ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #40933

Work-in-Progress Study on the Impact of Study Sheet Quality on Academic Performance: A Case Study in an "Engineered Systems in Society" Course Examination.

Mr. ISAAC DAMILARE DUNMOYE, University of Georgia

Dunmoye Isaac is an Engineering Education Ph.D. student, in the College of Engineering, University of Georgia. His area of research focuses on students' learning, cognition and engagement in virtual and online learning environments. He is interested in qualitative, quantitative and mixed methodology research that are needed for proper design of instructional material, necessary for harnessing and experimenting the multidisciplinary nature of engineering context to make engineering education suitable for the 21st century.

VINCENT OLUWASETO FAKIYESI, University of Georgia

Vincent Oluwaseto Fakiyesi received the B.Tech. degree in chemical engineering from the Ladoke Akintola University of Technology, Ogbomosho, Oyo State, , Nigeria in 2015, and He is presently a Doctoral Students at Engineering Education Transformative Institute at the University of Georgia College of Engineering.

Dr. Wayne Johnson, University of Georgia

Wayne M. Johnson is a Senior Lecturer in the School of Environmental, Civil, Agricultural and Mechanical Engineering at the University of Georgia (UGA) in Athens, GA. Prior to joining UGA in 2022, he was a Professor of Mechanical Engineering at Georgia Southern University-Armstrong Campus, Savannah GA. He received his Ph.D. and M.S. in Mechanical Engineering from Georgia Institute of Technology and his B.S. in Mechanical Engineering (Cum Laude) from Louisiana State University. He has published 16 papers in peer-reviewed journals, 28 papers in peer-reviewed conference proceedings, and given 12 technical presentations on various topics including: additive manufacturing, mechatronics, biomechanics, and engineering education. He currently teaches the Engineered Systems In Society, Mechanical Engineering Professional Practice, and Capstone Design I and II courses.

Dr. Dominik May, University of Georgia

Dr. May serves as a Professor for Technical Education and Engineering Education Research at the School of Mechanical Engineering and Safety Engineering at University of Wuppertal. His work revolves around generating both fundamental and practical knowledge that defines, informs, and enhances the education of engineers.

His primary research thrust centers around the development, implementation, practical utilization, and pedagogical value of online laboratories. These laboratories span a range of formats, including remote, virtual, and cross-reality platforms. Dr. May's scholarly pursuits extend into the sphere of online experimentation, particularly within the context of engineering and technical education. Prior to his role at the University of Wuppertal, Dr. May held the position of Assistant Professor within the Engineering Education Transformations Institute at the University of Georgia (Athens, GA, USA).

Central to Dr. May's scholarly endeavors is his commitment to formulating comprehensive educational strategies for Technical and Engineering Education. His work contributes to the establishment of an evidence-based foundation that guides the continual transformation of Technical and Engineering Education. Additionally, Dr. May is actively involved in shaping instructional concepts tailored to immerse students in international study contexts. This approach fosters intercultural collaboration, empowering students to cultivate essential competencies that transcend cultural boundaries.

Beyond his academic role, Dr. May assumes the position of President at the "International Association of Online Engineering (IAOE)," a nonprofit organization with a global mandate to advocate for the broader advancement, distribution, and practical application of Online Engineering (OE) technologies. His leadership underscores his commitment to leveraging technological innovation for societal progress.

Furthermore, he serves as the Editor-in-Chief for the "International Journal of Emerging Technologies in Learning (iJET)," a role that facilitates interdisciplinary discussions among engineers, educators, and engineering education researchers. These discussions revolve around the interplay of technology, instruction, and research, fostering a holistic understanding of their synergies.

Dr. May is an active member of the national and international scientific community in Engineering Education Research. He has also organized several international conferences himself – such as the annual "International Conference on Smart Technologies & Education (STE)" – and serves as a board member for further conferences in this domain and for several Divisions within the American Society for Engineering Education.

