Social Annotation Systems for Large-Scale Classroom Collaboration and Learning

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Why Social Annotation (SA)?

- Social annotation (SA) systems anchor discussions on selected (typically highlighted) parts of a document.
- SA has gained popularity in education due to its usefulness for learning and mastery of course materials. Students' social annotation learning exercises can encourage **peer-to-peer learning, critical thinking, meta cognitive abilities,** and **reading comprehension.**
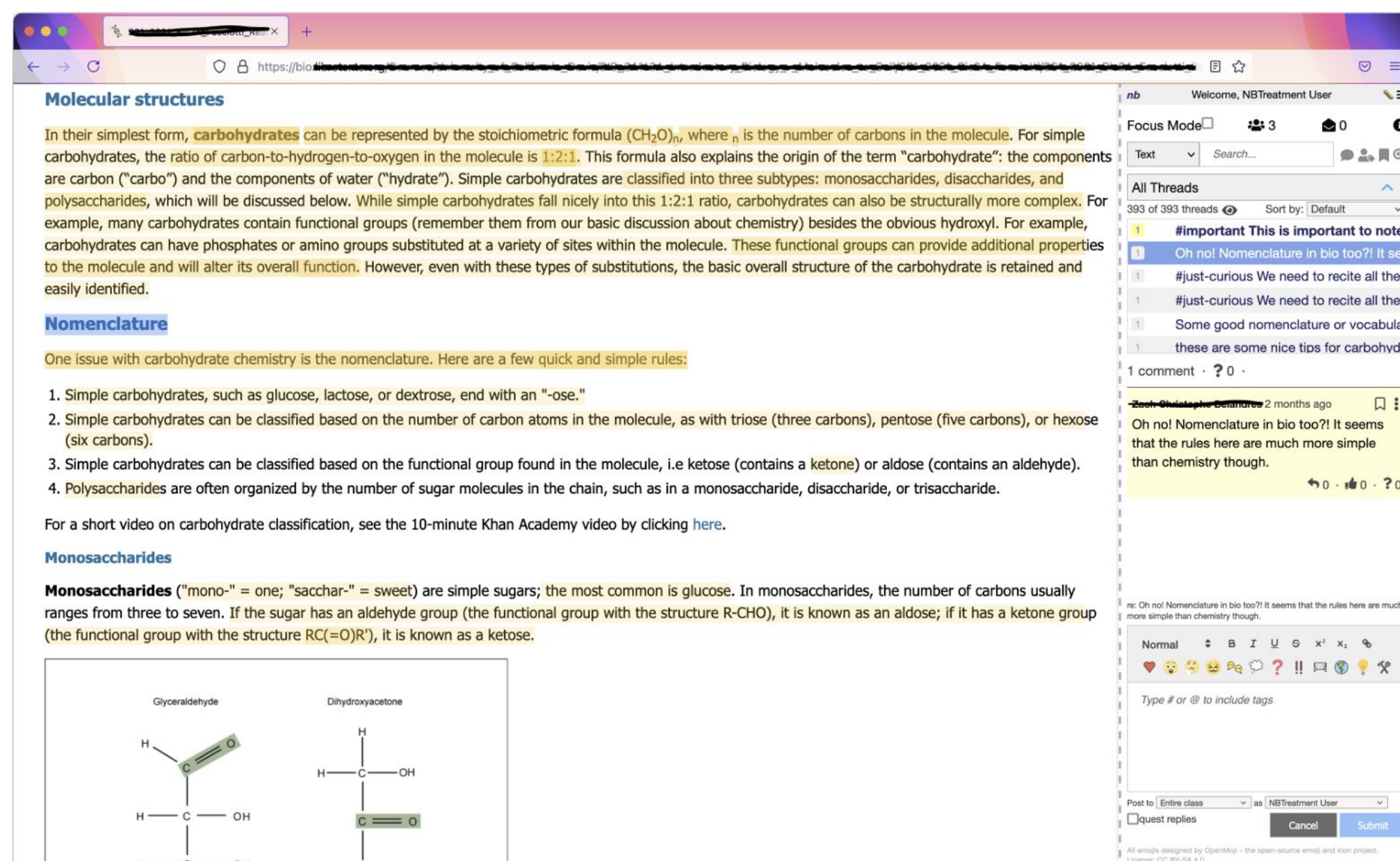
- Nota Bene (NB) is an open-source, social annotation tool developed at MIT, enabling collaborative annotation of online documents for educational purposes.
- With **40,000+ users**, NB allows students to annotate course materials directly, fostering synchronous and asynchronous discussions within the content's context.

