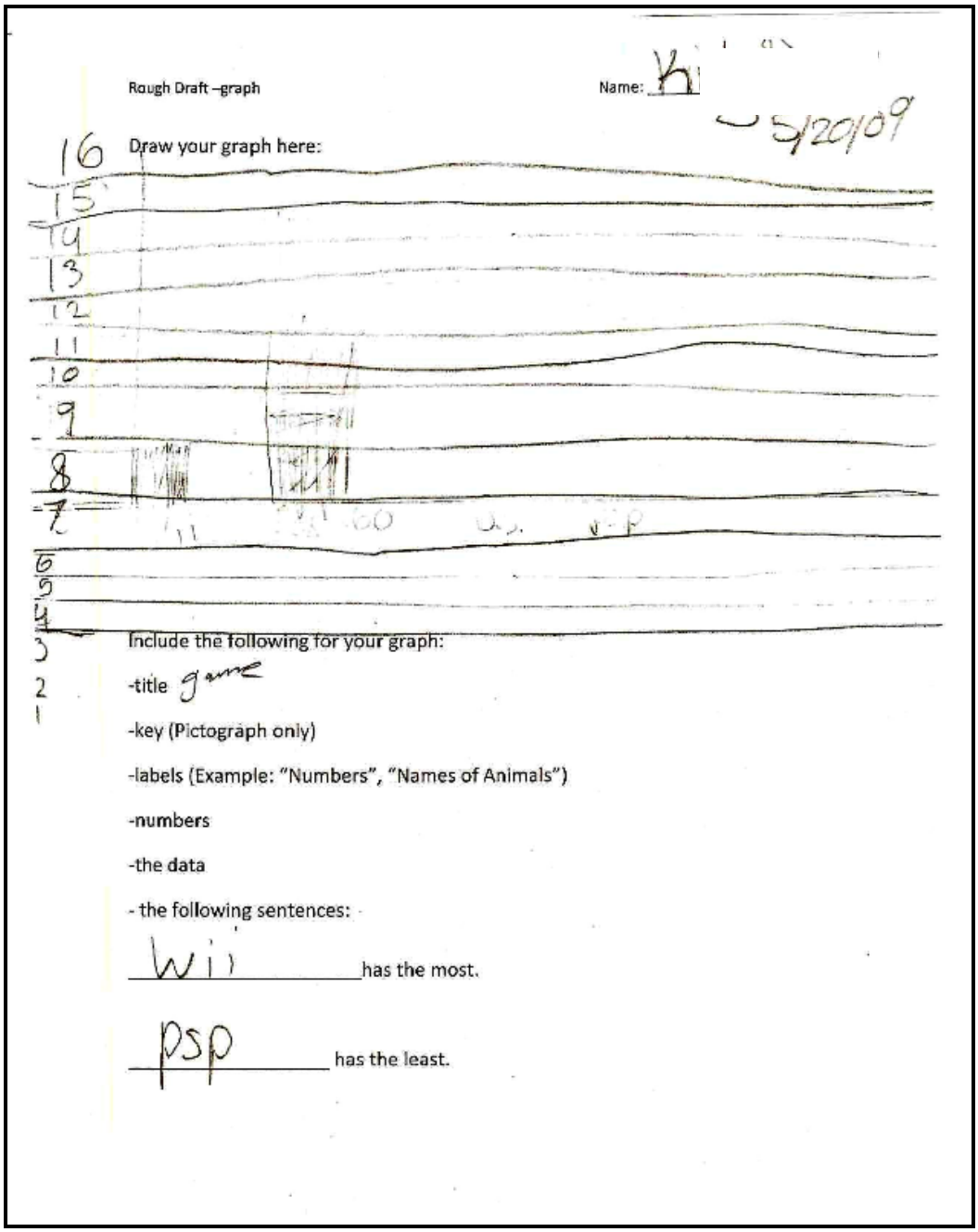
RL's Rough Draft Graph



KD's Class Survey



KD's Rough Draft Graph



Rough Draft –graph

Name: Ki

5/20/09

Draw your graph here:

16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1

Include the following for your graph:

-title game

-key (Pictograph only)

-labels (Example: "Numbers", "Names of Animals")

-numbers

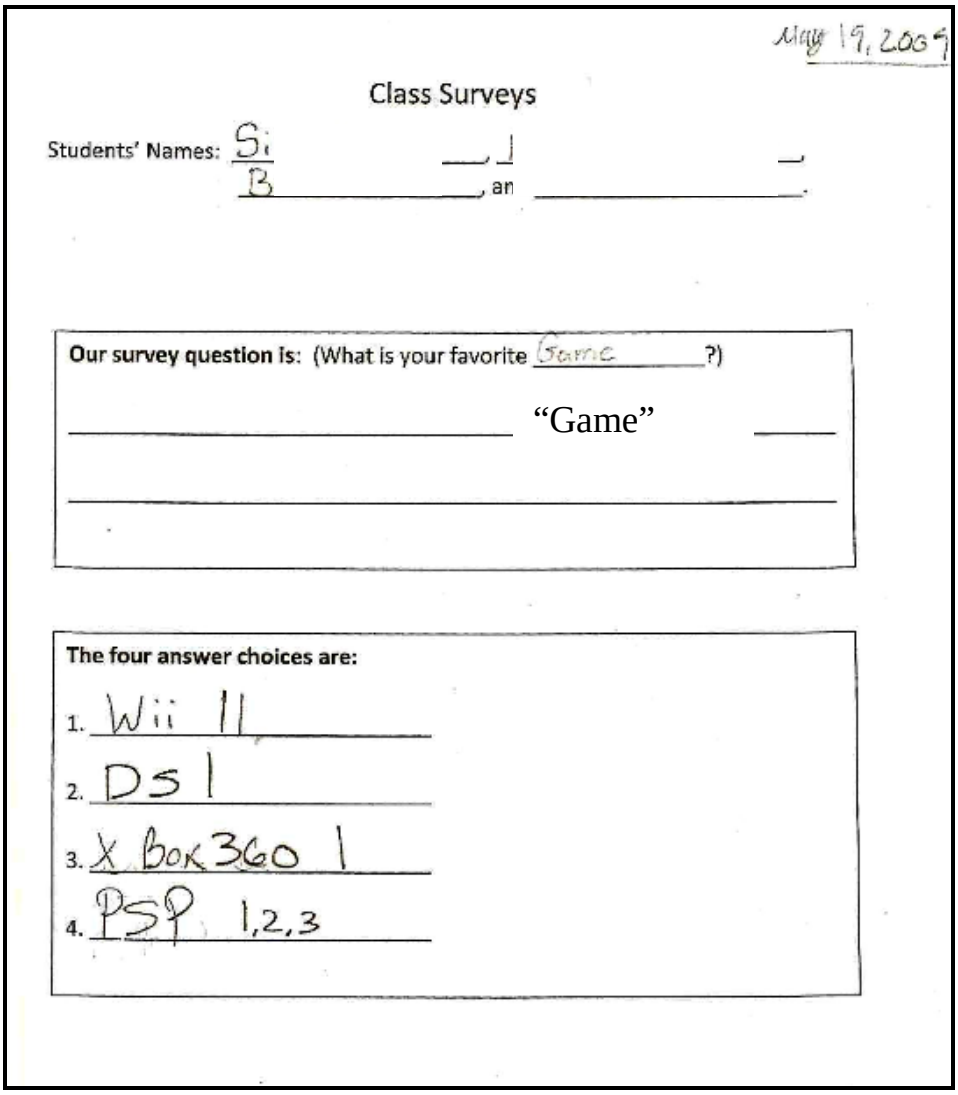
-the data

- the following sentences:

Wii has the most.

PSP has the least.

PG's Class Survey



May 19, 2009

Class Surveys

Students' Names: Si J
B an .

Our survey question is: (What is your favorite Game ?)

"Game"

The four answer choices are:

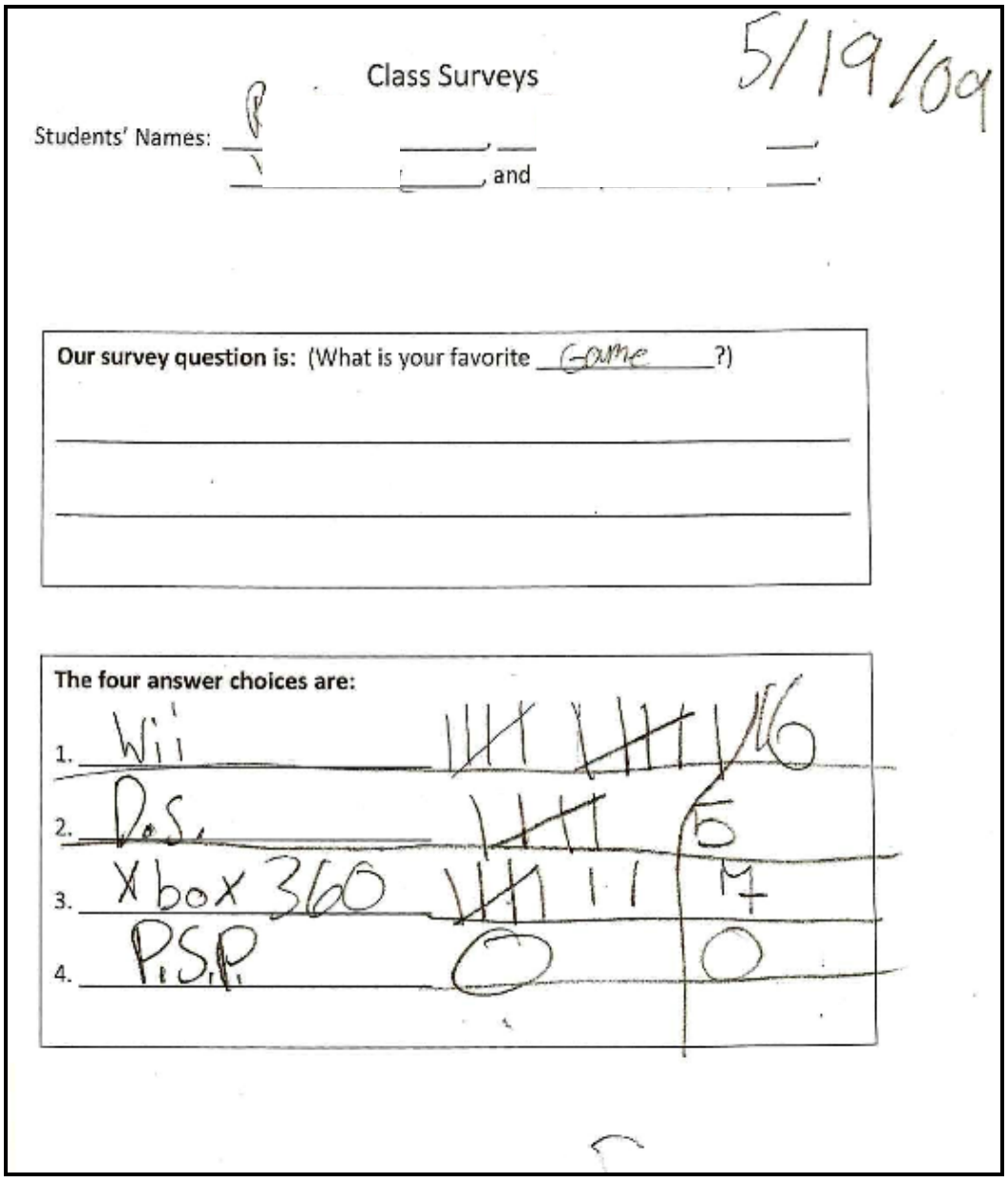
1. Wii 1
2. DS 1
3. X Box 360 1
4. PSP 1,2,3