Work-in-Progress Study on the Impact of Study Sheet Quality on Academic Performance: A Case Study in an "Engineered Systems in Society" Course Examination.

Abstract— This work-in-progress study explores the impact of the quality of study sheets on student performance in an "Engineered Systems in Society" course examination. The students prepared and used the study sheets for their spring 2023 mid-semester examination. The quality of the sheet was coded based on the depth of the instructional content and the organization of the written study sheet. The students' performance was measured by the percentage scores they obtained on the examination. In this study, we analytically linked the coded quality of the summitted study sheets with the students' examination performance. The preliminary findings of this study reveal that none of the students that prepared study sheets with medium and high levels of detail achieved less than a distinction grade while at least one (1) student, either prepared a study sheet with low details or not preparing any scored below the distinction grade. Hence, this study finds that the preparation and use of study sheets for examination does impact students' performance. In a future study, we plan to conduct an experimental study to establish a causal relationship between the study sheets and performance. The findings of this research are expected to encourage purposeful studying habits among students, thereby contributing to their academic success.

Keywords- Study sheet, Examination, Performance, Engineering

Introduction

In the pursuit of effective teaching and learning, there has been ongoing research on the effectiveness of various modes of examinations in enhancing students' understanding and retention of classroom concepts [1]. To examine students' comprehension of engineering concepts, many instructors prefer closed-book time-limited exams, while others advocate for alternative methods such as open-book exams or the use of study sheets, also known as cheat sheets.

Despite the prevalence of closed-book exams in undergraduate courses, critics argue that this approach may prioritize memorization at the expense of genuine comprehension [2]. One suggested modification to closed-book exams of interest to engineering course instructors is students' preparation and use of a study sheet during exams. A typical study sheet would consist of notes and/or example problems prepared by a student for use during an exam. Instructors typically establish guidelines for these cheat sheets, such as requiring them to be handwritten and/or limited to one side or two sides of a sheet of paper [3].

Past studies have highlighted the positive impact of study sheets on student learning. For example, the study by Erbe [4], found preparation of cheat sheets for examination deepened students learning and contributed to structuring their study time. The study by Williams and Wong [5], also found that students' examination anxiety can be reduced, and better performance can be achieved with the use of cheat sheets or study sheets for examination. Students have a good attitude towards using study sheets for examinations and research has shown that it can reduce academic dishonesty among students [6]. Additionally, the study of Hsiao [7] found that there exists a statistically significant and positive correlation between the proportion of notes on a students' study cheat and final examination grades. Also, Song and Thuente [8] study on the efficacy of cheat-sheets quality on the students' academic performance found that the quality of students' cheat sheets is positively correlated with their academic performance.

Other studies reveal that study sheets have negative or no effects on students learning. To illustrate this relationship, Dickson and Miller [9] conducted a study in which they administered surveys in a course which allowed students to use cheat sheets for their multiple-choice exams. The study revealed that cheat-sheets did not have any impact on the student academic performance. Additionally, the students believed cheat sheets are for simple questions, hence, the number of students that used study sheets decreases with time during the semester. In addition, the study by Johnson and Sargent [10] finds that the study sheet did not help the students in answering questions. It may also lead the student to be overconfident when preparing for exams, which may lead to failure [11]. Some studies argue that they may lead to shallow, or surface level understanding of a topic and that the quality of the cheat sheet may not correlate with students' actual performances [2, 12]

Amidst the divergent findings, this study aims to contribute to the literature by examining whether study sheets prepared by second-year engineering students for an examination in the effectiveness of study sheets as a learning tool, offering valuable insights for both students and educators. The research question that will be guiding this study is: *How does the quality of study sheets impact the academic performance of second-year engineering students in an 'Engineered Systems in Society' course examination?*

