

**University of Toronto**

## **Exploratory Analysis of the Course HMB201 Quercus Data**

*A report derived from the Data-Driven Design: Quercus Analytics (D3:QA) Project*

**Written by:** Alan da Silveira Fleck

**Course:** HMB201H1 “Introduction to Fundamental Genetics and its Applications”

**Instructor:** Prof. Naomi Levy-Strumpf

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## Background and Objectives

The course HMB201H1 “Introduction to Fundamental Genetics and its Applications” provides a comprehensive introduction to key therapeutic approaches including gene therapy, CRISPR-based gene editing, epigenetic manipulations & regenerative medicine. A variety of activities including lectures, readings, supplementary course material and mandatory tutorial quizzes are planned to help the students learn the material. Each one of the 10 tutorial quizzes tests the material covered in the previous lecture.

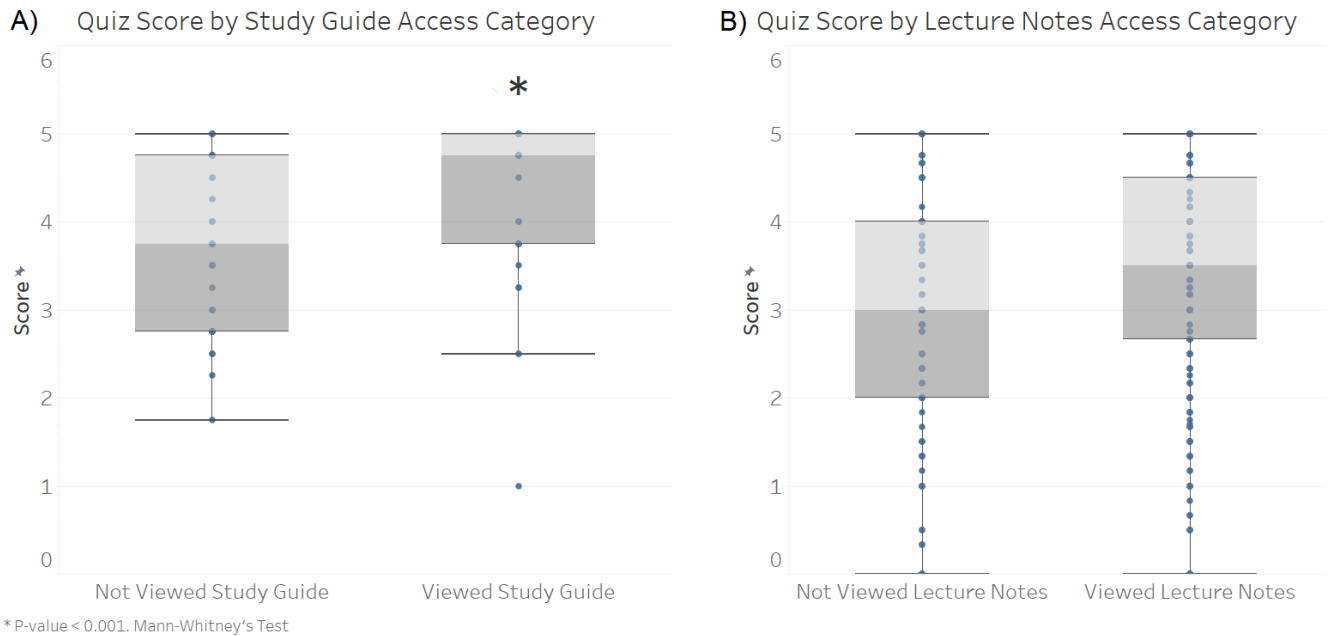
Given the variety of preparatory material (i.e., mandatory lecture notes and study guides), it was still unclear if the students were effectively accessing the different resource types and whether this engagement was associated with the weekly quizzes’ performance. Thus, the objective of this analysis was to investigate the level of engagement with the course material – measured by the number of views and timing of access to the mandatory lecture notes and study guide – was associated with quiz scores. Furthermore, we gleaned data from weekly quizzes and designed strategic interventions to address gaps and misconceptions leading to deeper comprehension and greater mastery at the completion of the course.