PG's Rough Draft Graph

Data not available-

Student did not finish the rough draft of her graph.

BS's Class Survey



Class Surveys

5/19/09

Students' Names: B _____, _____ and _____.

Our survey question is: (What is your favorite Game ?)

The four answer choices are:

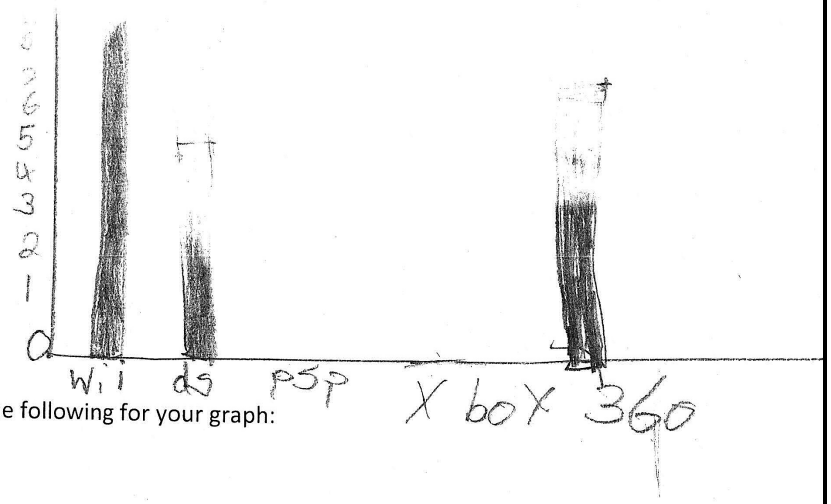
1. Wii — 16
2. D.S. — 5
3. Xbox 360 — 7
4. P.S.P — 0

BS's Rough Draft Graph

Rough Draft –graph 05/2?6a Name: BS

Draw your graph here:

3rd grade favorite games



Include the following for your graph:

-title

-key (Pictograph only)

-labels (Example: "Numbers", "Names of Animals")

-numbers

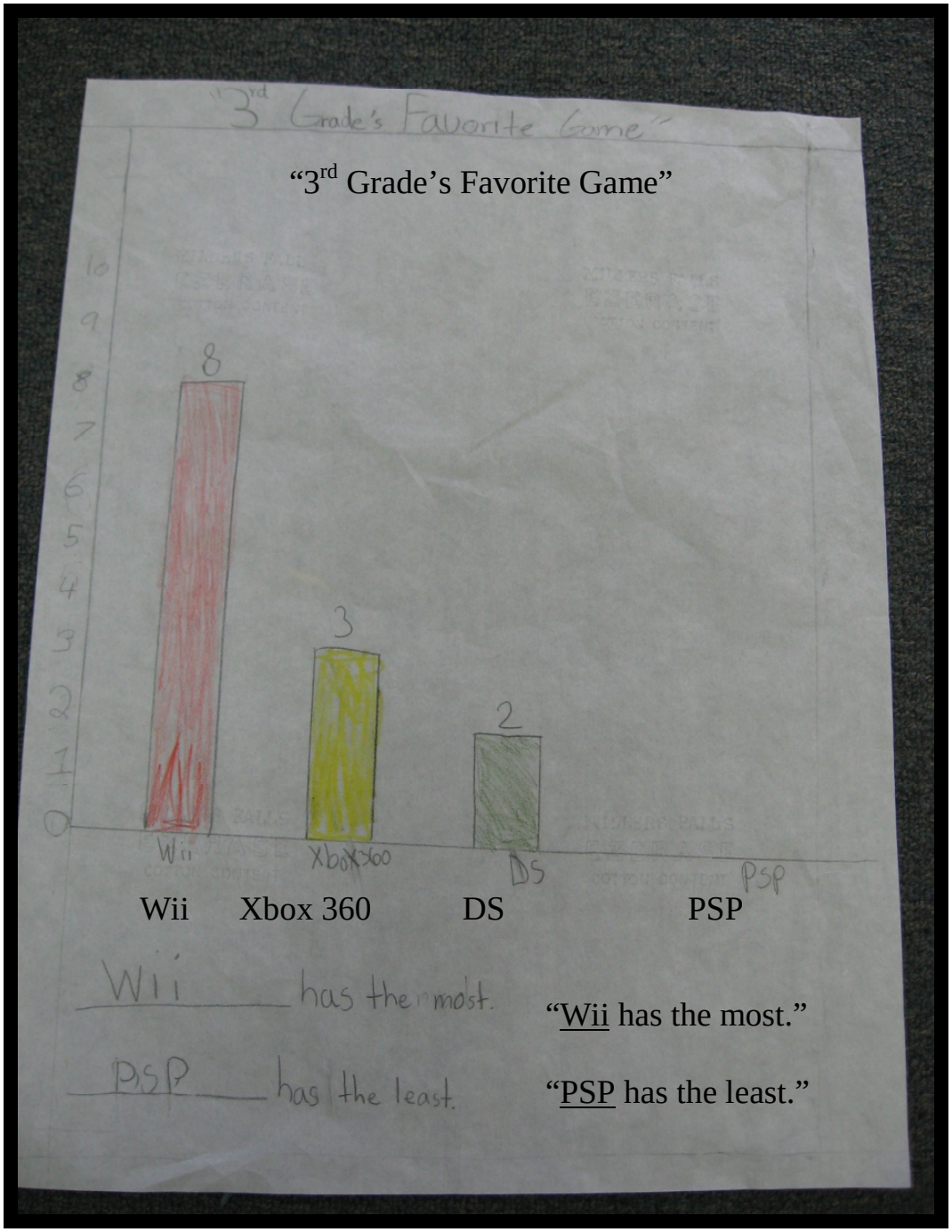
-the data

- the following sentences:

Wii has the most.

~~X box 360~~ PSP has the least.

Green Group's Graph



"3rd Grade's Favorite Game"

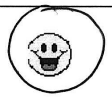
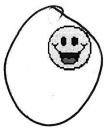
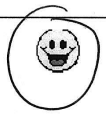
Wii Xbox 360 DS PSP

"Wii has the most."

"PSP has the least."