Methodology

A. Study participants and study context

This study is action research that focuses on the study sheet strategy used by the instructor of a required second-year engineering course, "Engineered Systems in Society". Study sheet and exam grades were collected from thirty-three students which they prepared for Spring 2023 mid-semester examinations. The course incorporates contemporary readings, team projects, and experiential learning to enhance students' conceptual and practical understanding of socio-technical systems. The use of systems thinking concepts and tools are used to help students frame socio-technical problems with an emphasis on stakeholder perspectives and ethical decision making within a historical and contemporary context. The course also provides students with an opportunity to demonstrate an understanding of the role of public policy and intellectual property in the development and implementation of engineered systems. During the course lectures, emphasis is placed on developing students' critical reflection and social engagement as contemporary engineers. The students' grade in the course was calculated based on class participation (attendance, reflections, and scribe reports), written assessments (mid-term and final examinations) and projects.

The course instructor (third author) taught two sections of the course in the Spring 2023 semester. However, due to time constraints, only the study sheets of one section were analyzed for this study. We analyzed the grades of nineteen (19) students who submitted the study sheet they used for the examination and three (3) students who did not submit any study sheet. We plan to analyze the data from the other Spring 2023 semester section along with new data collected from the Fall 2023 semester for a future full paper.

B. Data Analysis

The data analysis was based on the study sheets the students prepared for the mid-semester examinations. They created a hand-written exam study sheet with notes from the course textbookr and/or class lectures for use during the examination. The mid-semester exam covered the course terminologies, concepts and applications and consisted of two take-home parts: 16 short answer questions accessed via the university's learning management system (LMS), and an essay-style task based on prompt which was uploaded to the LMS.

The students were required to submit the study sheets prior to the exam becoming available in the LMS. The instructor of the course marked both the mid-semester examination and study sheets. The study sheets were coded with a single value between 0 and 3 based on the combination of the sheet's detail, organization, and length, with a qualitative emphasis on detail. Additional aspects of the coding are shown in Table 1. The exams were manually graded within the LMS system using a rubric with partial credit given as appropriate. The grades were assigned based on the scale described in Table 2 below.

Table 1: Details of study sheet coding

Score	Criteria
0	No sheet submitted
1	Low level of detail (includes notes from class discussions of readings, but limited to no notes on lecture discussions), poor organization, and typically 1 page or less
2	Medium level of detail (includes notes from class discussions of readings and notes on lecture discussions), reasonable organization and greater than 1 but less than 2 pages.
3	High level of detail (includes notes from class discussions of readings and notes on lecture discussions), excellent organization and between 1.5 to 2 pages.

Table 2: The scale for the students' performance grades

Grade	Scale	Grade	Scale
A	94 -100	C+	77 – 79
A-	90 – 93	C	74 – 76

B+	87 – 89	C-	70 – 73
B	84 – 86	D	65 – 69
B-	80 – 83	F	64 and less

Results and discussion

The results are presented below based on the grades of each of the students in the different categories of coded quality of study sheets. “A” and “B” grades are described as distinction while ”C’s” are described as credit. Pass grades include “D’s”, and “F” grades are described as fail.

A. No study sheet

Three (3) students did not submit a study sheet with their marks and grades are shown in Figure 1 below. One of the students got a distinction grade (85), another student obtained a pass grade (69) while the third student failed the examination (60).

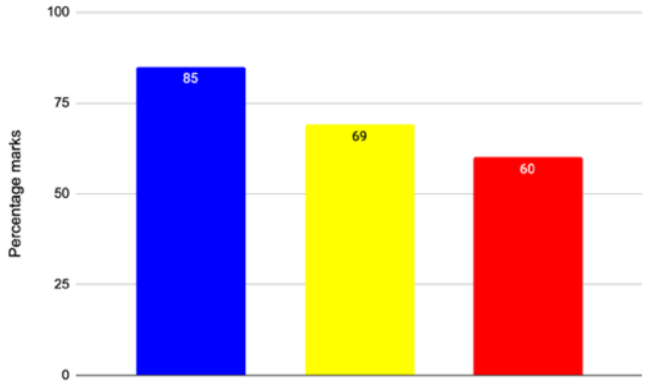

Figure 1: Performance of students who did not submit a study sheet.