## Data

Information on the number of views and timing of access to the lecture notes and study guide was collected from the New Analytics Course Activity Report on the course’s Quercus page. The data were filtered by the resources and dates relative to the weekly quizzes. The scores of the weekly quizzes were extracted from the Quiz Report on the course’s Quercus page.

## Main Findings

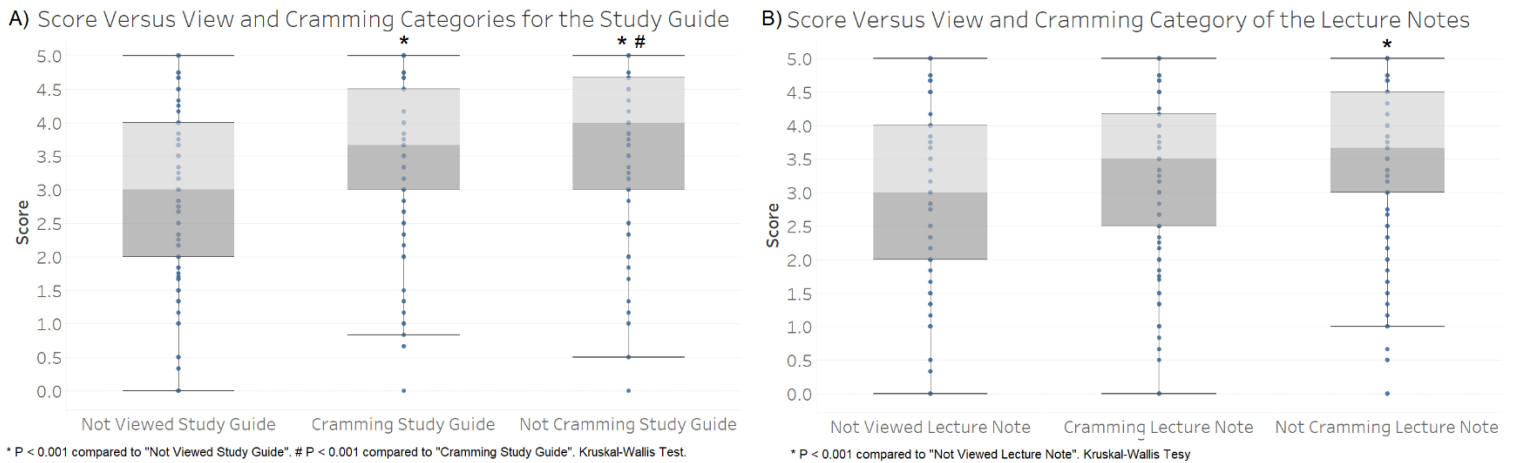
For the first analysis, students were divided into two categories: viewed and not viewed the relevant course material before each weekly quiz. Figure 1A shows that **students who viewed the study guide before a quiz had a statistically higher median quiz score compared to students that did not access this resource**. This pattern was constant throughout all individual quizzes (data not shown). On the other hand, Figure 1B shows that there was **no statistical difference in the quiz scores of the students who viewed and not viewed the lecture notes**.



**Figure 1:** Box Plots of Quiz Score by View Category of Resources (View vs Not Viewed Study Guide (A) and Lecture Notes (B)).

