

Students' use of consistency checks while sensemaking in inquiry-based labs



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Background

- Growing implementation of inquiry-based labs in physics means students are no longer following rote procedures and are expected to engage in complex experimental skills [1,2]
- Most literature on sensemaking in physics instruction focuses on lecture and problem-solving contexts, not laboratories [3]
- This study identifies a type of sensemaking process that occurs in laboratory settings, namely consistency checks
- We argue that consistency checks are a productive sensemaking strategy in lab environments

Research Methods

Setting:

- Introductory Physics for Life Sciences (IPLS) labs at the University of Utah

Research Subjects:

- Undergraduate students enrolled in the IPLS labs
- Majority life science majors
- Previously or concurrently enrolled in the introductory physics lecture class

Data Collection:

- Audio and screen recordings of students working in lab
- Submitted student work (group design plan, lab reports)

Analysis:

- Open-ended narrative analysis identified excerpts when students engaged in consistency check sensemaking, as defined below and shown in Fig 1

Consistency check: a student identifies an element of the data and checks whether that element is consistent with their knowledge of the relevant system

- Studied two groups of students, chosen due to the diversity of the groups and prevalence of open conversation
- Analysis presented here includes two of these instances that are demonstrative of the groups' use of consistency checks

Conclusion

- One dimension of sensemaking in inquiry-based labs is consistency checks
- In the two analyzed groups, the consistency checks are used during different parts of the experimental process; in both cases, the checks are productive and encourage the groups to think more deeply about their experiments
- **Broad range of instructional implications for inquiry-based labs:** instructors' abilities to identify and encourage the use of these checks has the potential to improve students' sensemaking abilities and overall understanding of physical mechanisms in biological contexts

References

- [1] N. G. Holmes and C. E. Wieman, *Phys. Today* **71**, 38-45 (2018)
[2] B. M. Zwickl *et al.*, *Phys. Rev. ST Phys. Educ. Res.* **11**, 020113 (2015)
[3] T. O. B. Odden and R. Russ, *Sci. Ed.* **103**, 187-205 (2019)