B. Study sheet with low levels of details

As shown in Figure 2, nine (9) students submitted study sheets with low level of quality. All of these students obtained distinction grades with the exception of one (1) student who obtained a credit grade.

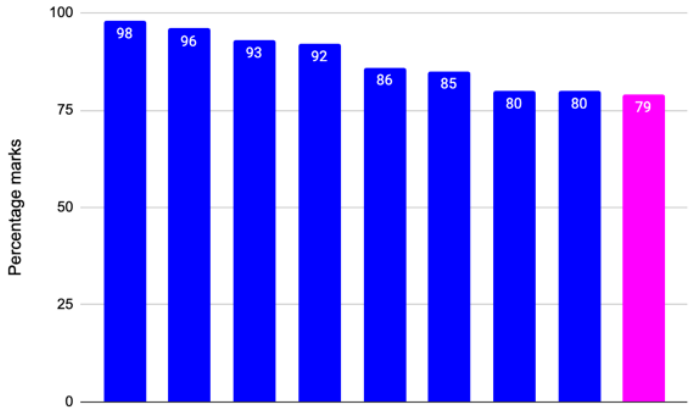

Figure 2: Performance of students who submitted a study sheet with low levels of details.

C. Study sheet with medium levels of details

As shown in Figure 3 below, the four (4) students who submitted a study sheet with medium levels of details obtained distinction grades.

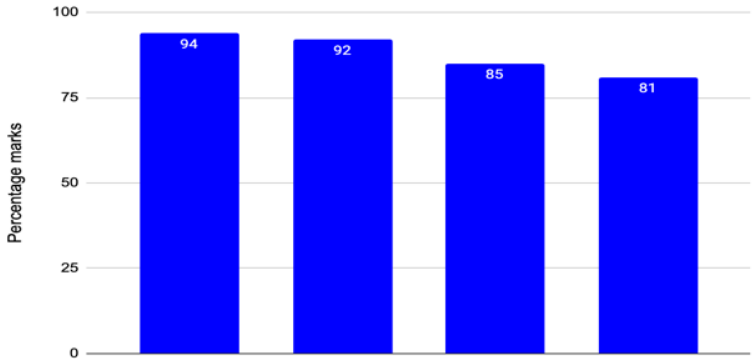

Figure 3: Performance of students who submitted a study sheet with medium levels of details.

D. Study sheet with high levels of details

In addition, the six students who submitted high levels of study sheet datils obtained distinction grades (Shown in Figure 4).

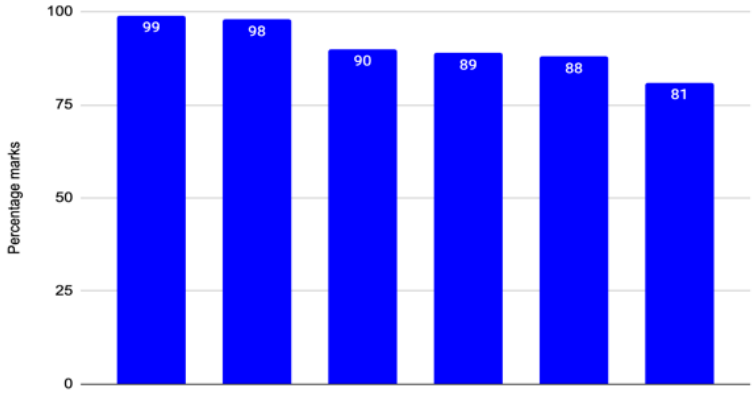

Figure 4: Performance of students who submitted study sheet with high levels of details.