Context: We have piloted, deployed, and studied the effectiveness of NB in a **large-scale intro biology course (with 1000+ students)** at a large public university in the United States. Students are required to leave comments and engage with the textbook material as part of the course grade requirements.

SA in Biology Learning Environments

We used a mixed methods approach **(45 student interviews & 1000+ survey responses):**

RQ1: How do students' **goals and motivations** influence their learning strategies, satisfaction, and performance in intro biology courses?

RQ2: What **study strategies, time management practices, and resources** do students use, and what challenges do they face in their learning process?

RQ3: How do digital **SA platforms, like NB, affect students' study habits**, resource use, and collaboration with peers?

RQ4: How do students **prepare for exams, use feedback**, and adjust their study strategies based on their academic performance?
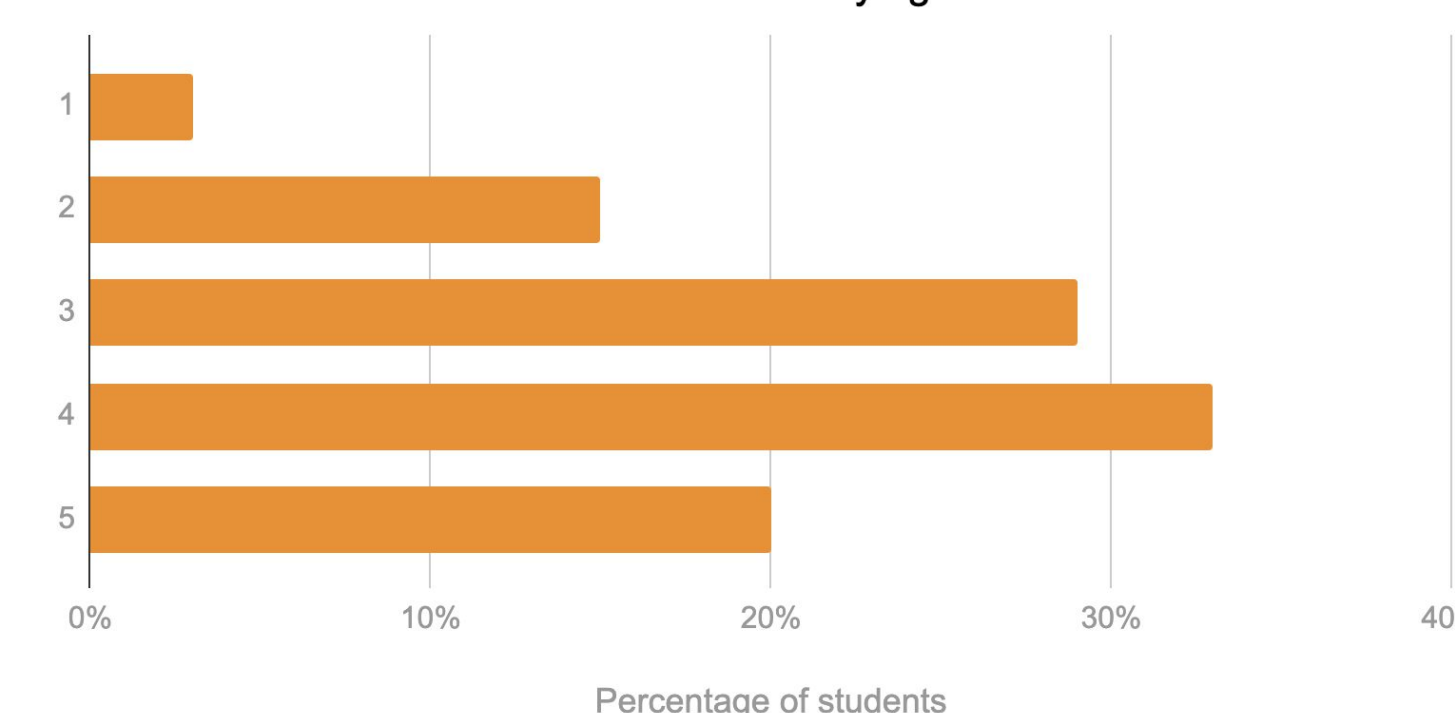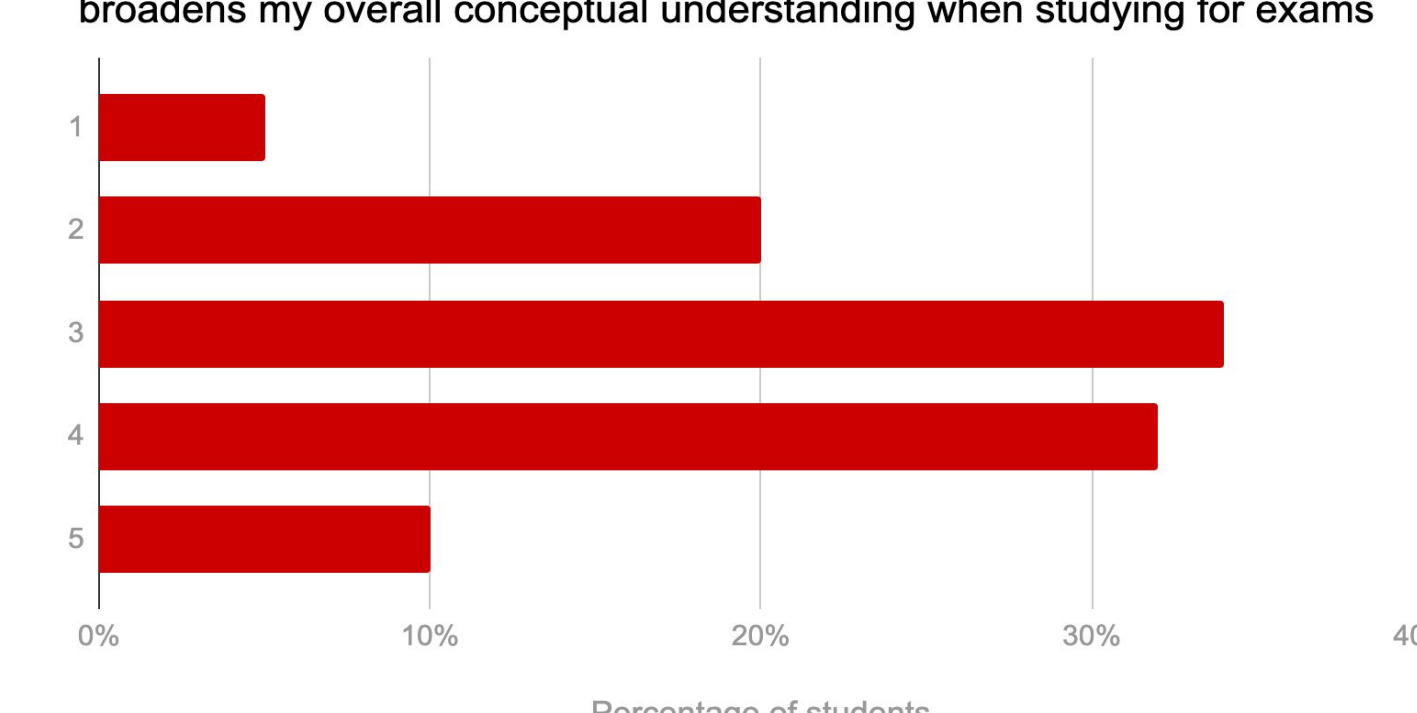