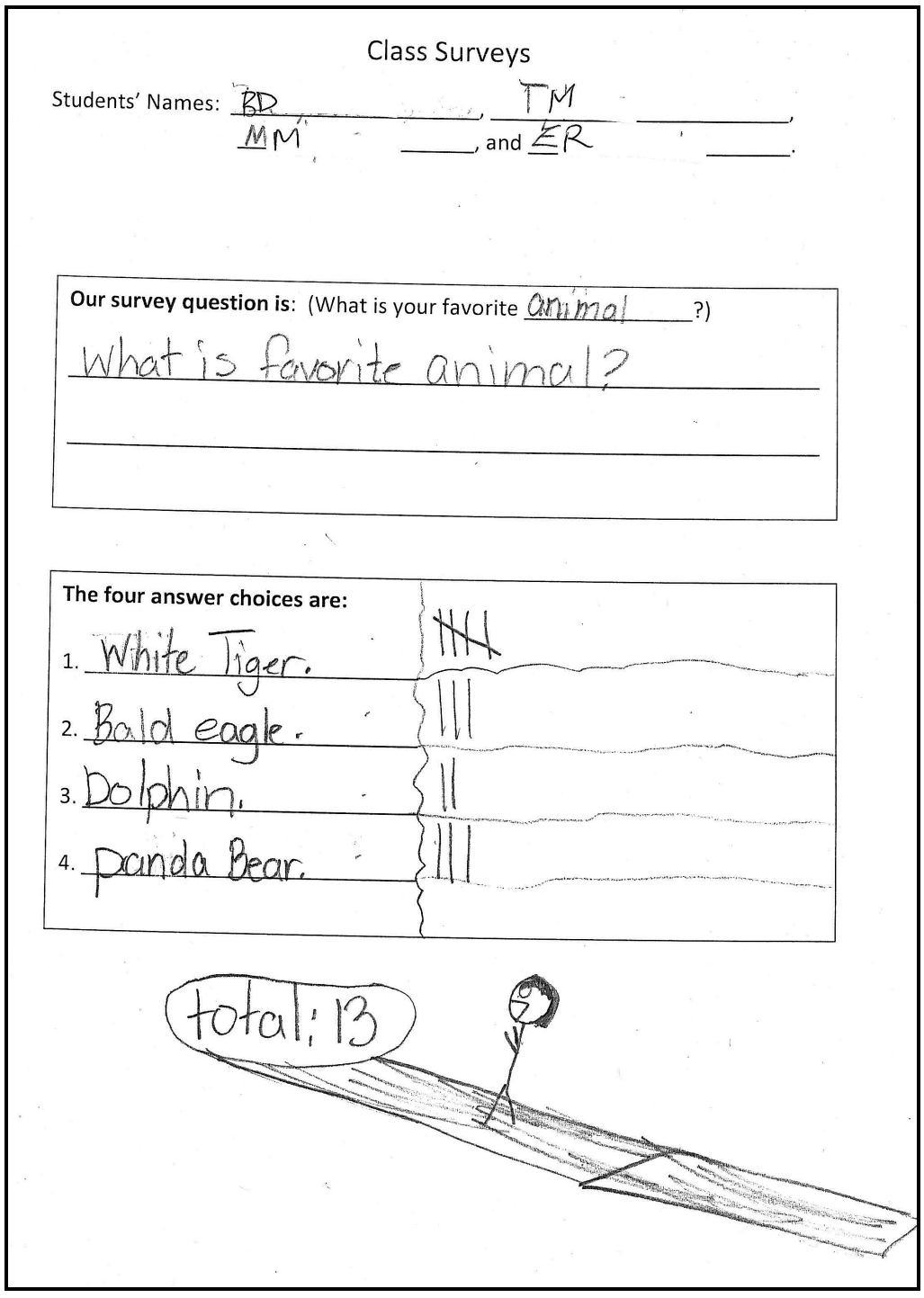
Green Group's Rubric

Name: Green

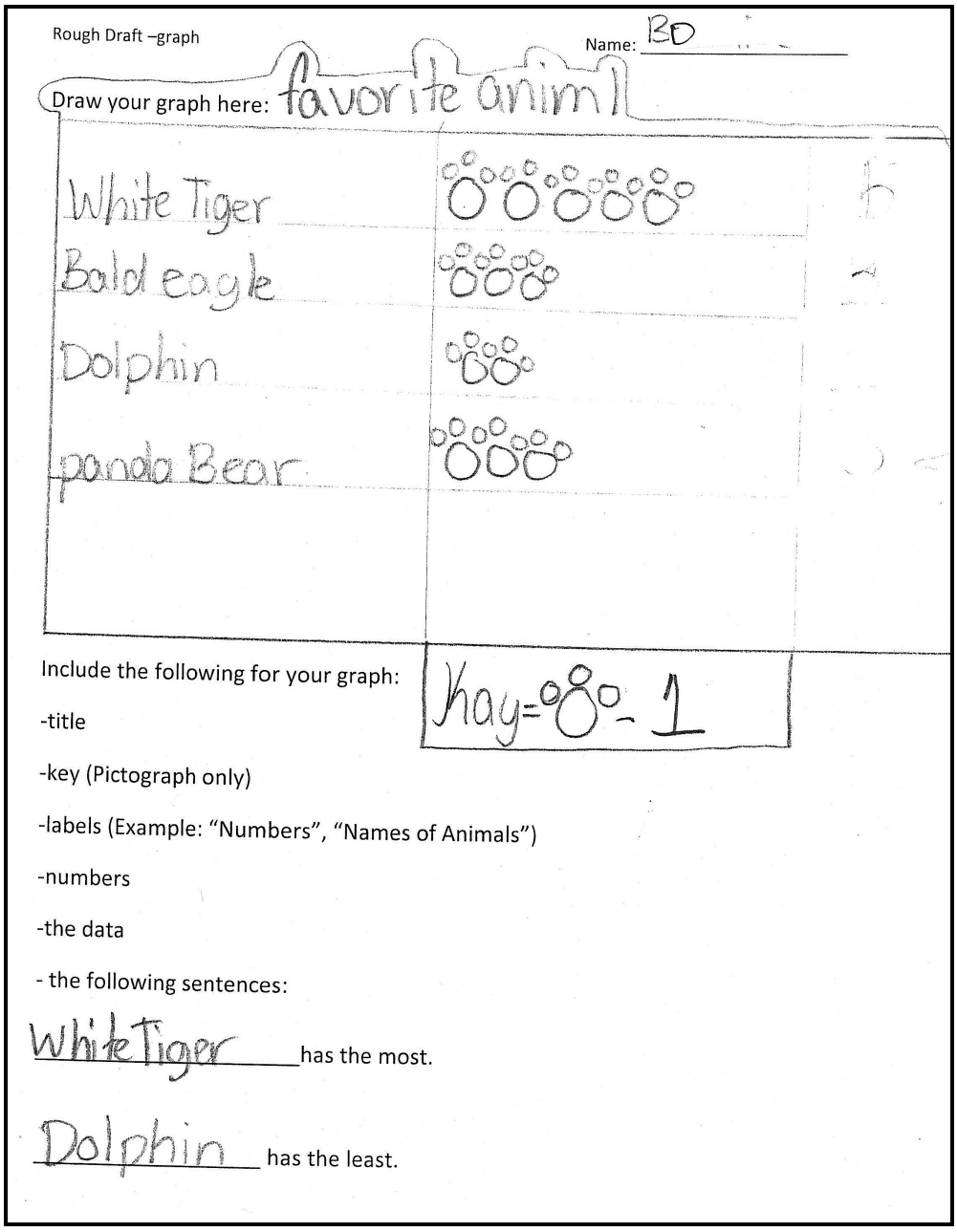
Math Presentation Rubric		
Skill	**Great Job!**	**Need Practice**
1. I signed my group's question.		
2. I identified the four choices.		
3. I included the data.		
4. I identified which kind of graph we drew.		
5. I explained the most/least for my graph.		

Pink Group's Final Project

BD's Class Survey



BD's Rough Draft Graph



Rough Draft –graph

Name: BD

Draw your graph here: favorite animal

White Tiger	
Bald eagle	
Dolphin	
panda Bear	

Include the following for your graph:

Key=8o=1

-title

-key (Pictograph only)

-labels (Example: "Numbers", "Names of Animals")

-numbers

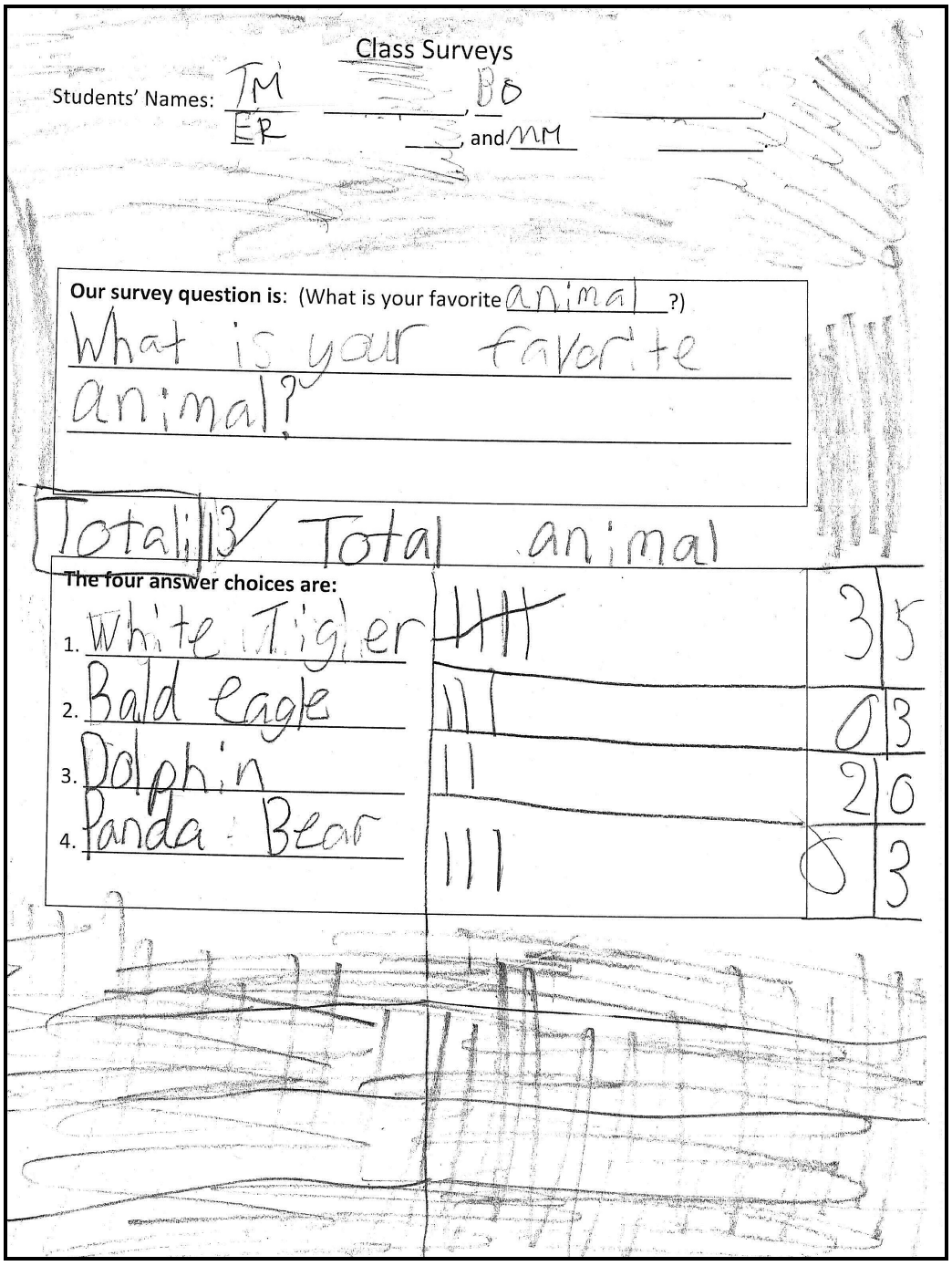
-the data

- the following sentences:

White Tiger has the most.

