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Open-Resource Examination: Merits of an Alternate Approach to Student Assessment

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Traditional examination methods are not always sufficient for measuring a student's knowledge, skills, or abilities on a given subject. These traditional exams also create sufficient anxiety for the student to warrant the exploration of alternative assessment methods. Open-resource examination was explored in this longitudinal study that spans a six-year timeline in a construction finance course. The use of an online application to design, administer, and grade was considered in this study. This was accompanied with a survey of the students. Exam results as well as survey results are presented and discussed in this paper. Descriptive statistics were used to evaluate the results over the timeline of the study. Advantages to students include reduced exam anxiety, immediate results, and control of exam location and environment. Advantages to instructors include automated grading as well as statistical analysis of individual exam questions and aggregate performance. Additionally, both instructor and student gain valuable class-time to treat content and context of the subject. Limitations of open-resources exams are also considered. The results make a compelling case for a broader implementation of open- resource, online exams.

Key Words: Assessment Methods, Construction Education, Open-resource Exams

Introduction

The career pathway of a construction manager is highly technical, demands organizational skills, and the ability to command a vast library of resources. With repetition and experience, the construction manager commits certain aspects of the job to memory. Regardless of their knowledge and intelligence, many construction managers are highly adept at *organizing* access to information rather than storing that information in their active memory. They are expert in process management and interpreting information into insight for decision making. Construction managers are not the *creators* of new knowledge – but they are the highly effective *users* of knowledge. Thus, construction management education considers creative ways to teach interpretation, critical thinking, and pragmatic application skills. It is therefore necessary that assessment methods in construction

management education reflect that teaching approach. The purpose of this paper is to provide insight into the potential use of open-resource examination in construction education. The merits as well as the challenges are presented, and the results of five years of use are considered herein. The open-resource examination was used in one course of that time period, and as such, general application to all courses in a construction management (CM) program are not considered. The approach is explored herein and presented for consideration by a broader audience. Therefore, this paper serves to inform that broader audience of CM educators.Background and Literature Review Educational assessment techniques are critical to student engagement and motivation beyond measurement purposes. The traditional assessment techniques typically provide the effectiveness of the learning and teaching processes and focus less on revealing the long-term retention of knowledge. Several studies focused on analyzing the relationships between assessment techniques, learning theory, individual achievements, evaluating programs, and mental processing (Kang et al. 2021). National Research Council (NRC)'s study in 2001 explored the issues in traditional assessment techniques such as (i) the use of a single type assessment in all topics and/or programs, (ii) the lack of design and connection of assessments on cognition, observation, and interpretation, (iii) absence of an approach considering cognitive science and learning representing students' competencies and (iv) insufficient structure of innovative and authentic teaching approaches in the practical applications (NRC, 2001). As suggested in general assessment theory, standardized assessment procedures are often useful in measuring knowledge at a specific point in time (Rovai, 2000); however, they are ineffective in assessing the overall learning performance.

Opportunities of Open-Resource Examinations

Open-resource examination techniques received increasing attention in the educational assessment literature as an alternative and authentic assessment method. For example, Green et al. (2019) focused on using open-resource exams to enhance student learning, performance, and motivation. Their study revealed that students could focus on mastering materials rather than memorization and short-term learning, such as applying equations without a fundamental understanding of principles. In addition, statistical significance was identified in the effectiveness of open-resource exams in the same study. The same study also emphasized the importance of exam protocol to prevent students from solely transferring information from the textbook rather than utilizing the textbook information in testing critical thinking and applying concepts (Green et al., 2019). Open-resource examination approach can be considered as an assessment that supports student learning with increasing motivation and engagement. As indicated in the very early studies (Feldhusen, 1961), students reported their positive experiences in open resource examinations such as reduced anxiety, lower tendency to cheat, and promoted learning during the exam even though they didn't have a structured exam protocol. In addition, current literature highlighting the effectiveness of open resource examinations reported that students appreciate the time and location flexibility of the exams and the focus on mastering content with applying relevant skills (Williams & Wong, 2009).

Challenges of Open-Resource Examinations

On the other hand, studies indicated that open-resource examination style may lead to decrease class attendance and may devote less effort to studying (Moore & Jensen, 2007). In addition, overconfidence is a critical problem in open-resource examinations, which may lead to inadequate preparation for the exam (Theophilides et al., 2000). Another potential issue in the literature highlighted is the time spent finding the information in the resources while taking the exam (Theophilides et al., 2000). Students might also have challenges with overall time management in the

open-resource examinations, spending more time finding answers to certain questions, which then results in not having enough time for some questions. The structure of questions and the time limit have a significant impact on the student's performance in the open-resource examinations. Deneen (2020) provided a guideline for the open- resource examinations by emphasizing the structure of the exams with a focus on using and applying the knowledge rather than investigating additional and new knowledge. Their study suggests structuring the open-resource examinations by asking problem-solving, analysis, data-interpretation, and compare & contrast type of questions (Deneen, 2020).

