Student Data Interpretation and Analysis Skills and Understanding of Intermolecular Forces

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Background:

- Reforms in science education call for student engagement in Science and Engineering practices (SEPs)
- SEPs including arguing with evidence, analyzing and interpreting data and constructing explanations (NRC, 2012, NGSS Lead States, 2013)
- Incorporating SEPs into student learning connects learning to how science is conducted
- Introduction should integrate SEPs while emphasizing conceptual understanding of disciplinary core ideas
- One's prior knowledge affects what they see in data
- One needs to identify important features in data, as well as important relationships
- Ability to analyze and interpret data accurately, and to extract relevant information is important in evaluating and communicating science
- Students are sometimes unable to differentiate between relevant and irrelevant information in data
- Sometimes, students only use bits of data or neglect some data

Questions:

1. What is the nature of General Chemistry students' data interpretation and analysis skills?
2. To what extent can general chemistry students account for trends in boiling points data?
3. What prior knowledge do students reach for/bring out?
4. In what ways is the prior knowledge used in explaining data trends?

Methodology:

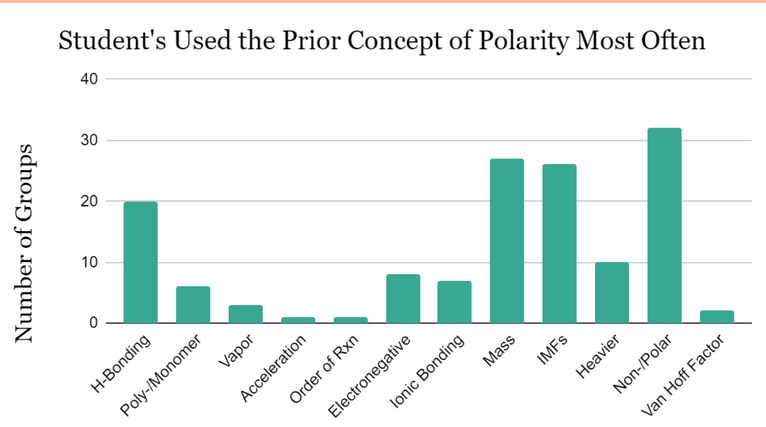
- General Chemistry (II) Students
- Non-chemistry majors
- 210 students made 47 groups (2-4)
- 20 minutes to complete worksheet
- Students asked to write down responses and record conversations
- Audio recordings emailed to instructor and transcribed

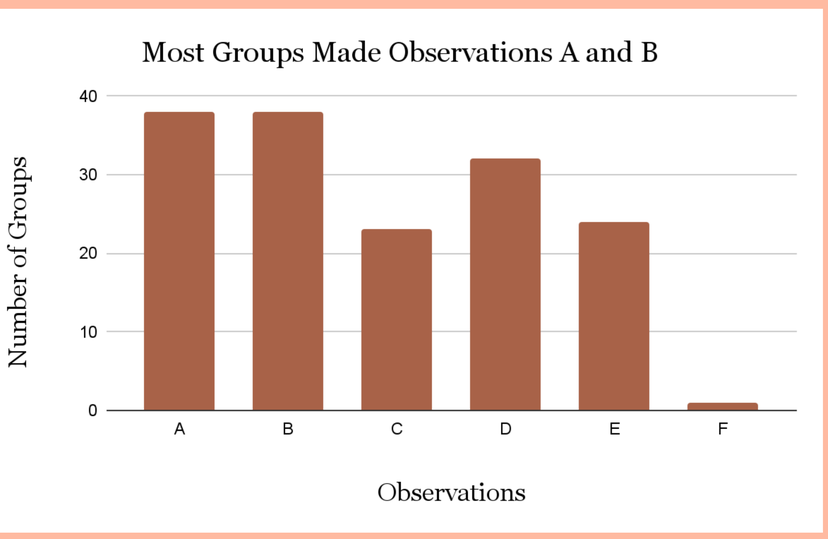
Below is a table of Comparative Boiling Points of Alkanes and Alkyl Halides (°C).

