A Study of Graphical Representation of Data
In Social Science of Standard IX

Rishi Raj Balwaria[a], Sushma Bavishi[b]
[a]Assistant Professor, School of Science and Education, Navrachana University, Vadodara, Gujarat, India.
[b]Investigator, School of Science and Education, Navrachana University, Vadodara, Gujarat, India

Abstract

The author's recent investigation was related to the application of data handling techniques in Social Science among students of Grade IX in an English medium school. During the transaction phase of topic 'Population', the investigator realized that students had difficulty in understanding the statistical data on 'Population' and plotting it on graphs. These related difficulties were again identified by administrating a pre-test that included plotting of population data. Through this, it was evident that that the students lacked in conceptual clarity and were also unable to plot the given data correctly. Investigator found this surprising since the students had been studying this topic since Grade VII. Thus, an action plan was formulated with the help of his mentor to find out problems and help students use the skill of Data Handling and Interpretation (DHI) in other subjects. Through effective strategies and hands-on experiences that were learner centered, the investigator was able to deduce that children need to be provided with challenging opportunities and activities to be able to push any content across discipline boundaries and hence, internalize knowledge.

KEYWORDS: Graphical Representation of Data, Data Handling and Interpretation, Teaching Learning Process

INTRODUCTION

"Teachers often leave a mark on their students, but they seldom leave a mark on their profession"-(Wolfe, 1989)

Teachers regularly attempt to make the teaching-learning process more interesting and appealing to students and this often leads to identification of deficiencies in the learning processes. A teacher has the ability to improve or resolve these deficiencies by adopting various systematic strategies. This type of systematic effort by the teachers to improve the teaching learning process is called 'Action Research'.

Various definitions offered by different authors in the form of observations on Action Research in Education: Emily Calhoun (1994) defined Action research as a fancy way of saying 'let's study what's happening at our school and decide how to make it a better place.' Cohen and Manion (1994) describe the emergent nature of Action research in their definition. They describe Action research as essentially an on-the-spot procedure designed to deal with a concrete problem located in an immediate situation. Bassey (1998) describes 'action research as an enquiry which is carried out in order to understand, to evaluate and then to change, in order to improve educational practice'. Hopkins (2002) maintains that 'action research combines a substantive act with a research procedure; it is action disciplined by enquiry, a personal attempt at

understanding while engaged in a process of improvement and reform'. Christine Miller (2007) definition is, "Action research is a natural part of teaching. Teachers are continually observing students, collecting data and changing practices to improve student learning and the classroom and school environment. Action research provides a framework that guides the energies of teachers toward a better understanding of why, when, and how students become better learners."

The ability to interpret data presented in tables, graphs and charts is a common requirement in many management and professional jobs and therefore the ability to make inferences and predictions based on data is a critical skill students need to develop. In studying data and statistics, students can also learn that solutions to some problems depend on assumptions and have some degree of uncertainty.

Data Handling and Interpretation is a topic in Mathematics taught from the seventh grade onwards in the CBSE schools. It is an important topic since learners not only collect data but also sort and organize number data and represent it on graphs in order to develop the ability to read and derive meaning from them. Study conducted by Rodrigues (1994) found that Line graphs had the potential to enhance the children's interpretation of their investigations. It was also revealed that they could discover relationships that were hidden or less obvious in the results table. Similar study was conducted by Nisbet (2003) suggested that numerical data was significantly harder for children to organize and represent than categorical data. Given this latter result, a pedagogical approach that asks students to make links between raw data and a frequency representation of it may prepare students to create and construct their own frequency representations.

There are levels of deriving meaning from graphs. And every teacher must consciously ask the learners questions that will encourage them to think at each of these levels:

- Reading the data – lifting information from the graph
- Reading between the data – interpreting information in the graph
- Reading beyond the data – predicting or inferring from the graph
- Reading behind the data – connecting the information and its context.

But the question arises that are these learners able to go beyond the math textbook and employ these skills of data handling and analysis in real life situations; in other subjects such as English and Social Science? The Grade IX CBSE English Board Examination paper has a 5-mark question on analyzing data. Learners are presented data in the form of a pie chart/bar graph/ line graph/table etc. The data has to be analyzed and utilized by the student to form a paragraph providing factual information.