Considering these, instructors have a critical role in conveying the objectives of the open-resource examination with clear exam protocol to students. Understanding the fundamental purpose of this type of exam will increase student's engagement in terms of attendance, attention to course material, and their study efforts. Moreover, the instructors must comprehensively assess the pros and cons of the open-resource examinations with the subject matter and question types.

Other considerations in the learning assessments

Test anxiety is a prominent problem that negatively influences students' performance. Cassady and Johnson (2001) revealed that a higher level of cognitive test anxiety is associated with significantly lower test scores. The various causes of text anxiety were explored in the literature extensively. For example, Mealey and Host (1992) identified three categories that lead to text anxiety: (i) lack of study and preparation strategies, (ii) distraction at the time of the exam, and (iii) misconception of adequate study and preparation strategies. Moreover, examination type (essay, multiple choice, open-ended, etc.), time limit, length, lack of clarity in instructions, environment, and stress of final score were identified as contributing factors to test anxiety (Trifoni & Shahini, 2011).

As an effective alternative to traditional teaching and learning techniques, student-to-student learning provided promising results in the recent studies. Student-to-student learning approach transitions the individual learning process to a team and group based active learning style (MacLeod et al., 2018). Allen (2000) identified that it improves peer communications and supports students in being more open and transparent to each other. Considering the importance of interpersonal skills in almost every profession, student-to-student learning approach empowers development of these skills: communication, active listening, teamwork, patience, motivation, etc. Rugut and Chemosit (2009) focused on determining relationships between motivation and student-to-student learning. Their study revealed that student-to-student relations is a statistically significant predictor of the student motivation (Rugut & Chemosit, 2009). Ultimately, it is evident that alternative and authentic assessment and teaching techniques lead to improve student's performance with promoting their learning experience with an active style.

Theoretical Background of Assessments

It seems apparent that a deviation from traditional assessment methods is appropriate – and perhaps more so with construction management students. Considering the notable benefits of open-resources examination, namely reduced anxiety, lower tendency to cheat, and promoted learning during the exam; we considered the development of an open-resource examination in the construction finance course offered within the Construction Management program at Colorado State University. In addition to these three benefits, we sought to also increase the rigor of the exam without negatively impacting performance (average grade).

Research Methodology

Exam Development and Administration

Addressing exam anxiety presents an interesting challenge, as anxiety types vary from student to students. To remove, or at least attempt to diminish some of these exam anxieties – an online examination was designed. The online exam was created to allow the student to choose their test location – thus addressing the concern for environmental conditions. Many distractions may exist during scheduled exams in specified spaces. Thus, the freedom to choose the exam location provides options for the student to determine the best location for their particular preferences.

One of the distractors is time limits. Often, a traditional exam is administered in the scheduled classroom setting and has a limit to the time allotted for the course. Therefore, this exam was designed to allow the student a window of time over the course of three days. This allowed the student to work on the exam at their pace. And, as distractors or other scheduled events interrupted the student – the online application automatically saved their work. After three days (72 hours) the exam was shut off for all students.

Some exam anxiety is the result of under preparation by the student. They "mistakenly believe they have adequate" preparation (Mealey & Host, 1992) but as soon they begin the exam, they realize they have not preparedsufficiently. Thus, this open-resource examination allowed the student to accompany the exam administration time with their preparation time. Where traditional examinations require sufficient time to study or "cram" information related to the exam – this exam allowed students to identify the problem, study the appropriate strategy to solve theproblem (or question), and to determine their response. This exam writing strategy also justified the necessary extension to the time limit. Prior to the administration of the exam, students were informed of this condition and cautioned that if the student chose to use this strategy to study-as-you-go, that the full time to take the exam would be significantly extended.

In open-resource exams, there immediately exists the concern for cheating. To address this concern, the exam was written with both (i) pools of questions and (ii) variable questions. Questions pools are used so that multiple choice, true/false, fill-in-the-blank questions can be written on the same, or similar question but the same level of rigor. The online application automates a random choice for which question is presented to the student. Thus, with a sufficient pool of questions the likelihood of the same question presented to two or more students collaborating together is very low. Questions with higher standards on the Bloom's taxonomy were associated in the same pools – considering the fairness of the test from student to student without diminishing the rigor.