Analysis

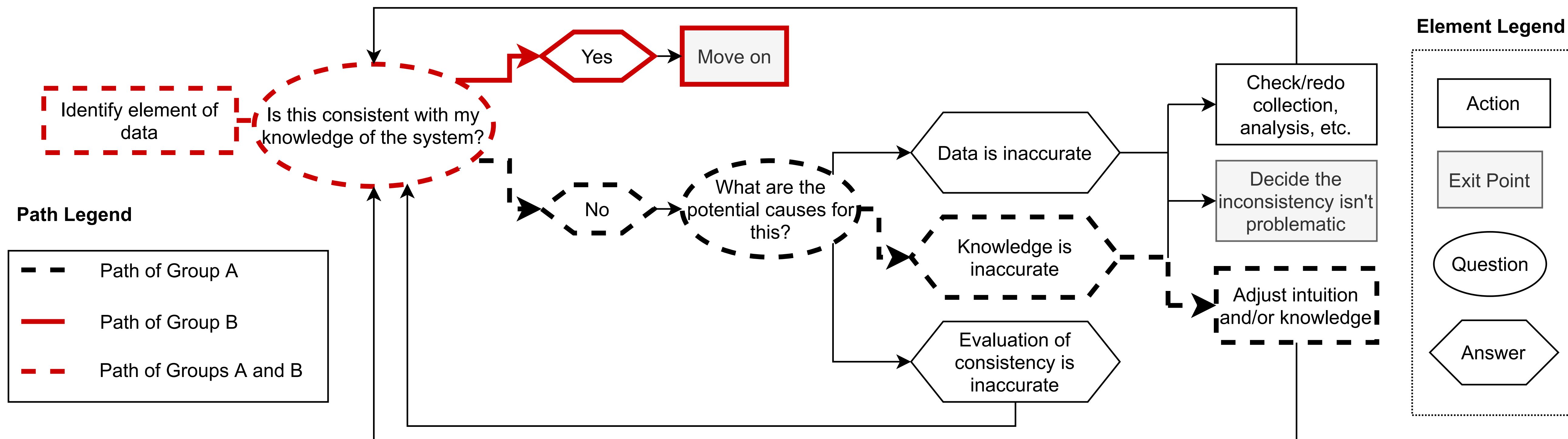
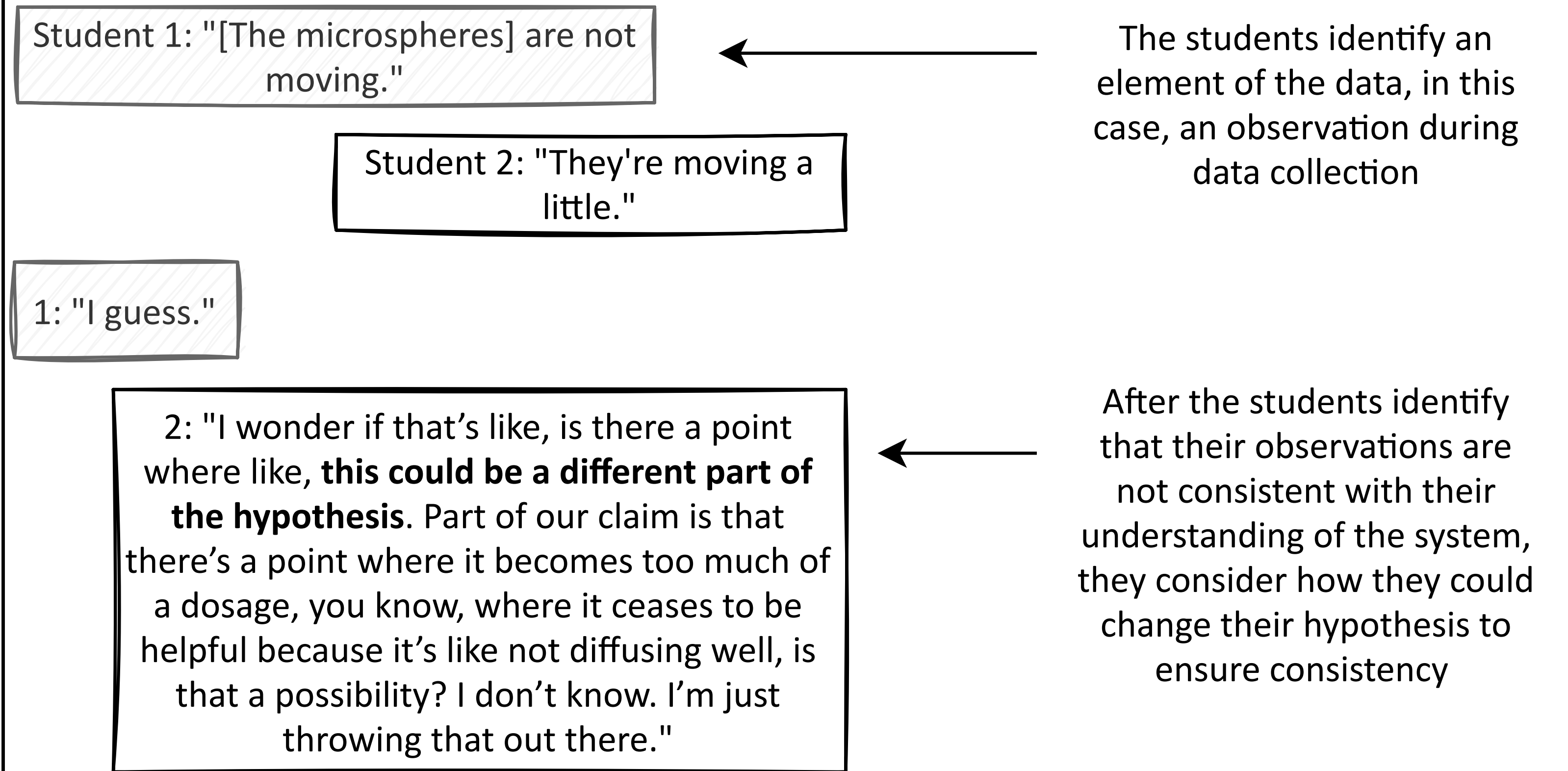


Fig 1. This diagram shows a model of potential paths students can take while engaging in sensemaking during lab experimentation through consistency checks. This model was developed after review of all identified consistency checks and roughly models the sensemaking processes of the two presented groups below.

Group A

Context: This group is completing a lab in which the goal is to investigate different facets of Brownian motion, diffusion, and directed motion using several provided materials and fluids.