The Social Sciences often include several statistics (e.g. nation's mineral deposits, land composition, labour, demographical statistics), which students find boring and tedious to study. If interpreted correctly, these statistics and large numbers could provide a visual picture thus changing their outlook as well as their understanding of such topics.

SPECIFIC QUESTIONS

Were the students really having a problem?
Were the students able to apply their mathematical skills in social science?
Were the students able to plot the given data?
Were they able to interpret and analyze the data?
What was more difficult? Plotting bar graph, pie chart or line graph?
Why did the problem arise?
What is the solution to the problem?
What were the strategies used to resolve this problem?

OBJECTIVES OF THE STUDY
- To identify the underlying problem related to Data Handling and Interpretation among students of Grade IX.
- To put forth effective strategies to resolve this problem.
- To educate the students regarding the importance of Data Analysis in other subjects.

SAMPLE
Thirty-five students enrolled in standard IX of Kendriya Vidyayala School in Gujarat constituted the sample. The participants of this study were 9th standard students of an English medium school. The students contributed by way of participation in the pre test (plotting of population census results) and a post-test (mock census conducted within the classroom). They also became active researchers by conducting the census themselves, analyzing the data and putting forth problems faced during this activity.

METHODOLOGY
The content population was chosen from the textbook of IX standard CBSE Board. Investigator met the class four times a week, for 40 minutes each time for the duration of two weeks. There were thirty-five students in the class who had, in their curriculum, studied making of graph from standard VII. Students were given a pre-test on graph understanding, to provide a baseline for the study. The pre-test provided a baseline for the present study through which the investigator came to know that students had a weak understanding of graphical representations and there was a need to develop these skills among students of Standard IX. Investigator's detailed observation has been described below.

The topic chosen in Social Science was 'Population' and the class was Standard IX. During the introductory discussion itself, investigator observed that only very few students could answer or relate to questions and problems regarding our burgeoning population, population density or sex ratio. Even showing them the graphs in the textbook or a cartogram brought only a tepid response. Investigator was concerned about their lack of interest and inability to explain the information in graphic representations and realized that it was necessary for them to put into practice what they had learnt in Math -not only to correctly tabulate data but also critically analyze and interpret it in order to predict and establish co-relations. This formed the basis of action research study and research questions were formulated as: Are students able to apply their mathematical skills of Data Handling and Interpretation in other disciplines? Are students able to apply their analytical skills of Data Handling and Interpretation in Social Science?

RESEARCH METHOD

The research was done by adopting the experimental research method to identify the extent of lack of conceptual clarity regarding data plotting and analysis within the students of Standard IX.A pre-test was taken (plotting of population across decades on a line graph) to assess their plotting skills through which it became clear that a majority of students were unable to even plot a simple line graph. The discrepancies observed were in calculating correct intervals, plotting of co-ordinate axes, use of appropriate terminology as well as co-relating the data. These discrepancies were discussed with the concerned subject teachers and mentors and accordingly an action plan was formulated. Several strategies were identified and adopted by the investigator to find solutions to overcome the defined problem. These strategies were as follows.

Strategy 1: To clarify concepts regarding birth rate, death rate, sex ratio, age composition and growth rate by explaining the meaning and discussing examples.

Strategy 2: This strategy involved inviting a Math teacher to the class to clarify concepts of data handling and interpretation by making the students practice plotting graphs. Subject experts were approached and requested to clarify concepts of data handling and interpretation and they accepted to conduct a session on the same. They explained in detail focusing on related vocabulary as well as formulas required to plot graphs.

Strategy 3: To provide an experiential learning. The strategy was to conduct a mock census in class. This enabled the students to collect data by themselves, collate it, tabulate the data and finally plot it using appropriate graphs.

Strategy 4: In this strategy, the students used the mock census data to 'tell a story'. They critically analyzed, interpreted, read between and beyond the data, predicted future trends as well as discussed problems faced in conducting a census. Here, they took on roles of active researchers exploring the data from multiple angles.
This also worked as a post-test to examine the effectiveness of the strategies employed to improve use of data analysis skills.