Further variability in the question pool was achieved by using problem variables within the question. A simple example of this was a question pool which asked the student to calculate either the Schedule Performance Index (SPI) or the Cost Performance Index (CPI) given three variables: Budgeted Cost of Work Scheduled (BCWS), Budgeted Cost of Work Performed (BCWP), and Actual Cost of Work Performed (ACWP). On the programming side of the exam application, the instructor was able to create a range of values for each of these three variables, then program the simple logarithm to achieve the answer. Thus, the question can produce innumerable potential answers
– but the student will only have one correct answer.

Other examples of this would be to present the student with a summary balance sheet or income statement, with each value varied by the computer application. Next, the instructor programmed which financial ratio to calculate. This singular question becomes 50 questions and yet challenged the students at the same level of rigor.

While this exam writing approach was designed to eliminate cheating (because students simply were not taking an exam with the same questions), it was designed to promote student-to-student teaching and learning. Students were cautioned regarding the structure of the exam, and to not rely solely on the appearance of the question being the same, as some questions may seem the same but in fact the rephrasing of questions may have changed. However, students were not discouraged from using each other as knowledge resources. Peer-to-peer teaching can be a powerful tool, both for the student-learner (the student who is learning from another student) and for the student- teacher (the student who is also enrolled in the course but takes on the role of providing knowledge to the fellow student). In many cases, student-learners may have difficulty applying the instruction and context provided by the instructor/professor. A second voice, which explains the same material but in a different manner, may have a significant impact on the student-learner's ability to retain and now apply the new knowledge. Or, as often may be the case, the student-learner has merely forgotten the lesson taught – even though there was a level of confidence at the time that the principle was introduced.

Additionally, the student-teacher gains from the experience of providing explanation to a fellow student. This process serves to reinforce their own learning. Indeed, this process or interaction was suggested from the instructor with a word of caution regarding the use of student-teacher provided information. Ultimately, the student-learner was responsible for their own final response and could not hold the student-teacher accountable for the exchange of knowledge.
In the development of the open-resource exam, there was a going concern for the rigor. There still remained a number of questions which assessed the student at the foundational 'Understanding' level on the Bloom's taxonomy – but there was now an opportunity to increase the rigor and challenge the students at higher levels of knowledge, skills, and abilities related to the course content. The open-resource exam format also presented an opportunity to more fully examine the students' knowledge, skills, and abilities on a more comprehensive level. Thus, the length of time for the exam could be extended sufficiently to meet those expectations.

Initially in 2018, only the mid-term exam was administered through this online application and the final exam was administered in a traditional two-hour, in-class format. After some initial success, the final exam was in development when the COVID-19 pandemic impacted educational institutions around the world. This condition forced the final development and completion of the final exam in an online format. To ensure consistency in the results of this study, only the mid-term exam was considered for its effectiveness over the five-year period.

Development of a Feedback Instrument

A survey instrument was developed in 2019 to consider the impact of the students' experience with the open- resource examination. The survey was purposefully brief, with only 14 questions, to increase the response rate. The survey was administered through the same online application as the exam. Extra-credit points were awarded to students for participating – incentivizing participation. Twelve questions used a Likert-type scale from 'Strongly Agree' to 'Strongly Disagree'. One question asked the students regarding the time necessary to take the exam and used a Likert-type scale

from, “Took a lot more time than normal” to “Took much less time than normal”. One question was a simple, Yes or No response. Table 1 provides the list of questions and the response type.

Table 1

Survey Questions and Question Types

Question No.	Survey Question	Response Type
1.	The open-resource mid-term was a good measure of my understanding of the material	Likert-Type
2.	The open-resource format provided sufficient time to complete the mid-term	Likert-Type
3.	I was able to collaborate with others while taking some or all of the exam	Yes or No
4.	The ability to collaborate on the exam created an opportunity for me to learn from others also taking the exam.	Likert-Type
5.	The ability to collaborate on the mid-term created an opportunity to help others learn from me.	Likert-Type
6.	The open-resource mid-term encourages students to take advantage of other students’ knowledge and learning without making the effort to learn themselves.	Likert-Type
7.	The collaborative nature of the mid-term helped reinforce my learning because I was able to confirm my answers with others working the same, or similar problems.	Likert-Type
8.	I spent sufficient time studying and preparing prior to taking the exam.	Likert-Type
9.	Considering the time it takes to study for AND take the exam, this mid-term…	Likert-Type
10.	I prefer the open-resource mid-term	Likert-Type
11.	Traditional examinations are NOT effective at measuring my knowledge, skills, or abilities (Traditional examinations are in-class, closed resource exams).	Likert-Type
12.	I prefer in-class, open note examinations over the open-resource examination used on this mid-term.	Likert-Type
13.	Examinations are an effective way to measure a student’s learning and intelligence on a given subject.	Likert-Type
14.	This open-resource mid-term challenges me to learn the material.	Likert-Type

The survey was administered after each mid-term examination and open for a full week. The extra-credit points associated with participation were awarded separately from the exam scores reported in the results section of this paper. The survey followed IRB protocols and indicated that participation was voluntary and that the aggregate results could be used in further research and publication.