Dolphin has the least.

TM's Class Survey



Class Surveys

Students' Names: TM, ER, BO, and MM

Our survey question is: (What is your favorite animal?)

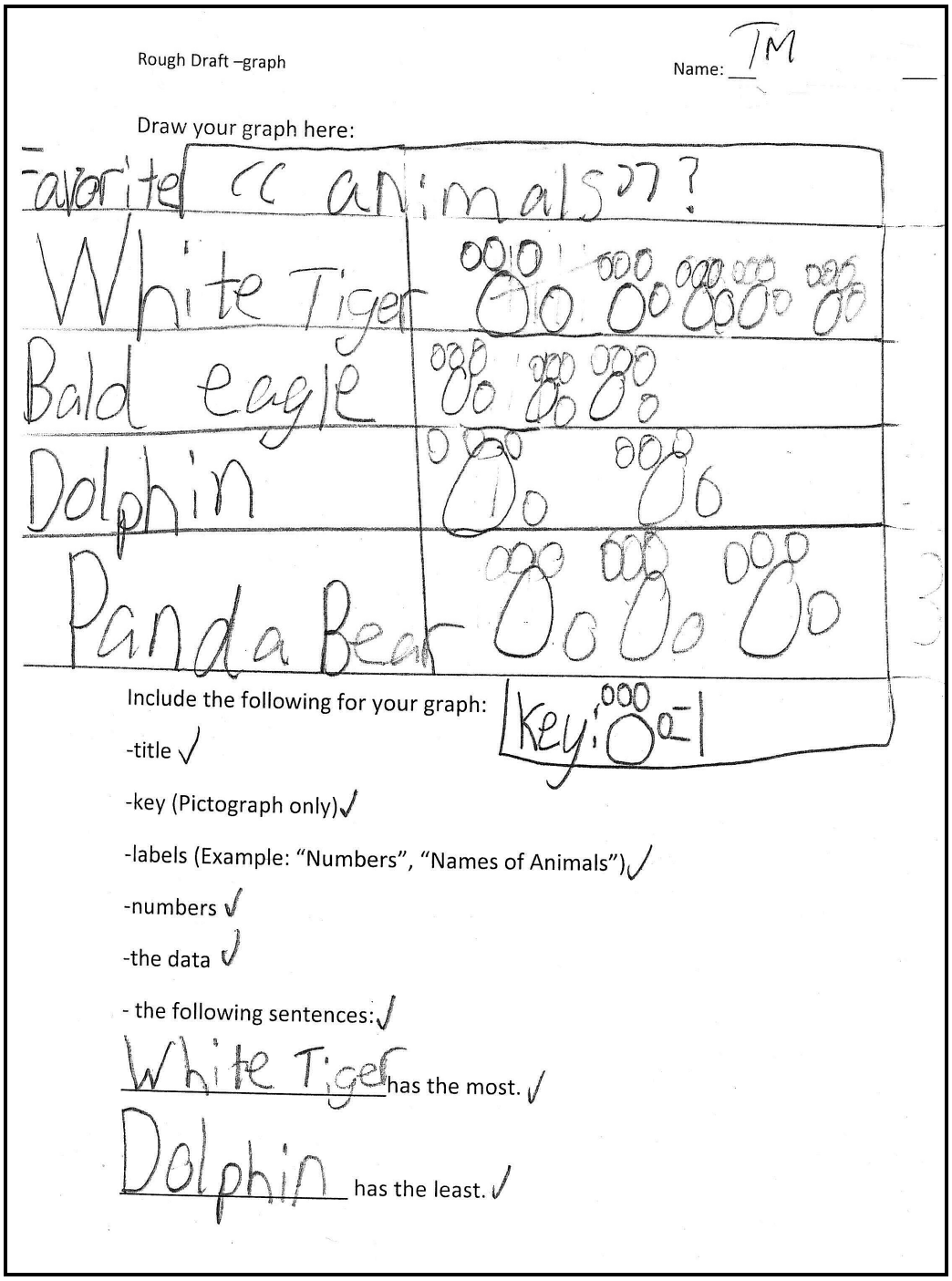
What is your favorite animal?

Total: 13 Total animal

The four answer choices are:

1. White Tiger	IIII	3 5
2. Bald Eagle	III	0 3
3. Dolphin	II	2 0
4. Panda Bear	III	0 3

TM's Rough Draft Graph



Rough Draft –graph

Name: TM

Draw your graph here:

Include the following for your graph:

-title ✓

-key (Pictograph only) ✓

-labels (Example: "Numbers", "Names of Animals") ✓

-numbers ✓

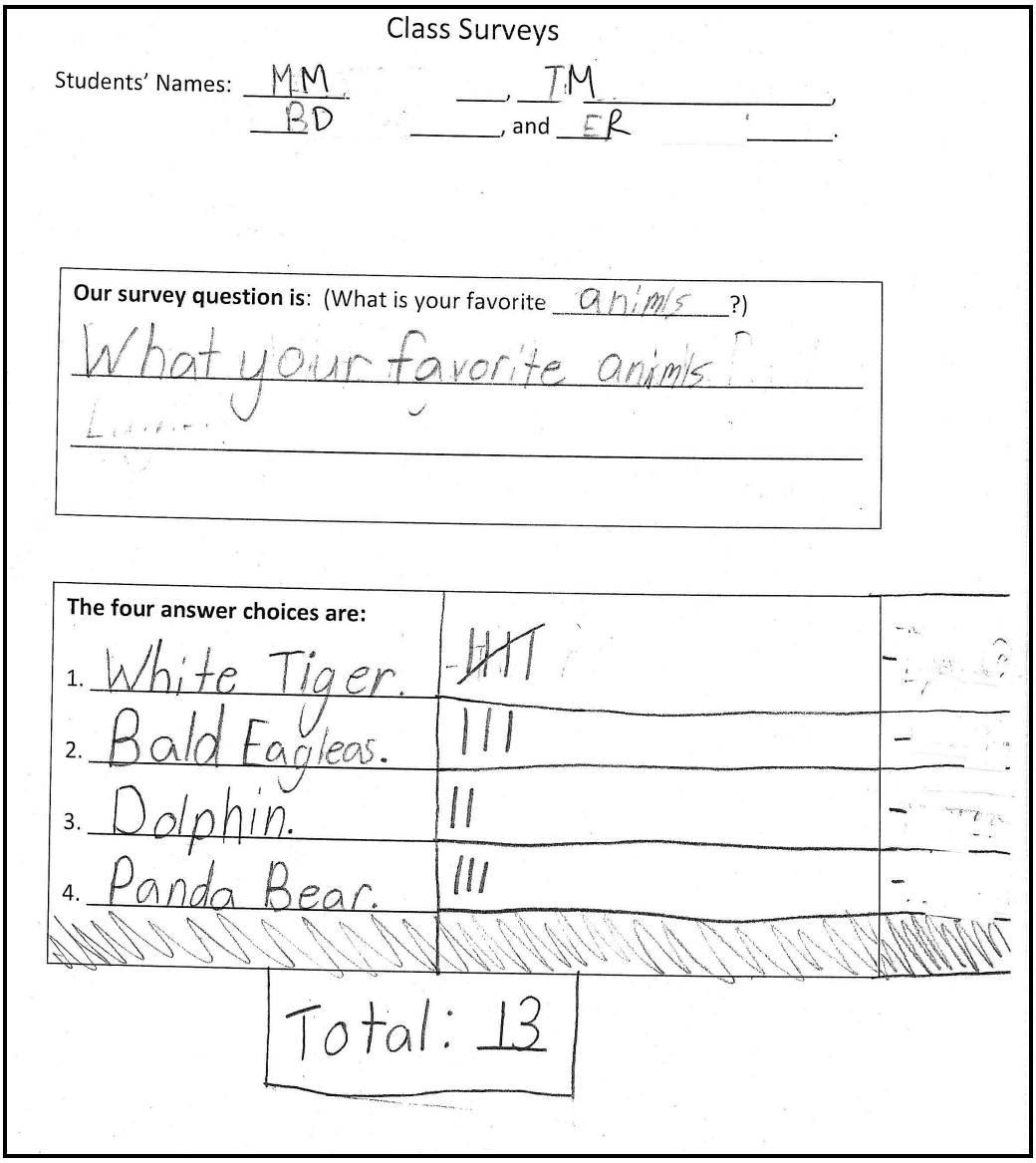
-the data ✓

- the following sentences: ✓

White Tiger has the most. ✓

Dolphin has the least. ✓

MM's Class Survey



Class Surveys

Students' Names: MM, TM, BD, _____, and ER.