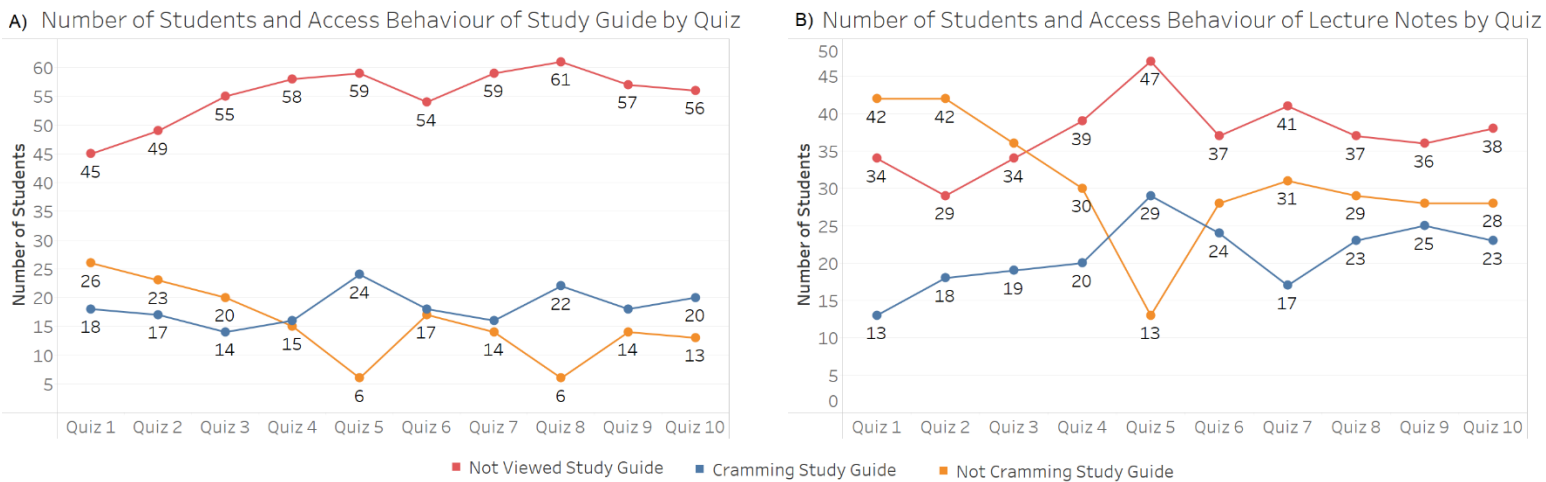
The next analysis investigated whether there was an association between the pattern of resource access of the Study Guide and Lecture Notes in relation to the quiz deadline (i.e., Not Viewed versus Not Cramming versus Cramming). Figure 2 shows that students who were **Not Cramming the Study Guide had the highest median score**, followed by students who were **Cramming the Study Guide**, and **students that were not viewing the material**. Both cramming and not cramming statuses were associated with a higher quiz score compared to the students who did not view the study guide. In addition, not cramming the study guide was associated with a higher median quiz score compared to cramming the study guide.

On the other hand, Figure 2B shows that **only students that were not cramming the Lecture Notes had a statistically higher median quiz score compared to the ones that were not viewing this resource**, which suggests a weaker effect of the Lecture Note pattern of access on the quiz score compared to the Study Guide.