Results

Prior to the use of the open-resource exam, the average mid-term exam score was 88.7% and 83% in the spring and fall of 2017, respectively. In the spring of 2018, the open resource exam was used for the first time. We observed that the average exam score initially dropped and then leveled out again in the mid 80’s. The exam analytics in the online application provided average scores on each question

as well as the standard deviation – thus assisting the instructor in identifying those exam questions which caused the most problems, or challenges for the students. This also served to consider whether the question was written appropriately. In each semester, there were small iterations for improving the exam, adding content or rigor and revising or removing poorly written questions. Table 2 provides the average score in percent form, as well as the low and high scores, and student enrollment count in a given semester.

Table 2

Descriptive Statistic Metric of Mid-Term Exam Results

Year of Exam	**Average % Score**	**Low Score**	**High Score**	**Student Count**
Spring 2017	88.7%	69%	98.5%	20
Fall 2017	83.9%	45%	96%	28
Spring 2018	79%	66%	94%	57
Spring 2019	87.5%	69%	98%	76
Spring 2020	85%	69%	97%	89
Spring 2021	81.2%	0% (58%)	98.7%	75
Spring 2022	86.4%	64%	100%	86

Participation rates for the survey varied somewhat, yet the responses were relatively consistent from year-to-year. The first semester wherein the survey was administered was the Spring of 2019. The total participation in the survey was 67 out of 74 students enrolled in the course, a response rate of 90.5%. In the Spring of 2020, we observed 65 responses out of 89 students enrolled in the course, a response rate of 73.0%. In the Spring of 2021, we observed 62 responses out of 74 students enrolled in the course, a response rate of 83.8%. Finally, in the Spring of 2022, we observed 80 responses out of 86 students enrolled in the course, a response rate of 93%. With an overall participation of 274 students out of a potential 323 students enrolled, the four year participation rate was 84.8%. Participation was incentivized with 2 points of extra credit, which was applied to the total grade score for the course (not the exam – so to not skew the results).

Table 3

Results from Student Survey over 4-years

Question No.	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**No Response**
1.	**138 (50.4%)**	121 (44.2%)	13 (4.7%)	2 (0.7%)	0	0
2.	**209 (76.3%)**	60 (21.9%)	3 (1.1%)	2 (0.7%)	0	0
3.	**[YES] 211 (77%)**	[NO] 63 (23.0%)				
4.	**144 (52.6%)**	76 (27.7%)	41 (15.0%)	8 (2.9%)	4 (1.5%)	1 (0.4%)
5.	**123 (44.9%)**	94 (34.3%)	45 (16.4%	7 (2.6%)	4 (1.5%)	1 (0.4%)
6.	41 (15.0%)	42 (15.2%)	64 (23.4%)	**87 (31.8%)**	39 (14.2%)	1 (0.4%)
7.	**118 (43.1%)**	104 (38.0%)	41 (15.0%)	8 (2.9%)	1 (0.4%)	2 (0.7%)
8.	81 (29.6%)	**134 (48.9%)**	45 (16.4%)	14 (5.1%)	0	0

9.	[A Lot more] 36 (13.1%)	**[A little more] 132 (48.2%)**	[the same] 87 (31.8%)	[A little less] 15 (5.5%)	[Much less] 3 (1.1%)	0
10.	**225 (82.1%)**	44 (16.1%)	5 (1.8%)	0	0	0
11.	**101 (36.9%)**	92 (33.6%)	59 (21.5%)	18 (6.6%)	4 (1.5%)	0
12.	19 (6.9%)	12 (4.4%)	42 (15.3%)	**126 (46.0%)**	75 (27.4%)	0
13.	23 (8.4%)	**95 (34.7%)**	90 (32.8%)	54 (19.7%)	12 (4.4%)	0
14.	96 (35.0%)	**152 (55.5%)**	23 (8.4%)	3 (1.1%)	0	0