- ❖ **Motivation and Goals:** Students' drive for high grades and course relevance to their career paths strongly motivate them to engage deeply with course material, leading to the adoption of varied, multimodal, and effective study strategies. Satisfaction and performance are closely tied, with **exam outcomes being the primary measure of success**.

- ❖ **Resource Utilization:** A variety of resources, including lecture slides and videos, practice exams, and forum discussions, are valued for enhancing learning outcomes. However, students report challenges in **prioritizing study content** due to the vast amount of material, leading to feelings of being overwhelmed.

- ❖ **SA Engagement (NB):** While instructors view NB's integration with the textbook as a crucial resource for the course, the **heavy textbook material** often leads to its underutilization for exam preparation. The platform's potential for enhancing understanding is recognized, but its effectiveness is diluted by the overwhelming nature of textbook content.

- ❖ **Exam Preparation and Feedback:** Students focus on simulating exam conditions and identifying areas for improvement through practice exams and discussions. There is an expressed need for more **targeted feedback** from instructors to optimize study strategies and improve academic performance.

Future Directions with LLMs

➤ **LLM-powered NB hypertextbook**

We propose an NB hypertextbook where different resources of the class are **mapped** using LLMs with **different levels of granularity.** Column 1 displays lecture slides, column 2 provides the corresponding transcript (condensed, conversational style version of the material), and the instructor's audio recording, and column 3 provides the corresponding detailed paragraphs from the textbook.
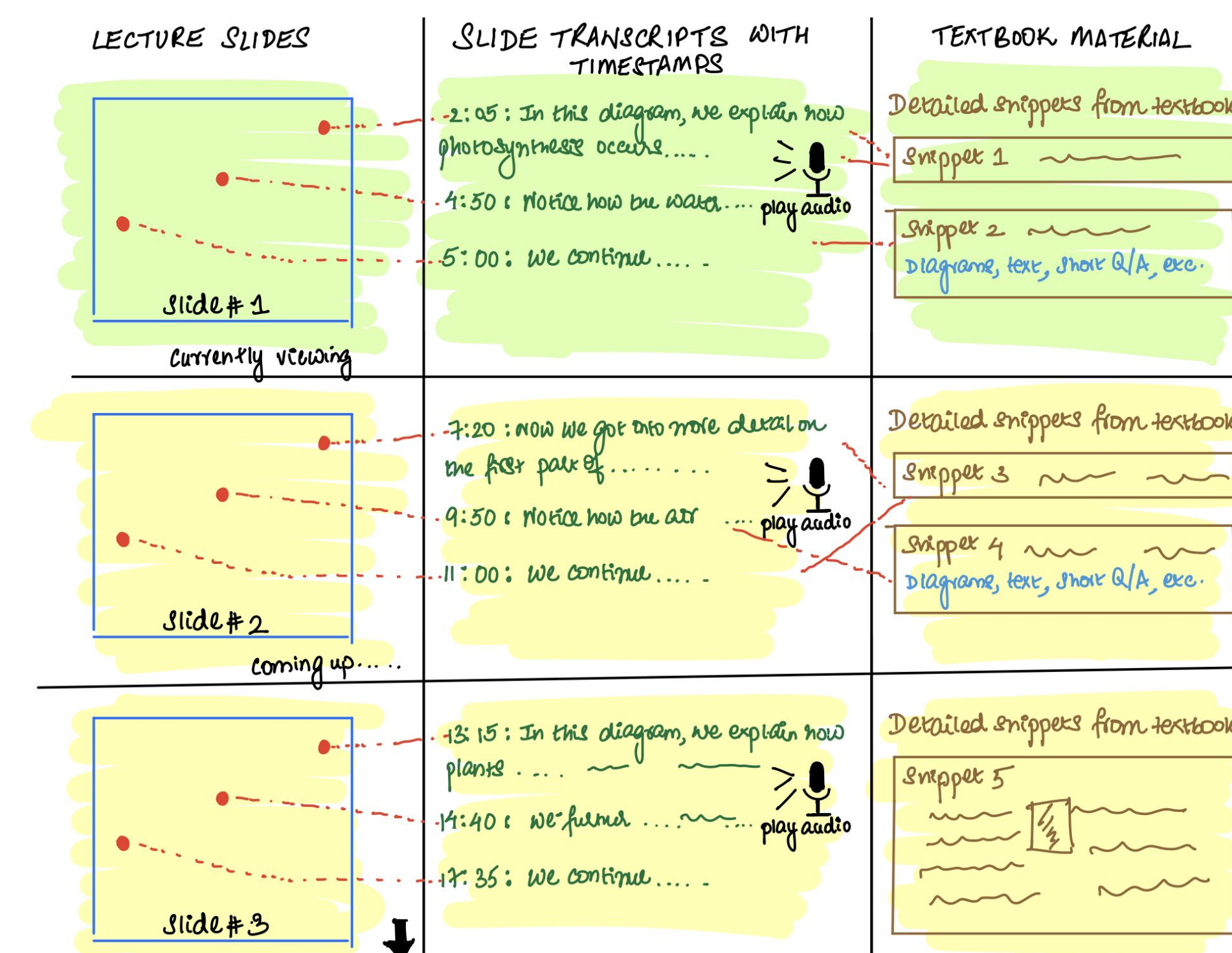
➤ **LLM-powered practice exams**

We are also exploring the integration of LLMs into practice exams for this course.

RQ: To what extent can a generative AI-powered adaptive practice system, which **links practice questions to specific course materials** and provides **personalized explanations and hints**, foster deeper conceptual understanding and support remediation, as measured by performance on subsequent exams and student feedback?