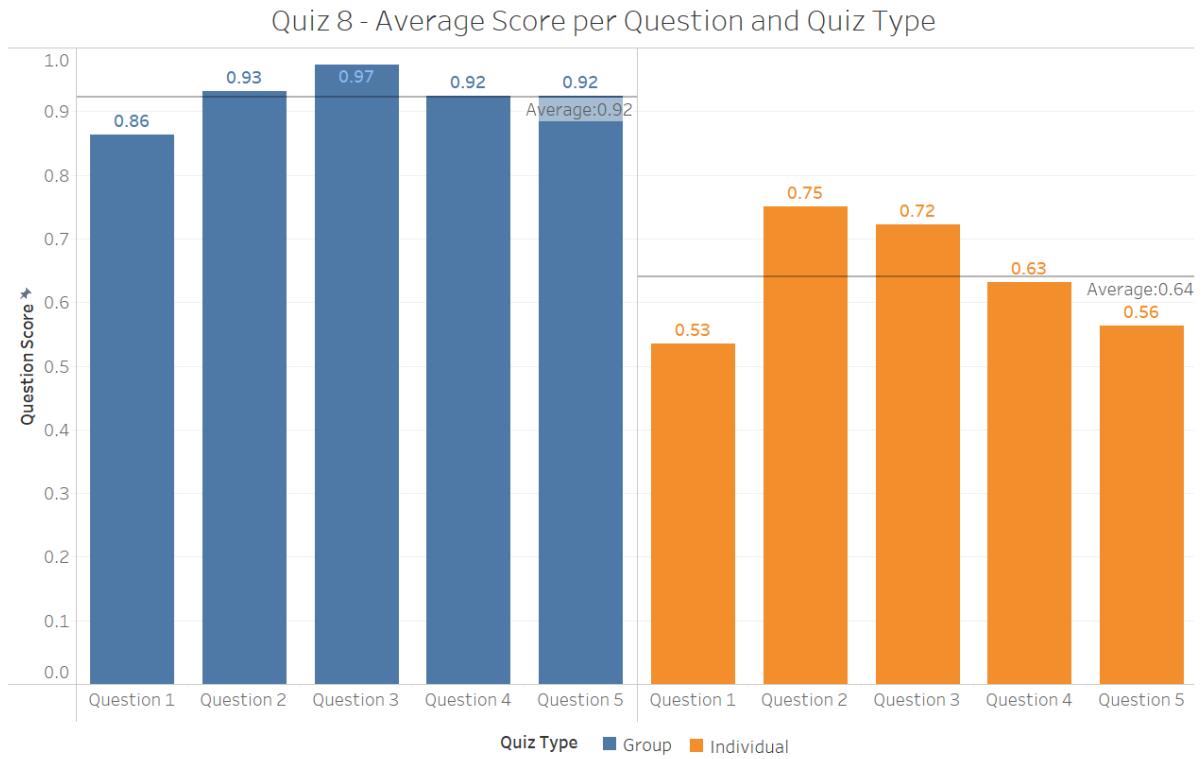
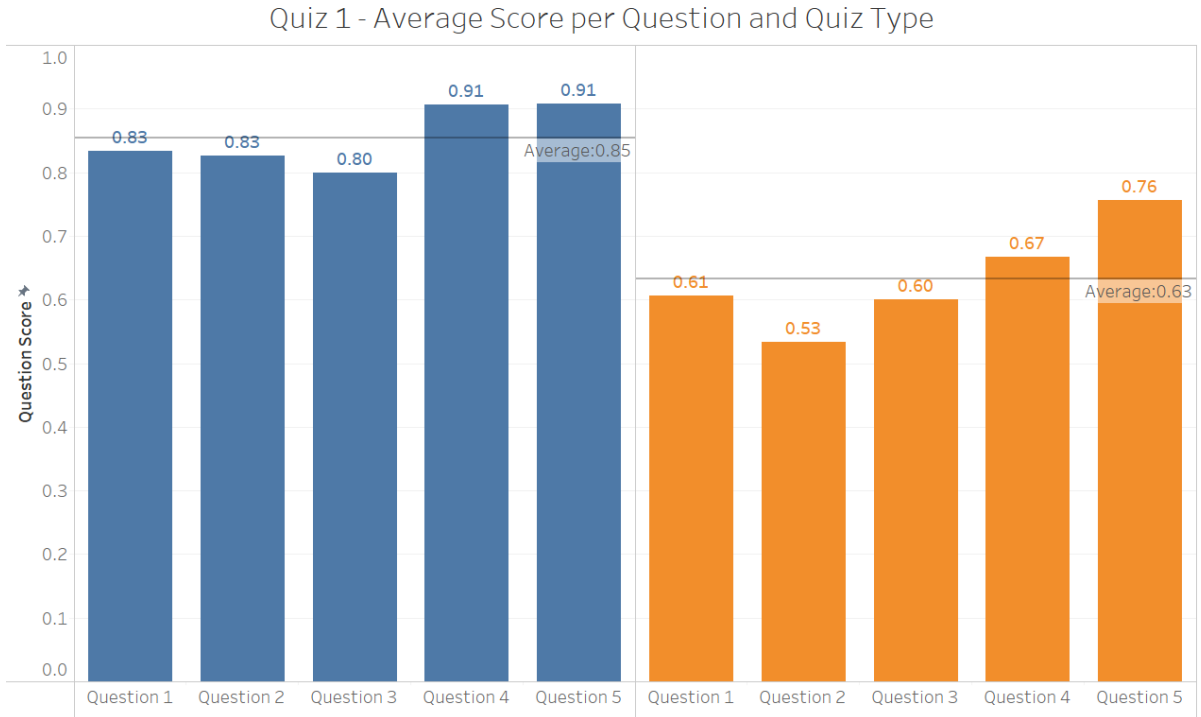
**Figure 2:** Box plot showing median quiz scores by the view and cramming categories of the Study Guide (A) and Lecture Notes (B)