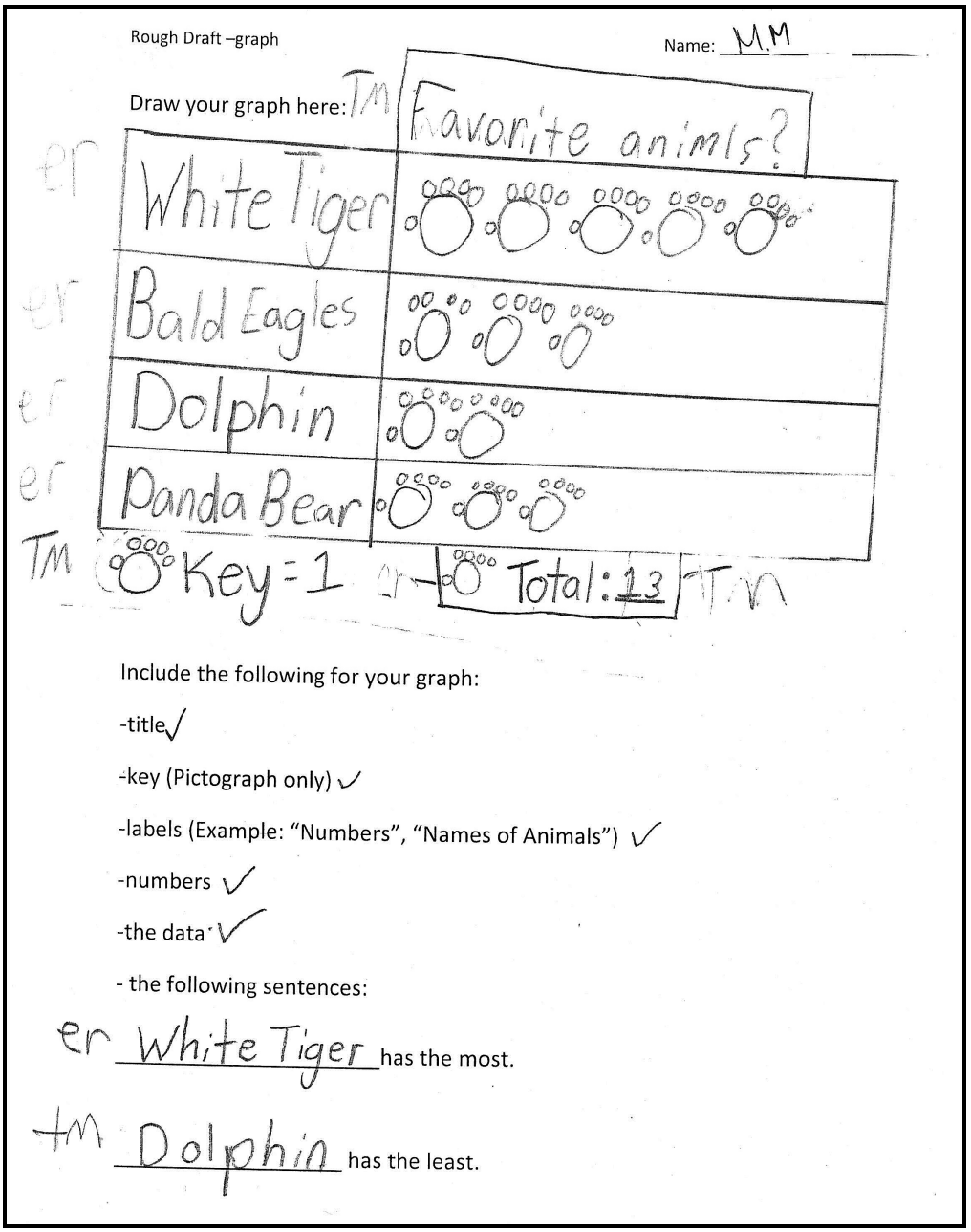
Our survey question is: (What is your favorite anims?)

What your favorite anims?

The four answer choices are:		
1. White Tiger.	~~IIII~~	
2. Bald Eagleas.	III	
3. Dolphin.	II	
4. Panda Bear.	III	

Total: 13

MM's Rough Draft Graph



Rough Draft –graph

Name: M.M

Draw your graph here: TM

Favorite animls?

White Tiger	○○○○○
Bald Eagles	○○○
Dolphin	○○
Panda Bear	○○○

er TM ○ Key = 1 er ○ Total: 13 TM

Include the following for your graph:

-title ✓

-key (Pictograph only) ✓

-labels (Example: "Numbers", "Names of Animals") ✓

-numbers ✓

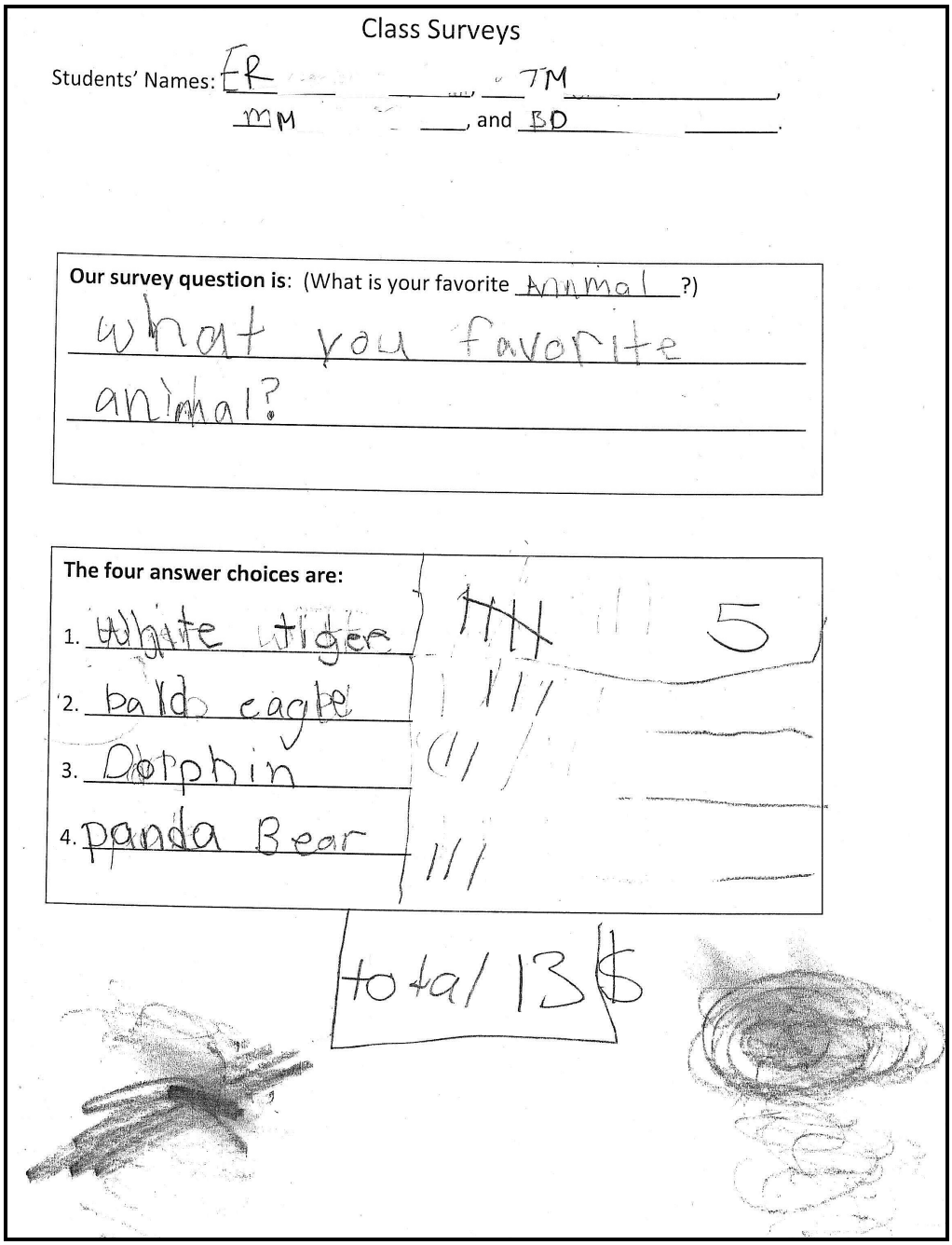
-the data ✓

- the following sentences:

er White Tiger has the most.

tm Dolphin has the least.

ER's Class Survey



Class Surveys

Students' Names: ER, TM, MM, and BD.

Our survey question is: (What is your favorite Animal?)

what you favorite animal?

The four answer choices are:

1. White tiger	𝍸 | |	5
2. bald eagle	| | |	
3. Dolphin	| |	
4. panda Bear	| | |	

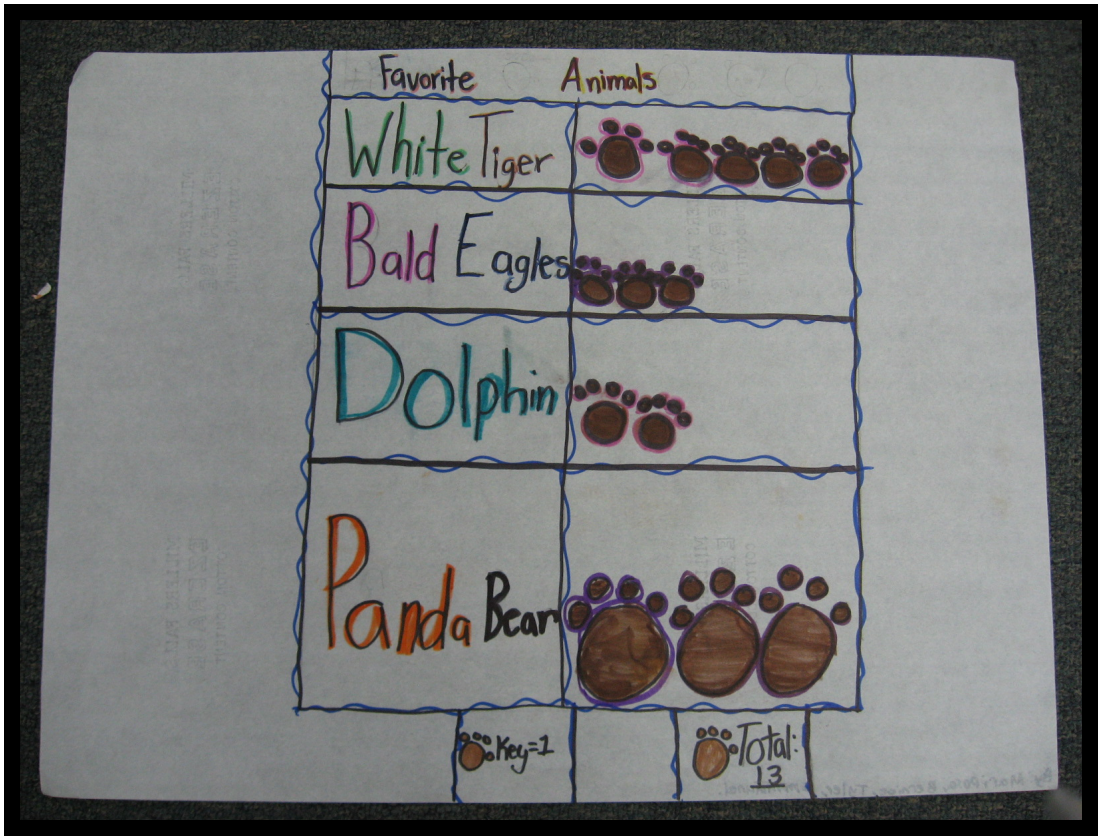
total 13 $

ER's Rough Draft Graph

No data available-

Student was not at school to finish the rough draft graph.

