The Impact of Practice Exams on Undergraduate Biology Majors

Subject/Problem

"Metacognition refers to higher-order thinking which involves active control over the cognitive processes involved in learning" (Livingston,2003). "Metacognition is also an important part of self-regulation—the ability to orchestrate one's learning: to plan, monitor success, and correct errors when appropriate. These skills are all necessary for effective intentional learning" (NRC, 2000; Tanner,2012). Self-regulated learners understand the necessary steps it may take to process what they are learning which involves their metacognition cycle. (Ambrose, 2010; Stanton et al., 2015). This can be a challenging task for students who struggle with gauging their own metacognitive knowledge as well as developing their ideas into plausible outcomes.

The way students think about their ideas contributes to how well students monitor and evaluate their understanding (Ziegler and Montplaisir, 2014). Through deliberate practice such as practice exams, students can develop stronger metacognitive skills. Balch (1998) followed the accuracy assessment theory showing students can benefit from any form of objective assessment before the actual exam. For example, Dotson, Sheldon, and Sherman (2010) showed a positive correlation between students' exam scores and the number of times students attempted practice exams. Although some research has focused on peer grading (Freeman and Parks, 2012) little work has focused on how students use practice exams to gauge or reflect on their understanding. Sabel, Dauer, and Forbes (2017) examined the use of enhanced answer keys with added reflection questions and instruction as scaffolds for engaging undergraduate students in self-regulated learning within introductory biology courses. Findings showed providing students with scaffolds can improve students' engagement in metacognition. However, this study only included students who were enrolled in introductory biology courses and research did not investigate the extent to which students engage in deliberate practice. Research is therefore needed to investigate how students' perception of practice exams has changed throughout their major. To address this issue, we asked the following research questions:

1.How do undergraduate biology students use practice exams in introductory biology courses?

2. In what ways do undergraduate biology students taking upper-division courses reflect on practice exams?

Methods

Longitudinal Study. The present study is an extension of a larger study centered around the development of metacognition in undergraduate biology students. All student recruitment and data collection for this study was approved through the Institutional Review Board. Data was collected at an urban Carnegie RI research institution located in the Mid-South. Participants were recruited from the required courses for biology majors which consisted of General Biology I

(approximately 160 students per semester), General Biology II (approximately 120 students per semester), Cell Biology (approximately 70 students per semester), Genetics (approximately 70 students / per semester), and Evolution (approximately 60 students per semester). Each course is a prerequisite for the subsequent courses. Students are typically second-semester freshmen or sophomores when they take General Biology I and are typically in the last semester of their senior year when they take Evolution. The longitudinal study had over 1,115 study participants and 86 interview participants. All students had the opportunity to complete two surveys: one at the beginning and one at the end of the semester.

Data Collection. Within the surveys, students were asked questions about their metacognition cycle which includes planning, monitoring, and evaluating (Schraw, 1998). Students were also asked Likert questions to gauge how often they engaged in metacognition. These surveys were completed online in Qualtrics and students received a small amount of course credit as an incentive. Students who consented to be contacted for interviews were invited to take part in semi-structured interviews.

The interviews were semi-structured, consisting of questions about students' metacognitive skills including how students planned to study, monitored their studying, and evaluated their study habits. Surveys also consisted of questions that covered metacognition. Over time, we were able to track cohorts as well as individuals as they progressed throughout the major. Students were compensated for interviews with a gift card.

Data Analysis. All transcripts were transcribed by the research group members. We used open coding to identify common segments of data and pattern coding to group segments into common themes across the data and between each course (Miles et al., 2014; Sabel et al., 2017). During the first round of coding interviews, we started by labeling portions of our data that fit our research questions. During this process, we specifically coded how students used practice exams. Examples of our codes are 1) memorization, 2) to gauge understanding, and 3) to gain insight on exams. We then met to discuss whether students reflected on practice exams as they progressed to the next sequential course. aa code for evaluating which falls under gauging understanding. We analyzed the codes and associated quotes to determine general trends across all five courses and to determine trends within each of the courses.

Findings

In our first research question, we asked " How do undergraduate biology students use practice exams in introductory biology courses?" Overall, we found that 1) students believed that practice exams would reflect the actual exam and 2) intervention helped change the way students thought about practice exams.