Next, the number of students in each one of these access behaviours by quiz was investigated. **Most of the students did not access the Study Guide (Figure 3A) or the Lecture Notes (Figure 3B) before each quiz (red lines).** However, the contrast between the viewing categories is larger for the Study Guide compared to the Lecture Notes.



**Figure 3:** Number of Student and Access Behaviour of the Study Guide (A) and Lecture Notes (B) by Quiz.

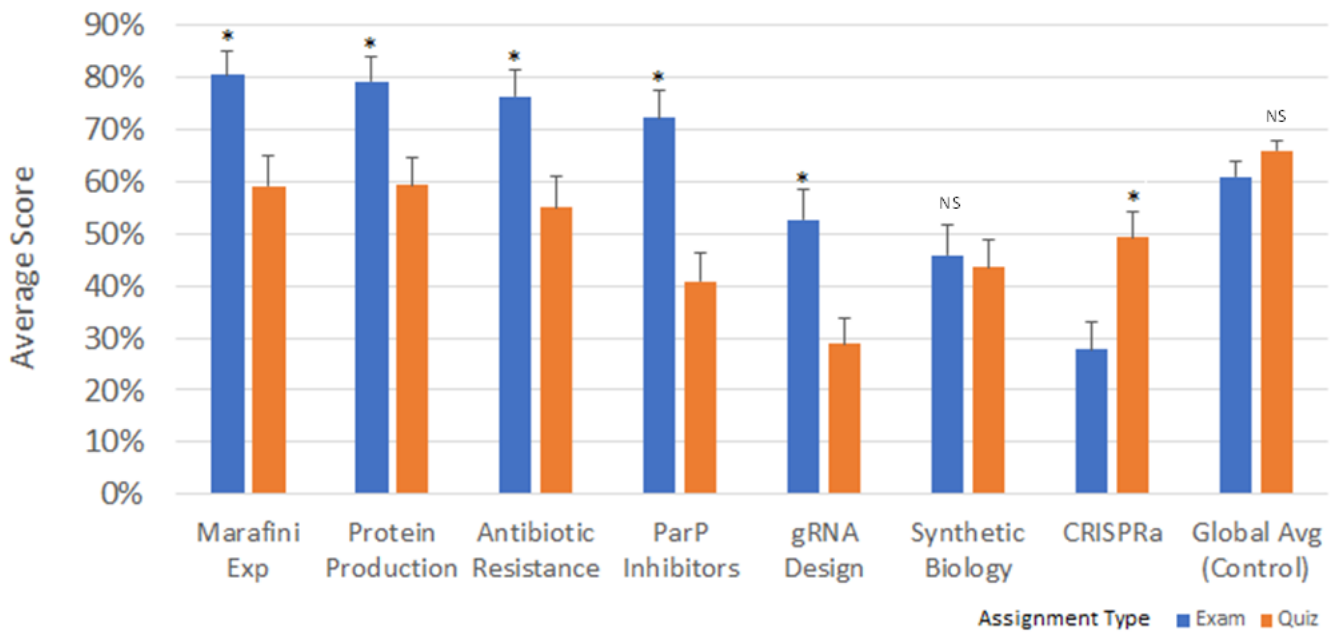
The next analysis evaluated the impact of peer-to-peer learning on quiz scores by comparing the average question scores between individual and group quizzes. **The average scores for the questions of the group quizzes were consistently higher than the average scores for the questions of the individual quizzes.** These results are illustrated in Figure 4 for Quizzes 1 and 8, but the same pattern was also consistently observed for the other quizzes.