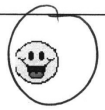
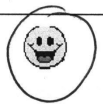
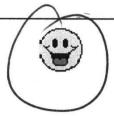
Pink Group's Graph



Pink Group's Rubric

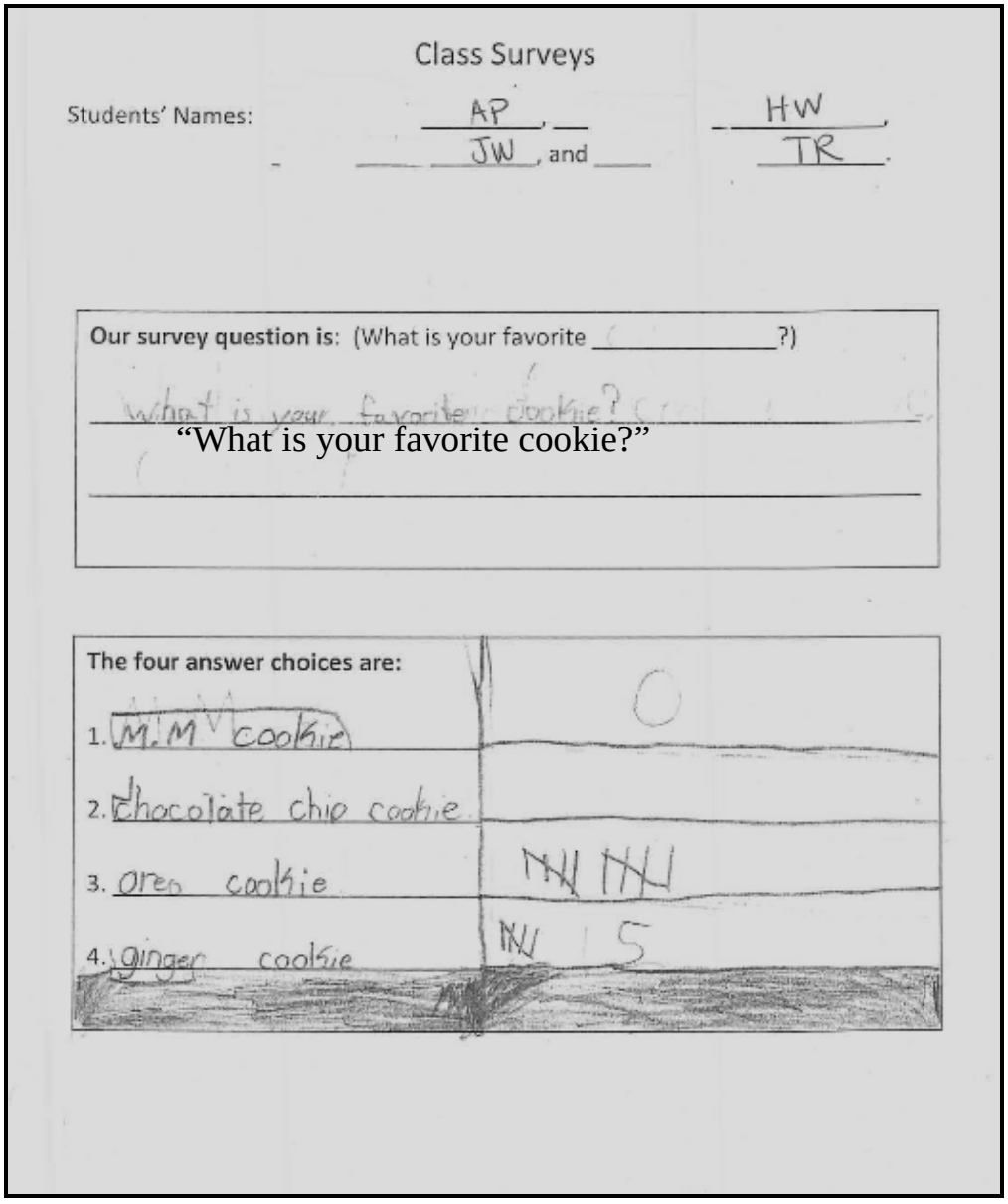
Name: Pink

Math Presentation Rubric

Skill	Great Job!	Need Practice
1. I signed my group's question.		
2. I identified the four choices.		
3. I included the data.		
4. I identified which kind of graph we drew.		
5. I explained the most/least for my graph.		

Yellow Group's Final Project

AP's Class Survey



Class Surveys

Students' Names: AP, HW, JW, and TR.

Our survey question is: (What is your favorite _____?)

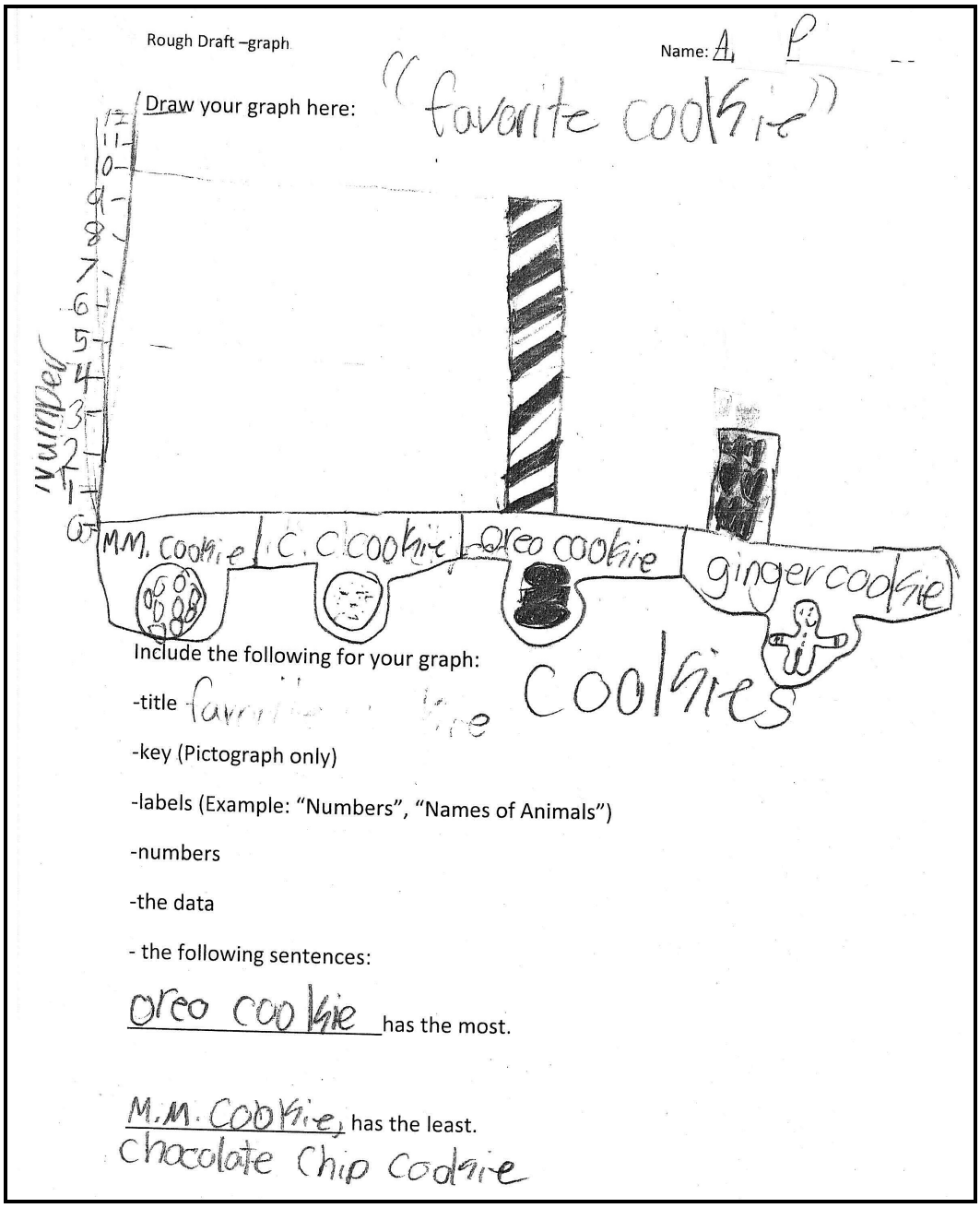
What is your favorite cookie?

"What is your favorite cookie?"