The results of the analysis reveal that all the students that prepare study sheets with medium and high levels of details obtained distinction grades, while at least one student who prepared a study sheet with low levels of details or did not prepare any study sheet scored below the distinction grade. This study's findings align with Erbe's [4] perspective, suggesting that preparing study-sheets for exams positively impacts students' performance.

One of the limitations with this study includes the academic integrity of the students when writing the examinations at home. There is no guarantee that the students did not use course materials beyond their study sheet and/or collaborated with their classmates during the exam. However, all students were bound by the university student honor code stated on the course syllabus regarding cheating. We plan to account for this in future study by requiring students to sign a declaration of complete academic integrity prior to taking the examination with their study sheets.

In conclusion, this study illuminates the intricate connection between students' self-generated study materials and their performance in examinations by exploring the impact of study sheets on students' performance. While this study could not establish the direct relationship between the quality of the study sheet with the students' performance, the study reveals that student's preparation and use of study sheets does not negatively affect their performance. The authors intend to conduct a future study to perform an analysis to see if there is a statistically significant difference in grades between students who prepare study sheets with medium and high levels of details and those who do not. Additionally, the density, organization and content features of the study sheets will be analyzed and correlated with their performance in the examination.

Acknowledgement
We would like to thank Dr. Joachim Walter and Dr. Nicola Sochacka for their tremendous efforts in creating the “Engineered Systems in Society course” in the College of Engineering, University of Georgia.

References

[1] D. Bansal, "Open book examinations: modifying pedagogical practices for effective teaching and learning," *The Law Teacher,* vol. 56, no. 3, pp. 354-367, 2022.
[2] R. A. Kalish, "An experimental evaluation of the open book examination," *Journal of Educational Psychology,* vol. 49, no. 4, p. 200, 1958.
[3] Y. Song and D. Thuente, "A quantitative case study in engineering of the efficacy of quality cheat-sheets," in *2015 IEEE Frontiers in Education Conference (FIE)*, 2015: IEEE, pp. 1-7.
[4] B. Erbe, "Reducing test anxiety while increasing learning: The cheat sheet," *College teaching,* vol. 55, no. 3, pp. 96-98, 2007.
[5] J. B. Williams and A. Wong, "The efficacy of final examinations: A comparative study of closed‐book, invigilated exams and open‐book, open‐web exams," *British Journal of Educational Technology,* vol. 40, no. 2, pp. 227-236, 2009.
[6] C. Theophilides and M. Koutselini, "Study behavior in the closed-book and the open-book examination: A comparative analysis," *Educational Research and Evaluation,* vol. 6, no. 4, pp. 379-393, 2000.
[7] I.-H. Hsiao and C. López, "Lessons learned from students' cheat sheets: Generic models for designing programming study guides," in *2016 IEEE 16th International Conference on Advanced Learning Technologies (ICALT)*, 2016: IEEE, pp. 209-211.
[8] Y. Song, Y. Guo, and D. Thuente, "A quantitative case study on students' strategy for using authorized cheat-sheets," in *2016 IEEE Frontiers in Education Conference (FIE)*, 2016: IEEE, pp. 1-9.
[9] K. L. Dickson and M. D. Miller, "Authorized crib cards do not improve exam performance," *Teaching of Psychology,* vol. 32, no. 4, pp. 230-233, 2005.
[10] B. G. Johnson and C. S. Sargent, "Impact of formulas, language and instruction on student performance on cost-volume-profit problems," *Accounting Education,* vol. 23, no. 1, pp. 22-41, 2014.
[11] N. Mathew, "Student preferences and performance: A comparison of open-book, closed book, and cheat sheet exam types," *2012 NCUR,* 2012.
[12] D. Visco, S. Swaminathan, L. Zagumny, and H. Anthony, "Interpreting Student Constructed Study Guides," in *2007 Annual Conference & Exposition*, 2007, pp. 12.955. 1-12.955. 10.