**Figure 4:** Average Scores per Question and Quiz Type (Group vs Individual)

The final analysis investigated the impact of data-driven interventions within the time frame of a single semester. For this purpose, gaps in concept comprehension were identified based on individual quiz results. These concepts were reviewed with students during class and the improvement in the performance on the questions related to these concepts in the final exam was evaluated.

Figure 5 shows that there was a significant improvement in student comprehension of 5 out of 7 different concepts following a data-driven strategic intervention. Concepts that had an average score improvement in the final exam after intervention were **Marafini Exp** (81% Final Exam vs 59% Quiz), **Protein Production** (79% Final Exam vs 59% Quiz), **Antibiotic Resistance** (76% Final Exam vs 55% Quiz), **ParP Inhibitors** (72% Final Exam vs 41% Quiz), **gRNA Design** (53% Final Exam vs 29% Quiz). The average score in the final exam was 61% while the average percentage score in all quizzes combined was 66%. This suggests that the improvement in the key concepts observed in the final exam may be a result of the successful intervention in class, and not the result of an overall improvement in the final exam grades compared to the quizzes.

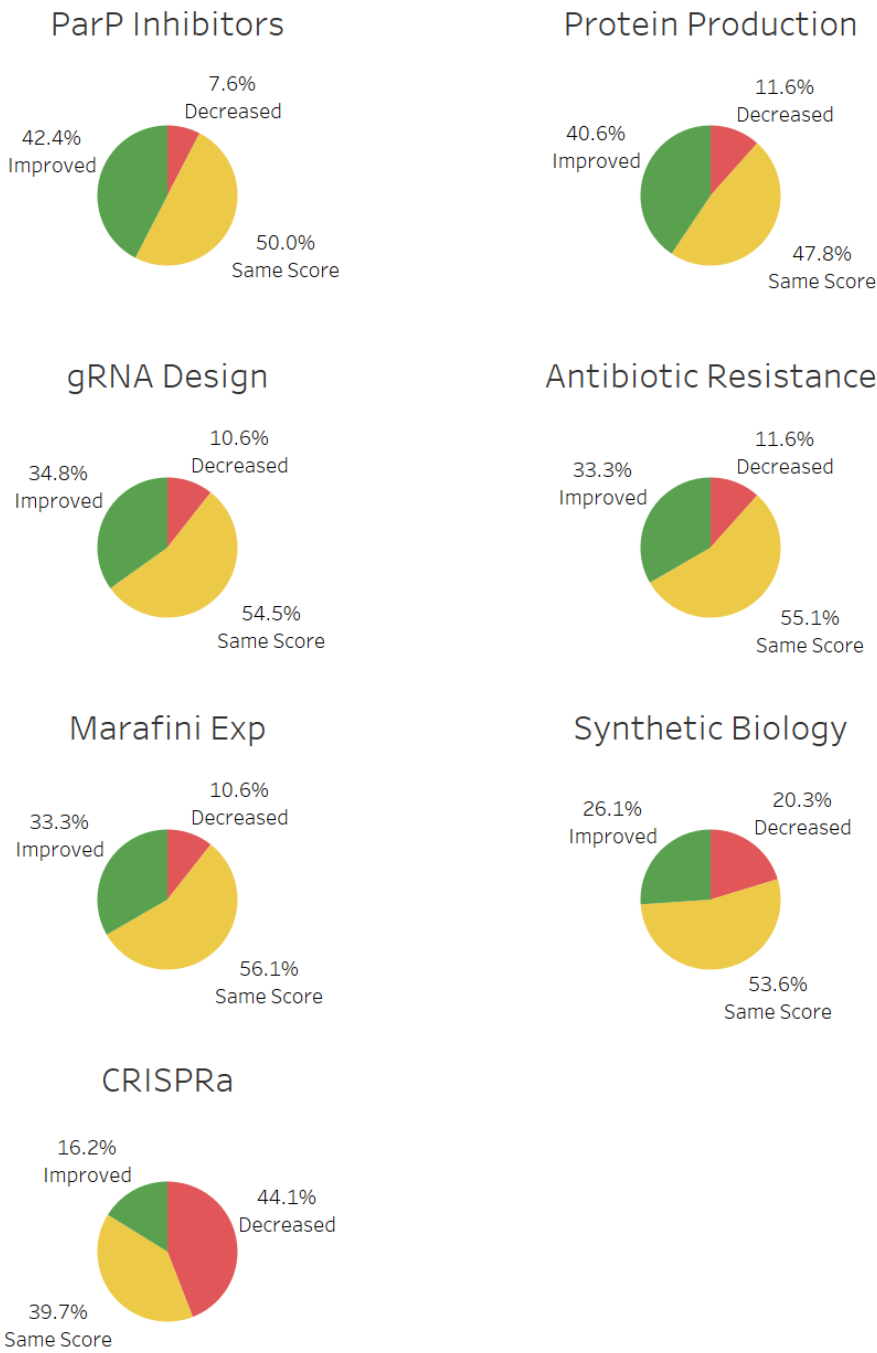


\*P<0.01, Paired T-test; NS: Not statistically significant.

**Figure 5:** Average Scores of Questions Related to the Key Concepts in the Final Exam and Quizzes.

Figure 6 shows the percentage of students that improved their scores in the final exam compared to the quiz, by topic. The topics showing the highest percentage of improvement in the final exam were **ParP Inhibitors** (42.4% Improved Score, 50 % Same Score, 7.6% Decreased Score), followed by **Protein Production** (40.6 % Improved Score, 47.8% Same Score, 11.6% Decreased Score), and **gRNA Design** (34.8% Improved Score, 54.5 % Same Score, 10.6% Decreased Score). **CRISPRa** was the only topic most students had an overall decrease in the average score in the final exam compared to the quiz (16.2% Improved Score, 39.7 % Same Score, 44.1% Decreased Score).

