Qualitative Abstract Review

Abstract Version 1 / Abstract Version 2

Study Context

Abstract Version 1:

Quantitative reasoning (QR) represents a key skill for undergraduate biology education. Despite its importance, however, QR remains a challenge for many students, and there remain limited empirical studies on how undergraduate students learn QR skills in the context of biology courses. Previous studies have measured and looked at how students organize and draw meaning when working with mathematical equations, but not at how students use QR in a laboratory environment.

Here, we use a framework called student noticing to investigate why some students struggle with QR in introductory biology labs. This framework has previously been used to understand how students learn new concepts, primarily in K-12 math education (Hohensee, 2014, 2016). Because students need to first notice information before they connect it, it forms the foundation upon which learning take place.

Context is described only briefly, and no citations included to show connection to literature base. Score: 1

Rationale for studying QR generally in biology is present, but why it is important to examine in a lab setting is not explained. Score: 2

Theoretical framework is mentioned but needs a deeper explanation. Score: 2

Abstract Version 2:

Context of QR landscape is described with citations. Score: 3

Rationale for studying QR generally in biology present, but explanation needed for why this particular study is important. Score: 2

Theoretical framework is well-described. Score: 3

Quantitative reasoning (QR) represents a key skill for undergraduate biology education. Despite its importance, however, QR remains a challenge for many students, and there remain limited empirical studies on how undergraduate students learn QR skills in the context of biology courses. Previous work has focused on creating instruments that measure QR skills in the context of biology (Stanhope et al. 2017) or on developing and assessing specific curriculum that promotes students' QR skills in biology (e.g., Hester et al. 2014; Hoffman et al. 2016; Thompson et al. 2010). In addition, there have been a number of recent studies examining students' sensemaking – i.e., how students conceptually organize and draw meaning from a given topic – when working with mathematical equations in biological contexts (Kaldaras & Wieman 2023; Zhao et al. 2021; Zhao & Schuchardt 2021).

Here, we use the theoretical framework of student noticing to investigate why some students struggle with QR in introductory biology labs. This framework has been used to understand how students learn new concepts, primarily in K-12 math education (Hohensee, 2014, 2016; Jones et al. 2023; Lobato et al. 2012). Under this framework, what students notice when given new information and data influences how they process this information and connect it with other events to form new conceptions (Dominguez, 2016; Hohensee, 2016; Lobato, Hohensee, & Rhodehamel, 2013; Wilkie, 2022). Students must mentally isolate given features, create mental records of those features, and then identify features or objects that they connect to existing knowledge (Hohensee, 2016; Lobato et al., 2012). Identifying these features or objects is thus critical since they form the foundation upon which learning take place (Hohensee, 2016).

Study Design

Abstract Version 1:

We had three research questions:

1. What are students noticing and reflecting on when working in introductory biology labs?
2. Do students show differences in how much they notice when working with data?
3. What factors influence students' noticing?

We observed nine groups working with data in an introductory biology lab. Students (n=33) were interviewed afterward, with questions aimed at eliciting their noticing. Interviews were transcribed and analyzed by multiple authors who independently read a portion of the interviews and came up with independent codebooks; the authors then created a consensus codebook through discussions to resolve differences.

Research questions are clearly delineated, but RQ1 asks about noticing in lab broadly rather than noticing related to QR. Score: 2

Study population described. Interview methods, types of questions, and qualitative analyses need more details. Score: 2

Methods may be appropriate for RQs, but it is difficult to determine because of the lack of details around how students were interviewed. Score: 1

Abstract Version 2:

Research questions are clearly delineated and related to QR. Score: 3

Study population described. Detailed methods of how interviews were conducted. Score: 3

Methods detailed enough to see they are aligned with RQs. Score: 3

We had three research questions:

1. What are students noticing when working with and analyzing their own quantitative data in introductory biology labs? How do students reflect on and characterize their noticing?
2. Are there differences in students' level/depth of noticing, including how much they notice, when working with quantitative data?
3. What factors influence students' depths of noticing when working with quantitative data in biology labs?