DATA COLLECTION TOOLS

Observation schedule was used to collect the data and the observations were recorded and videotaped for further analysis. The data was collected when students were involved in making of graph and completing the given task. The task involved specific analysis and interpretation was data where plotting of line and bar graph, pie chart bar and a mock census questionnaire was emphasized.

PROCESS OF DATA COLLECTION

The data was collected during the ongoing Social Science class conducted by the investigator during the two-week duration. It was included in the teaching session and did not hinder but aided the teaching process of the topic of 'population'. (As per principles of action-research as defined by Hopkins-1985)

STRATEGY 1: DEFINITION OF TERMS

Terminology and vocabulary related to the topic of 'Population' in Standard IX was discussed with the help of exercise based on data collected through need assessment of the learner.

STRATEGY 2: CONCEPTUAL CLARIFICATION

Concepts identified through need assessment were taken for discussion and subject experts explained examples with systematic instruction.

Steps to draw a Bar Graph

- We can draw the graph by following the steps given below:
- On a graph paper, draw a horizontal line OX and a vertical line OY.
- These lines are called the x-axis and the y-axis respectively.
- Mark points at equal intervals along the x-axis.
- Below these points write the names of the data items whose values are to be plotted.
- Choose a suitable scale. On that scale determine the heights of the bars for the given numerical values. Mark off these heights parallel to the y-axis from the points taken in Step 2.
- On the x-axis, draw bars of equal width for the heights marked in Step 4.
- The bars should be centered on the points marked on the x-axis. These bars represent the given numerical data.

Steps to construct a Pie Chart

- In a pie chart, the various components or observations are represented by the sectors of a circle and the whole circle represents the sum of the values of all components.
- The central angle for a component is given by:
  Central angle for a component
  $$= \left[\frac{\text{Value of the component}}{\text{Sum of the values of all the components}} \times 360\right]^{\circ}$$

- Calculate the central angle of a component, given by
  Central angle for a component $= \left[\frac{\text{Value of the component}}{\text{Sum of the values of all the components}} \times 360\right]^{\circ}$

- Draw a circle of convenient radius. Within this circle, draw a horizontal radius.
- Starting with the horizontal radius, draw radii making central angles corresponding to the values of the respective components, till all the components are exhausted.
- These radii divide the whole circle into various sectors.
- Shade each sector with different colour or design.

STRATEGY 3: MOCK CENSUS

A 'Mock Census at School' was designed to engage the students in statistical reasoning and problem solving, using data collected about themselves and about participating students.The purpose of census was explained to them and the common questions that are normally asked in a census were discussed. (e.g date of birth, sex, marital status, country of birth, religion, ethnic group, health, qualifications, employment status, means of travel to work, type of accommodation etc.) Based on this discussion, basic questions were formulated for the questionnaire.

Students conducted a brief survey with the help of a simple questionnaire to collect data about the total population of the participating sample (Students of Class IX), the age composition, sex ratio and the literacy status within this sample. After the data collection, they plotted and analysed their class census results.

Mock Census Questionnaire: The Questionnaire included the following questions.

- **Total Population**
How many members are there in your family? Or how many people live at this address?

- **Sex Ratio**
Among these members, how many are males and how many females?

- **Age Composition**
How many males of the following age group are there in your family? How many females in your family are in the following age group? (Under 15 years; 15-59; Above 59 years)

- **Literacy Ratio**
How many females in your family have studied /are studying. How many males have studied /are studying the following. (Not studied at all; tenth pass; college graduates; post graduate)

Tabulation of Data
After data collection, students then plotted the results using appropriate charts. Data on total population and sex ration was plotted using a bar graph while data on age composition and literacy ratio was charted using a pie chart.

For the purpose of conducting the mock census, the class was divided into 4 groups. Each group was in charge of collecting, collating and analyzing data for one question of the questionnaire

Group 1 Observation. The question assigned to this group was on 'Total Population'. After collection of data, it was observed that the group gathered and planned collectively as to what graph would be required, how the axes would be drawn and what class intervals would be needed to plot this particular data graphically. Here, the graph chosen was bar graph.