# Percentage of Students Improving Their Scores From Quiz to Exam by Topic



**Figure 6:** Percentage of Students who Improved their Scores from the Quizzes to the Final Exam by Topic.

## **Conclusions and Recommendations**

As observed in the results, the Study Guide may be a key resource related to higher quiz scores. Students who accessed this resource in advance had a better performance compared to those who accessed the material closer to the deadline. However, the majority of the students were still not accessing the Study Guide before each Weekly Quiz. Together, these results suggest that a possible intervention could focus on directing the students towards the Study Guide, which could increase the number of students engaging with the material in advance and, consequently, promote student success on the weekly quizzes.

Furthermore, the information-based strategic intervention changed the trajectory of student success within the time frame of a single semester, while also identifying topics that require a different approach in the next iteration of the course.

## **Limitations and Insights for Future Analyses**

It is important to highlight some limitations of these analyses and how they can guide future projects. Firstly, access to the lecture recordings was not available in the Course Activity Report since this report only captures views on files or pages within Quercus. In addition, the report does not contain information on whether a file was downloaded and viewed outside Quercus (only files and page views inside Quercus are included). These limitations may have affected the associations between the lecture notes and quiz scores; therefore, underestimating the impact of the Lecture Notes on students' success. A possible solution for future projects would be to extract the information regarding file downloads and clicks on external links and include it in the curated datasets derived from the Quercus Record Store.

In addition, the results described in this project do not necessarily imply a causal relationship between resource views and quiz results due to the transversal nature of the data collected. Future analyses containing longitudinal data from several terms (cohorts) are necessary to determine this causal relationship. This type of analysis would also benefit from the development of the Quercus Record Store.