We conducted running record observations (Poulson et al. 1995) of nine groups working with quantitative data in an introductory biology lab. Students (n=33) were interviewed afterward, with questions designed to probe what they noticed during lab and the factors that influenced their noticing. We utilized stimulated recall (Calderhead 1981) to further probe students' noticing. Interviews were transcribed and analyzed through thematic analysis (Braun and Clarke 2012). In brief, multiple authors independently read >10% of interviews and came up with independent codebooks; the authors then created a consensus codebook through iterative discussion. To ensure validity and reliability, we utilized a constant comparison approach (Glaser 1965) where one author would code an interview and compare to the existing codebook before discussing with the other authors.

Analyses & Interpretation

Abstract Version 1:

Our analyses reveal variation in what students notice as well as the depth of their noticing. We identify three levels of student noticing: 1) students who are not noticing any relevant feature during the labs ("not noticing"), 2) students who notice shallower features largely related to lab procedures and instruction ("shallow noticing"), and 3) students who notice deeper conceptual features that connect biological concepts with QR ("deep noticing"). We also observed that students at levels 1 and 2 tended to display lower self-efficacy for both biology and math and viewed math and biology as distinct disciplines, while those at the deep noticing level made connections between math and biology and thought the connection was useful.

Analyses described in section above (ok to do), but more details needed about qualitative coding process. Score: 2

Claims supported by reasoning but adding in a few quotes as evidence would enhance this. Score: 2

Results for RQ3 are not clearly presented. Score: 2

Abstract Version 2:

Analyses well described in section above. Score: 3

Claims supported by reasoning but adding in a few quotes as evidence would enhance this. Score: 2

Study seems complete; results for all RQs presented. Score: 3

Our phenomenological analyses reveal variation in what students notice as well as the depth of their noticing. We identify three conceptions of student noticing: 1) students who are not noticing any relevant feature during the labs ("not noticing"), 2) students who notice shallower features largely related to lab procedures and instruction ("shallow noticing"), and 3) students who notice deeper conceptual features that connect biological concepts with QR ("deep noticing"). We identify multiple aspects that vary within these conceptions. For example, students at the not noticing and procedural noticing levels tended to have lower self-efficacy for both biology and math and viewed math and biology as distinct disciplines, while those at the deep noticing level saw greater utility and connections between math and biology when doing QR. Similarly, we identify variation in the aspects that influence what students notice and their level of noticing. These include multiple cognitive and affective factors that shaped students' noticing, including their level of metacognition and motivation for completing the labs.

Contribution

Abstract Version 1:

Our study offers a first look at how students learn QR in intro bio labs, providing insight into what students are noticing, and how they begin to make sense of quantitative data. Our results suggest that students don't know how to notice deeper conceptual themes, supporting previous work showing that students don't know how to use quantitative reasoning. Our work is thus of interest to others because it can help understand QR and inform instruction on QR in biology labs.

Vague, broad statements about importance of study to literature in BER. Score: 1

Needs stronger statement about why this is important for BER community. Score: 2

More specific details would improve clarity of relevance of this study for teaching, learning, or BER Score: 2

Abstract Version 2:

More explicit connection to how it advances research in BER needed. Score: 2

Strong connection with teaching underscores relevance for BER community. Score: 3

Our study offers a first look at how students learn QR in intro bio labs, providing insight into what students are noticing when working with QR in bio labs, and how they begin to make sense of quantitative data. Our results reveal different conceptions of student noticing with multiple aspects that vary, suggesting that targeted interventions that influence any of the aspects that vary may guide students to notice deeper, conceptual themes when working with QR. Our work is thus of interest to both biology education researchers and practitioners since it offers new knowledge on the theoretical underpinnings of learning QR and can inform instruction on QR in biology labs.

Connects study specifically to teaching interventions and QR learning. Score: 3