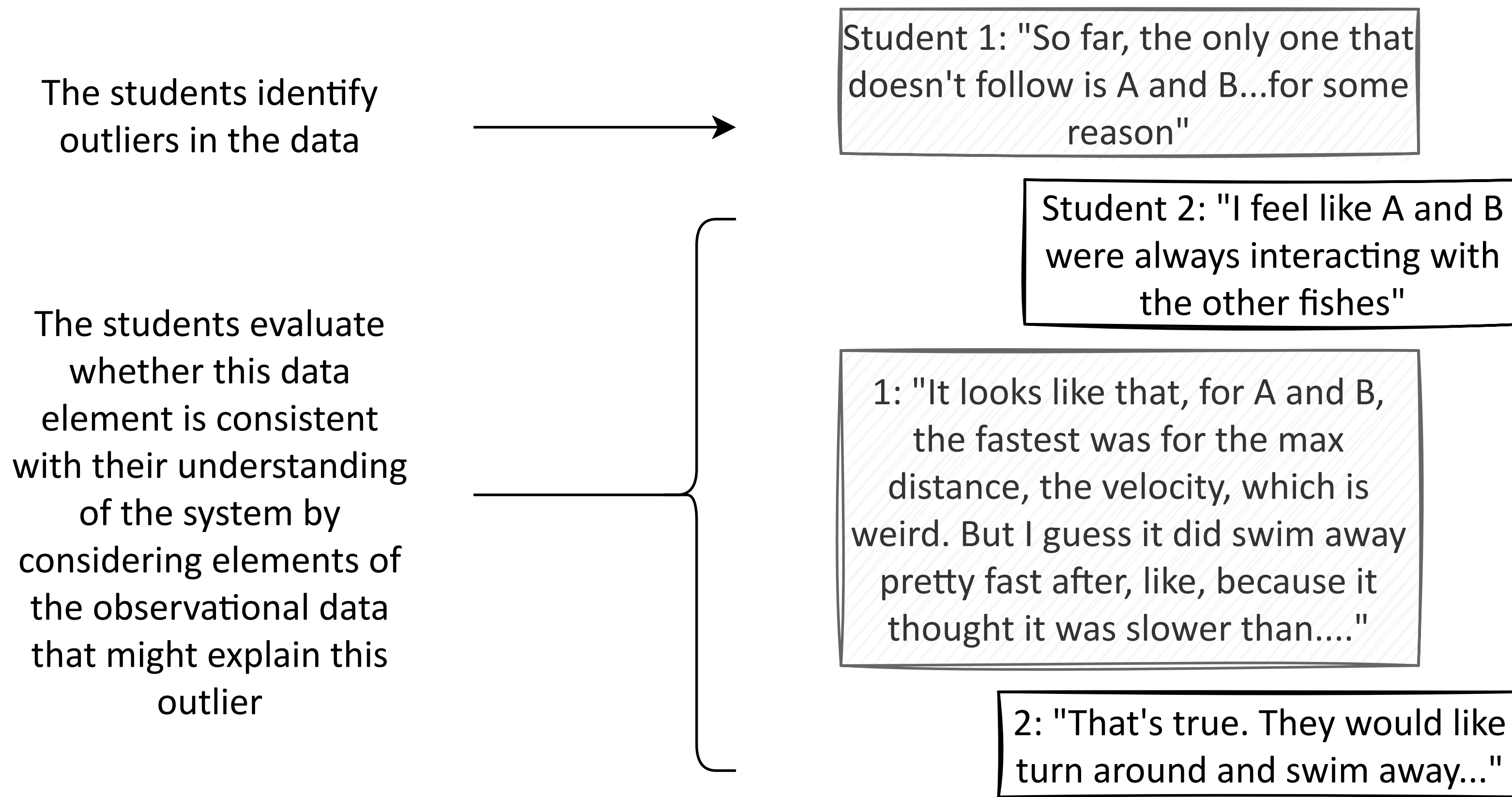
Excerpt: The students are in the process of collecting data and notice that the microspheres in the sample are not moving as they had expected them to. This excerpt is part of a larger discussion and troubleshooting process in response to their observations not lining up with their hypothesis.



Group B

Context: This group is completing a lab in which the goal is to investigate the motion of Zebrafish by tracking them in provided videos using a video analysis software.

Excerpt: The students are looking at their data and notice that the velocities of Fish A and Fish B are outliers from the rest of the data.



Group A

- Group conducted check as part of the data collection process
- Found data and understanding of system to be inconsistent, changed hypothesis as a result

Both Groups

- **Consistency check was a productive element of their experimental process**
- **Led to deeper thinking about the data and how it was related to the relevant system**

Group B

- Group conducted check as part of the data cleaning process
- Confirmed that data and understanding of system were consistent