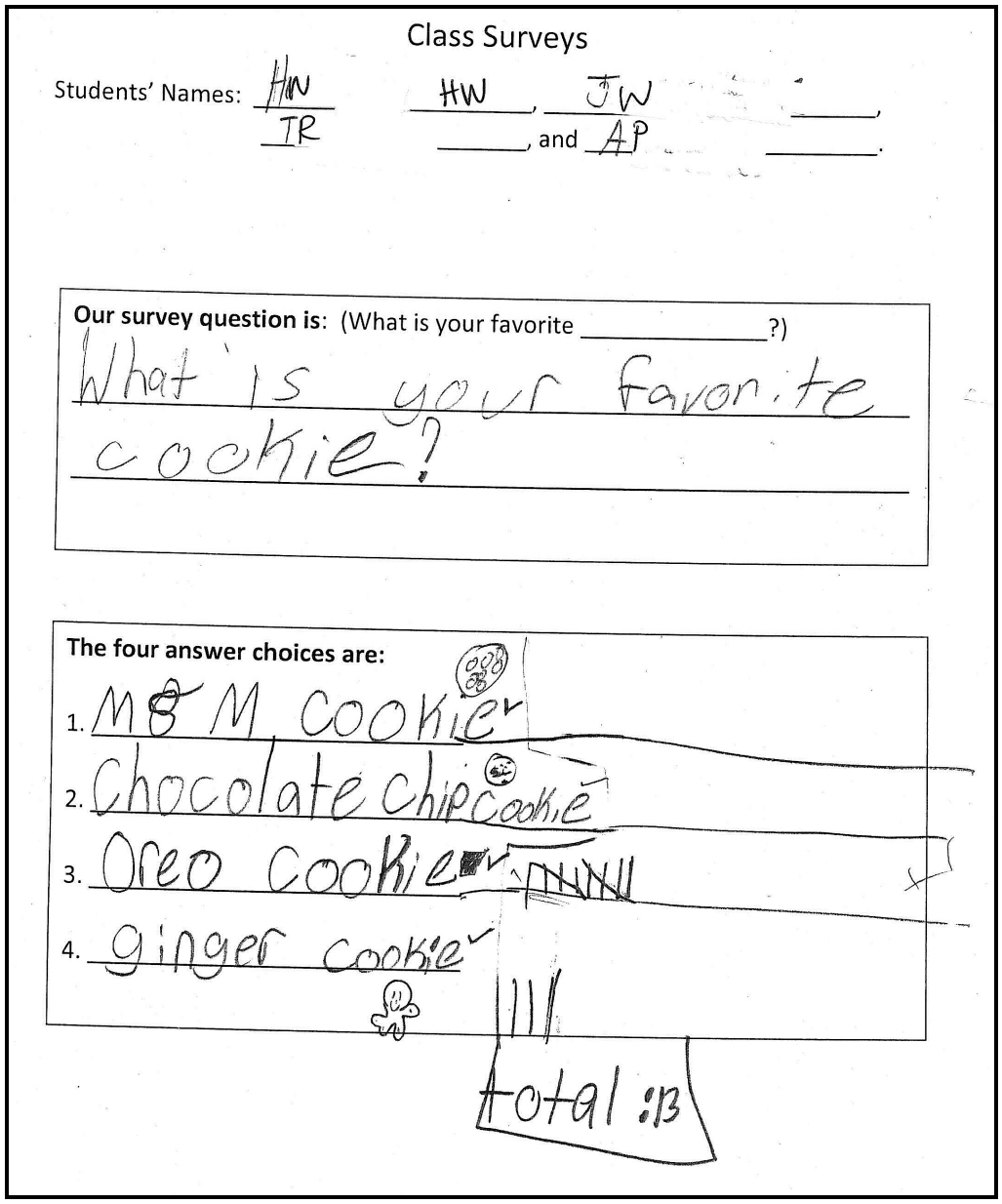
The four answer choices are:

1. M.M cookie	0
2. Chocolate chip cookie	
3. Oreo cookie	𝍸 𝍸
4. ginger cookie	𝍸 5

AP's Rough Draft Graph



HW's Class Survey



Class Surveys

Students' Names: HW, IR, HW, JW, _____, and AP, _____.

Our survey question is: (What is your favorite _____?)

What is your favorite cookie?

The four answer choices are:

1. M&M cookie
2. Chocolate chip cookie
3. Oreo cookie
4. ginger cookie

total: 13

HW's Rough Draft Graph

Rough Draft –graph "Favorite Cookies" Name: H W

Draw your graph here:

Include the following for your graph:

-title

-key (Pictograph only)

-labels (Example: "Numbers", "Names of Animals")

-numbers

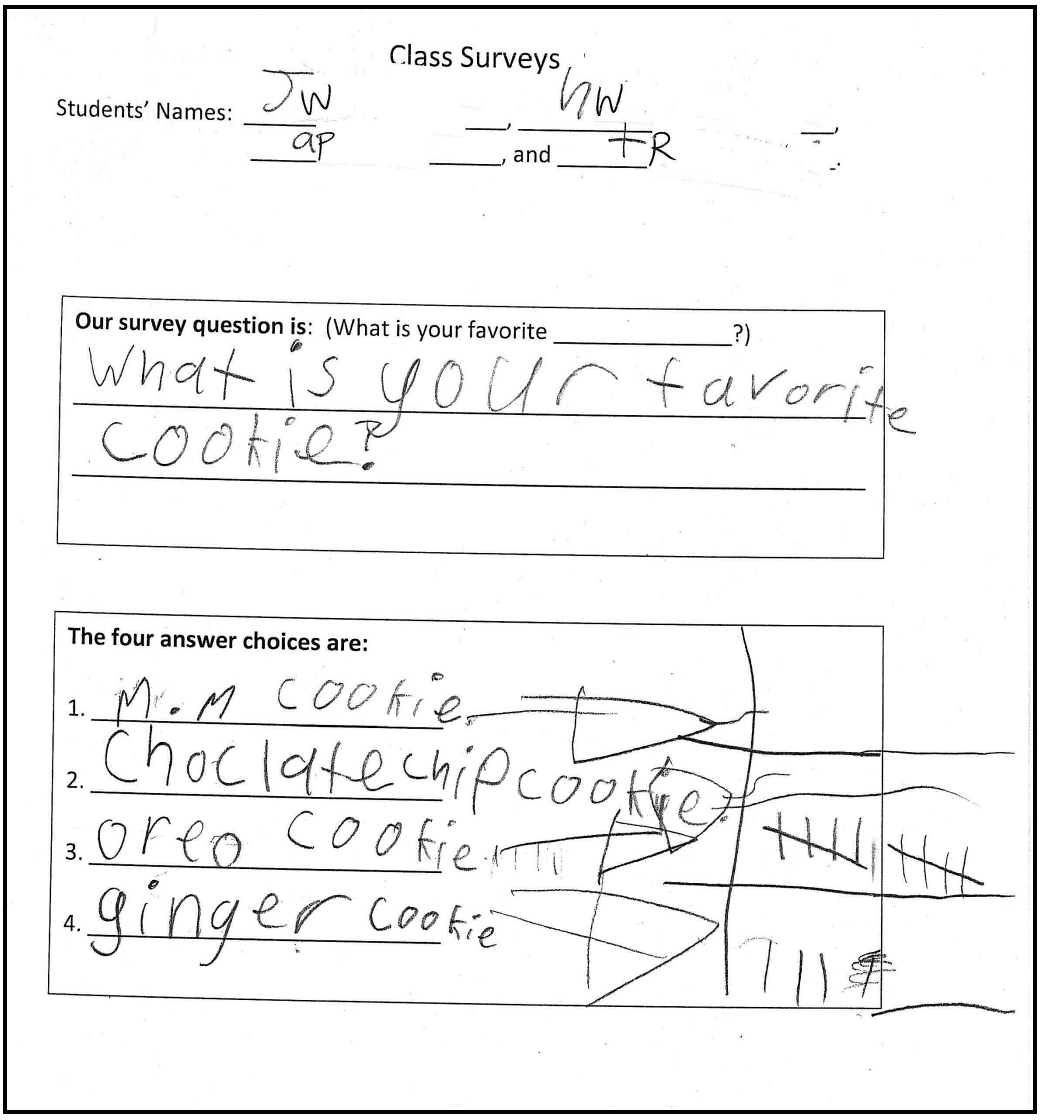
-the data

- the following sentences:

Oreo Cookie has the most.

M&M and chocolate Chips cookie has the least.

JW's Class Survey



Class Surveys

Students' Names: JW, hw, ap, ____, and +R

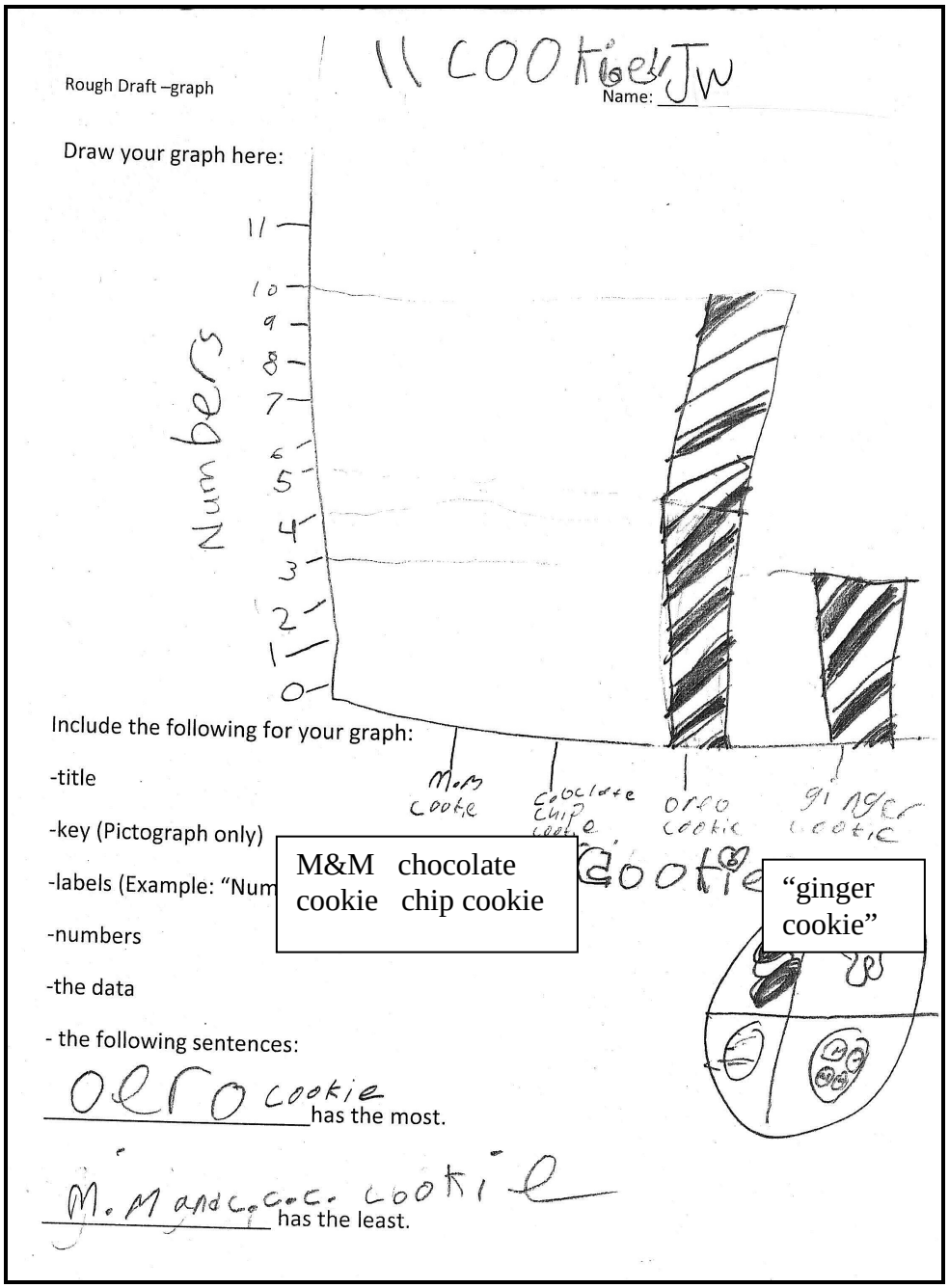
Our survey question is: (What is your favorite _____?)