Group 2 Observation. This group was assigned the question on sex ratio. It was seen that this group calculated the total male and female population and prepared a bar graph after similar discussion as Group 1. They also took care to colour the bars of the graph to highlight the data.

Group 3 Observation. The third group was a larger group of students and their data collection question was on Age Composition. They divided themselves into four pairs and distributed the task of data collection among themselves in such a way that each pair was gathering information about one part of the question. After collection of data, it was again observed that they regrouped and assigned duties to every member of the group. While one pair added up the values, the other drew the pie chart while the next two pairs calculated the percentage values to be put in the pie chart. Thus, an effective organization of collaborative working was also observed during this activity.

Group 4 Observation. Similarly, the fourth group had to collate information regarding the literacy ratio of the sample population. It was evident on observation that only a few members of this group were enthusiastic about the activity while the others were reluctant to participate and even displayed some signs of boredom. However, it was seen that the enthusiastic members worked together to tabulate the data and plot it neatly as a pie chart.

STRATEGY 4: ANALYSIS OF DATA

Reflection on post test analysis
The students were able to critically analyze the data collected:
1. The difference in sex ratio in the class room sample reflected that of the national ratio.
2. The students could observe immediately that fewer females were enrolled at the primary level or studying but even out of those; a surprise finding was that there were more female post graduates than male.
3. They could calculate the percentage of 'working population' and 'dependent population'.
4. There was no population in the age group above 59years in the mock census sample.

As mentioned earlier, during the session, students were assessed using on graph making skills using their content area on population. Students were observed and videotaped while solving these tasks. The method of analysis involved inductively deriving the descriptions and explanations of how the students interacted with the making of graphs and how well they are able to choose the appropriate graph for representation of graphical data. Investigator wrote descriptions of the students' strategies, actions and their reflections at the end of post test session. These descriptions formed the findings of the study.

FINDINGS OF THE STUDY
The findings of the study were as follows.
- There was a significant difference in the reflection of pre test group and post test group.
- From the pre-test to the post-test, there was a noticeable improvement in the students' ability to plot graphs and analyze data.

- There was significant difference in the pre-test group to the post-test group in the usage of appropriate vocabulary to describe the graphs.
- Graph representation of data is a tedious and complex task and requires problem solving and analytical skills. In the classroom, active participation and support of the teacher is necessary. And this is only feasible when the learning environment is flexible and conducive. Such a learning experience definitely provides opportunities for students to reflect upon observed phenomena, and develop their meta-cognitive capabilities.
- Students became actual researchers and were also able to understand the difficulties faced by researchers. E.g.: They found that some 'students were rude', 'some did not give correct information', 'some did not want to give information', 'it was time consuming', 'and some found it confusing'.
- In post test X and Y axes were labeled correctly, the intervals were equal and plotted neatly and accurately on the graph paper, key was mentioned as well as data was tabulated correctly. It observed that students had a better understanding in the making of graph.
- There was an appreciation of graph making skills required as researchers. They became aware of the need to be patient, organized and developed an ability to communicate effectively.

FURTHER IMPLICATIONS:
1. Students agreed that they would also be able to use this learning to write the 'data analysis paragraph' in the English Exam paper.
2. Similar study can be conducted taking mathematical concepts related to graph making.
3. Study can be conducted to find effectiveness of different strategies while teaching graphical representation of data in Mathematics or in Social Science.
4. They would also be able to better predict trends in the future and co-relate data.

CONCLUSION

The study helped to reveal the existing scenario in the classrooms about how bookish our knowledge is. It helped to understand how significant our role is as teachers and how important it is to immerse students in hands-on experiences to effectively 'teach' content. The entire gamut of data handling, interpretation, and analysis became easily understood when the students got involved in the mock census. Learning became an automatic by-product of the activity. This activity easily took on a higher order as students challenged the information and justified the reasons for its prevalence. A competent teacher can successfully create differentiated instruction as well as cut across disciplines to best utilize and disseminate textbook content.

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