The practice exams in Biology I served many purposes for students in their studying and reflection. In the beginning, students used the practice exams as an example of what the actual exam would look like. One student mentioned: "The professors make them, so the topics they cover in these practice exams are more than likely the things they find most important and will

ask questions similar or over the same topic on the real exam" (Sarah, Survey I). Another student mentioned: "Practice test shows what type of questions would be on the real test"(Paris, Survey I). Some students revealed during the first interview that they were not aware that they could go back and review the practice exams; therefore, their ability to study them was limited. In the second interview, students were using the practice exams a lot more to gauge their understanding. This idea is shown in the following statement: "The main thing is to do the practice exams continuously to see where the weakness is"(Marcus, Interview I). Through intervention, students found more value in the use of practice exams. "The interviews have made me more conscious about the importance of them. I used them a lot before the first interview, and I used them more as much now if not more" (Taylor, Interview II).

As students progressed into Biology II, more students mentioned using the practice exams to prepare for exams. Students started to place more emphasis on how the content could be reflected on the actual exam rather than relying more on memorization. Students assessed their understanding by testing themselves using the practice exams and identifying areas that would need further improvement utilizing the questions they got incorrect and the concepts they covered. One student mentioned: "Let's say I missed the topic about animals or something. I would go through that chapter and look at that section that talked about it and study that one over again, but still, review the rest of it but try to focus more on what I made wrong"(Sam, Interview I).

In our second research question, we asked " In what ways do undergraduate biology students taking upper-division courses reflect on practice exams?" Overall, we found that 1) checking for understanding remained important to students when practice exams were not present in the courses, and 2) students reflected on their understanding more than in introductory courses.

In Cell Biology, a lot of students had to find alternative ways to check for understanding through methods such as reading the book, flashcards, and creating their own notes because practice exams were not present. Also, several transfer students taking this course did not share the same experiences as others who have taken General Biology I and General Biology II. For example, one student mentioned: "I just am spending more time studying the material. I did not have to spend as much time studying at [previous school]. Just because I knew the instructors' teaching style. The test was the same every single time. It was also easier, just to kind of like, I feel like I was less stressed also because there was more homework and quizzes where these are my first few classes where it is three exams" (Cree, Interview I).

As students progressed to Genetics, they used the practice quizzes to learn more about conceptual ideas and used the problem sets to gain a better understanding of the application of concepts. Working in groups while taking the practice exams or going over the problem set was beneficial to students because it helped them see if their ideas aligned with others. While comparing General Biology I, General Biology II, and Genetics practice exams, one student mentioned: "The types of questions are different. But I think I would still use them the same way. Because they are similar to test questions, or, well, the ones in bio I and bio II were

definitely similar to test questions, you could see that same exact question on the test. But with genetics, it's like the concept of what that question is, you will see on the exam"(Racheal, Interview I). Students felt like they were making more connections as they increased their knowledge and understanding.

Within Evolution, several students mentioned how the practice exams in previous courses were useful and that they wished evolution consisted of practice exams. "And I think practice exams are definitely helpful because you quiz yourself without really getting penalized for it on an exam or something"(Racheal, Interview I). Another student mentioned: "Especially if it's the first time taking the class, they gave me an idea of what a test would be like. And, like, if I had answers to the practice problems, or if I figured out the answers on my own. It gave me an idea as to where I just really need to go over" (Alex, interview I).

Contributions

Practice exams are efficient tools that help students engage in metacognition. As students progress to upper courses, they are expected to engage in a higher level of critical thinking skills. When students do not have access to practice exams (like in Cell Biology), they must reinforce those skills they learned from taking earlier practice exams and incorporate them in different ways or methods. Practice exams also help students build upon their metacognitive knowledge and the regulation of their metacognition. In this study, practice exams were used to (1) gauge understanding, (2) assess what kind of questions were going to be on the exams, and (3) reevaluate what to study. Balch (1988) elaborated on how practice exams can help prepare students for assessment. Our findings support this earlier literature by suggesting that students also used practice exams not only to practice but to identify what to study. Sabel, Dauer, and Forbes (2017) elaborated on how scaffolds could help students reflect more on their understanding. Our findings expanding on this to show that students' prior experience with practice exams contributed to how they reflected on their own understanding.

General Interest

This research will be valuable to NABT members who are interested in metacognition and self-regulation and to those who are teaching undergraduate biology courses. In this study, we showed how the use of practice exams can help students learn and increase their understanding of complex material. This work also shows that intervention can prompt students to think about not only what they are learning but also how they are learning the material.

References

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