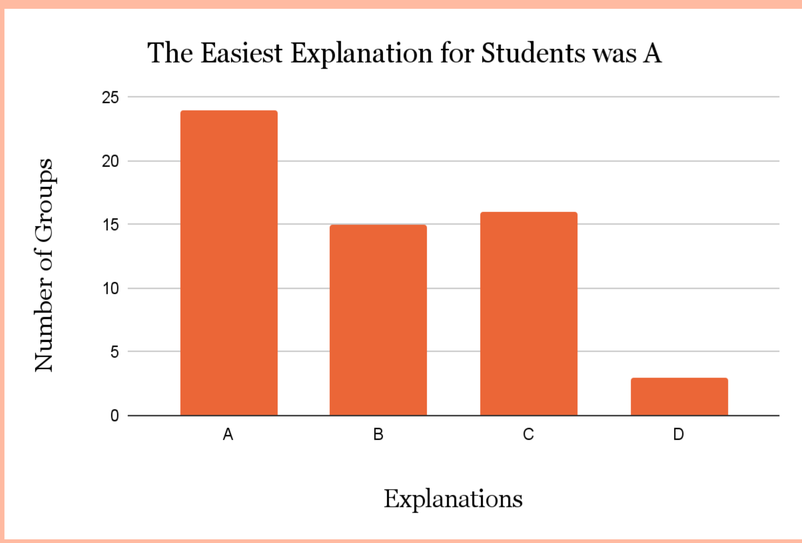
- Y	H	F	Cl	Br	I
$CH_3 - Y$	-161.7	-78.4	-24.2	3.6	42.4
CH_3CH_2 -Y	-88.6	-37.7	12.3	38.4	72.3
$CH_3CH_2CH_2$ - Y	-42.1	-2.5	46.6	71.0	102.5
$CH_3CH_2CH_2CH_2$ - Y	-0.5	32.5	78.4	101.6	130.5
$CH_3CH_2CH_2CH_2CH_2$ - Y	36.1	62.8	107.8	129.6	157.0

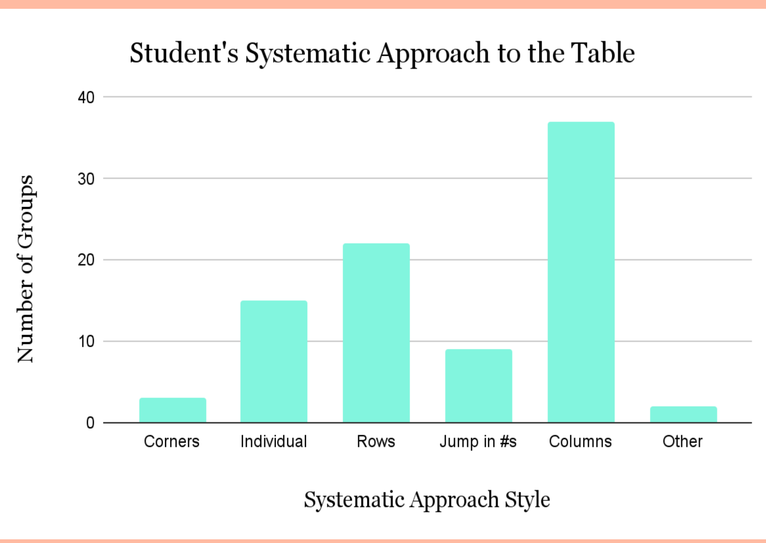
a. List all the observations you can make from the table. For example, identify and describe trends from the table

b. Explain each of the trends you identified above.









Discussion:

- Students adopted different approaches to data interpretation and analysis - some more systematic than others
- Students using a systematic approach had more observations about the boiling points than those that did not.
- Students were less successful at explaining trends in boiling points
- Students drew on prior knowledge, but not all was relevant
- Students confused bonds and intermolecular forces
- Working in groups led to mixed results in new learning

Implications:

- Students need authentic opportunities to practice using SEPs
- Need for effective assessments of students' use of SEPs outside of lab settings
- Need for effective mechanisms to provide timely feedback
- Instruction should integrate SEPs

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