What is your favorite cookie?

The four answer choices are:

1. M.M cookie
2. Choclatechip cookie
3. oreo cookie
4. ginger cookie

JW's Rough Draft Graph



TR's Class Survey

Class Surveys

Students' Names: TR _____, OP _____, _____ WN _____, and JW _____.

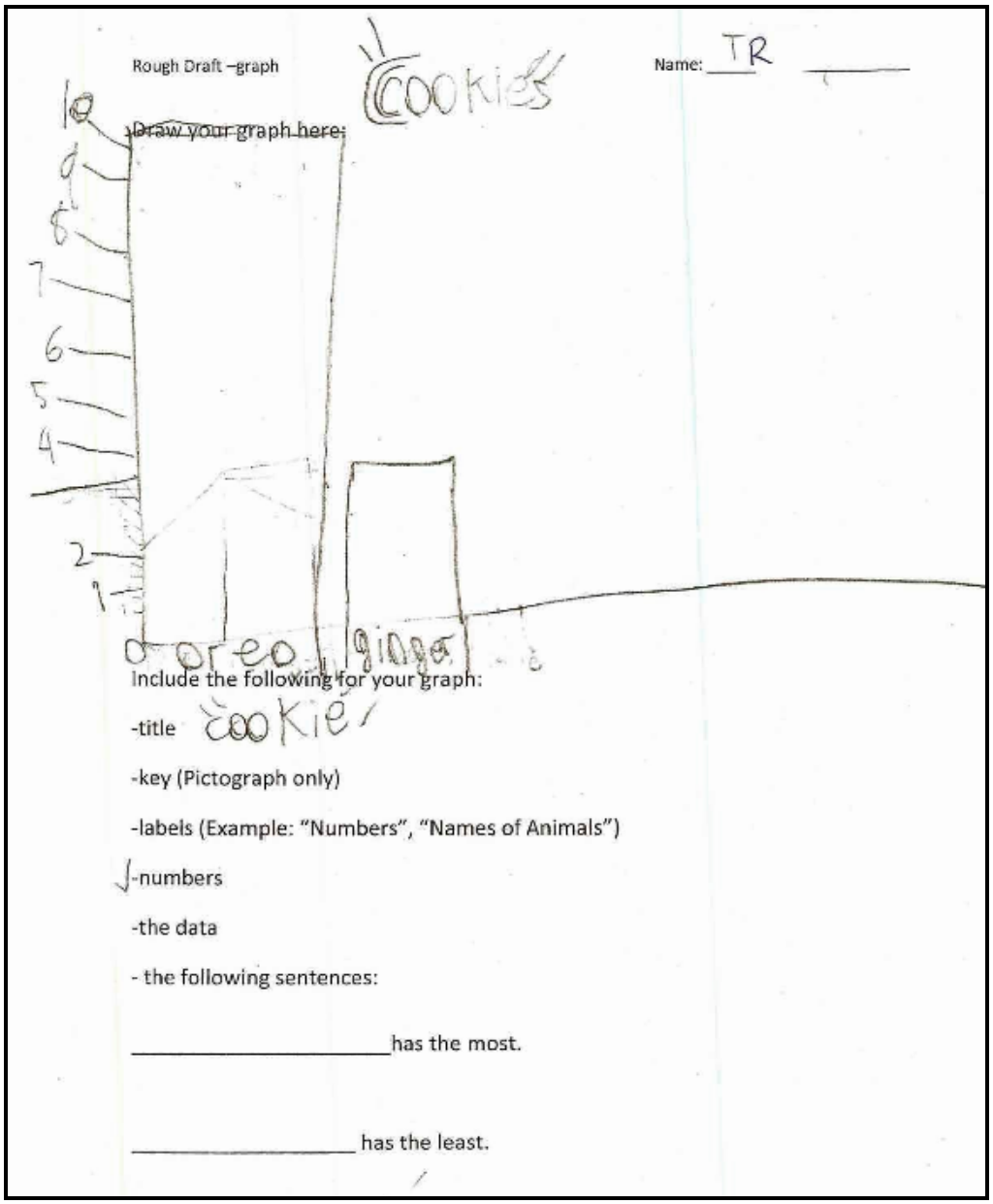
Our survey question is: (What is your favorite _____?)

What is your favorite cookie?

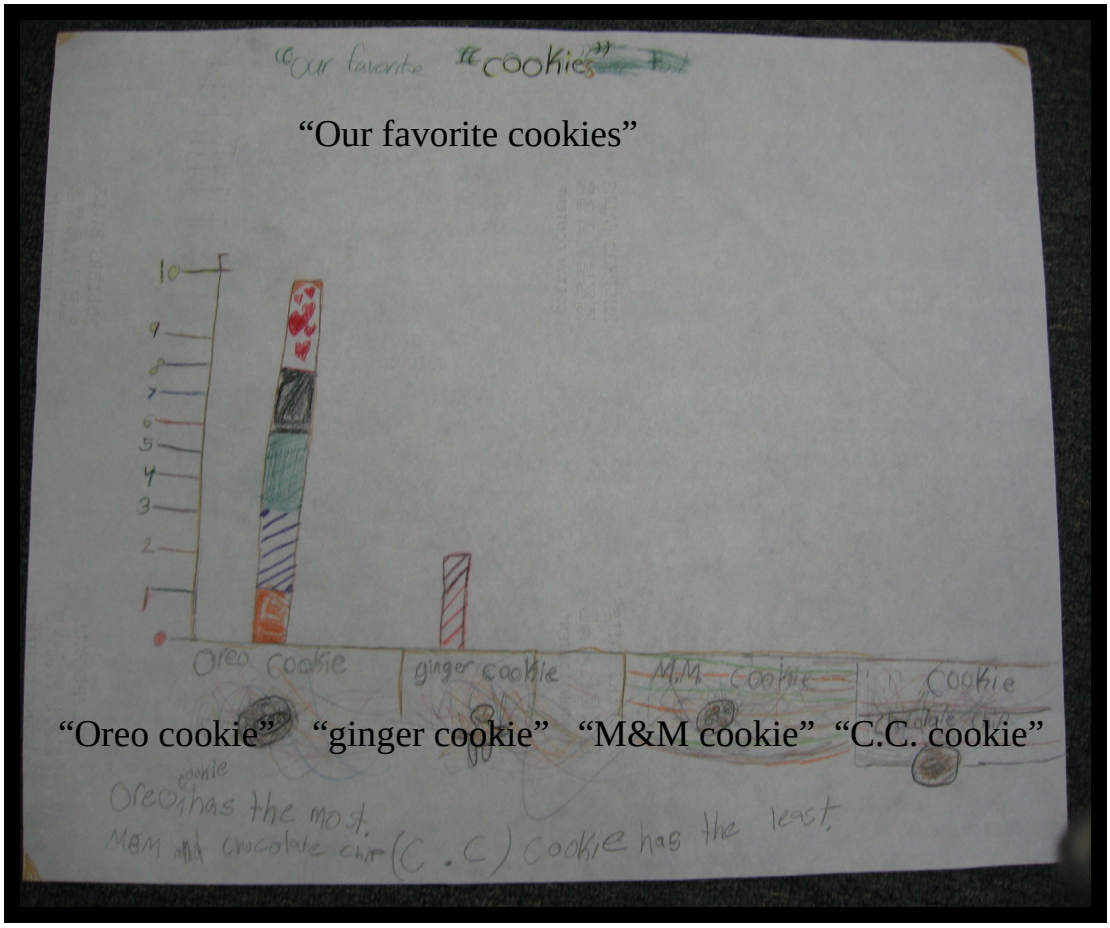
The four answer choices are:

1. M&M cookie 
2. Chocolate chip cookie 
3. Oreo cookie  IIII
4. Gingerbread cookie III

TR's Rough Draft Graph



Yellow Group's Graph

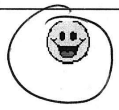


"Oreo cookie has the most."
"M&M and chocolate chip (C.C.) cookie has the least."

Yellow Group's Rubric

Name: Yellow

Math Presentation Rubric

Skill	Great Job!	Need Practice
1. I signed my group's question.		
2. I identified the four choices.		
3. I included the data.		
4. I identified which kind of graph we drew.		
5. I explained the most/least for my graph.