Discussion of Results

For nearly every one of the fourteen survey questions, the students expressed an overall preference for the open- resource examination structure. Students felt it was a good measure of their understanding of the course material (94.6%) – yet the same could be said of most, well-written exams. 98% of students agreed that there was sufficient time to complete the exam – addressing one of the most common causes of exam anxiety. 77% of students took advantage of the opportunity to work in a collaborative environment and about 80% expressed that this environment created both an opportunity to help others and to be helped by fellow students. This finding may be the strongest, and most meaningful reason for administering an open-resource exam. There were differing opinions about whether the format encourages taking advantage of other students' learning. However, 46% disagreed with that fact. It should be noted, that over the four years of the survey, there was a declining trend in the number of students who agreed with this statement. This may be a result of the increased variability and rigor of the exam writing. In a related question though, 81.1% of students indicated that they leveraged the format to verify their own results.

Most students (78.5%) reported that they did spend sufficient time studying and preparing prior to taking the exam. The following questioned asked the students to compare the time it took to take the exam compared to a traditional exam. Only 6.6% students indicated that it took less time than normal, while 31.8% indicated that it was about the same amount of time. One of the objectives of creating the open resource exam was to increase the rigor – and the anticipated byproduct was a longer exam. Therefore, when 61.3% of students indicated that it took a little more, or a lot more time – those results were not surprising.

The last five questions inquired about exam-format preferences. An overwhelming 82.1% 'Strongly Agreed' to their preference for open-resources exams, accompanied by another 16.1% who Agreed. There were no disagreements. However, a similar question was asked in the same manner, "I prefer in-class, open note exams OVER the open- resource exam." In this case, there were 11.3% of students changed their answer. This may be the result of shifting the question from a positive to a negative to validate the original question. Regardless, there were still 73.4% who disagreed and still indicated the preference for open-resource exams. Another question was asked with a negative connotation instead of a positive one, "Traditional exams are NOT effective…" – to which students responded with a 70.5% disagreement. Another similar, but different question was asked in a positive way, "examinations are an effective way to measure a student's learning and intelligence on a given subject". The responses to this question were the most varied in distribution, with only 34.7% of students agreeing, and 32.8% at a neutral position. This speaks highly of the need to consider alternative methods of assessment. Finally, the question was asked whether the open-resource exam challenged the students to learn the material, to which 90.5% indicated their agreement. Only 3

students disagreed and none strongly disagreed.

A number of advantages became apparent after moving to an online application to administer the exam. First, the students received their grades immediately after submitting their exam. Specific analysis of which questions are correct or incorrect are not available until after the exam window is closed, however the total score is calculated and provided to the student. This feature can relieve anxiety for the student – and those that performed lower than anticipated were able to schedule time with the instructor to review those questions missed or misunderstood.

Similarly, with the immediate analytics, the instructor was able to focus the exam review on the questions which were more frequently missed – or where increased instruction was needed. During the post-review of the exam, the instructor displayed the descriptive statistical results of the exam as well as the low and high scores, the standard deviation, and most frequently missed questions. This feedback became helpful to students who were concerned about their ranking in the class, or their performance relative to other students. Most importantly, students were able to ask specific questions so that they could improve their performance for the subsequent final exam.

Additional benefits for the students included, better use of class instruction time, schedule flexibility for the students to take the exam, and the promotion of student-to-student learning. With shifting the exam time to out-of-class, the instructor gained a full lecture – allowing greater review of the material, more meaningful contextualization, and even additional content. Typically, the additional time was spent providing new examples for the same principles – thus allowing the students to consider the question conditions in a new light, or from a different perspective. It also allowed those students additional time to form and ask specific questions. With a greater window of time for the exam, the scheduling of the exam fell on the student according to their preferences.

One unforeseen benefit that was discovered after several iterations of the open-resource exam was that students were able to prove their own interpretation of tools, notes, and applications. Much of the in-class instruction for this course was accompanied with the use of spreadsheet software. Within the lecture time, students were challenged to create their own spreadsheets, program calculations, and determine results of increasingly complex problems.

Because of this complexity, some students fall behind and get frustrated with needing to both learn the course material and develop the use of the spreadsheet tool. The collaborative nature of the open-resource exam allows students to verify their results with their peers. This peer-to-peer verification helps timid students who are not comfortable speaking up in a large classroom but do well with small-group work. One student described their experience while taking the exam. The student would perform their problem, while their peer did the same. Once the problem was solved, each other would solve their peer's problems using their own spreadsheet. If the same answer was achieved, they would validate their own spreadsheet. If the result of the question varied, then a follow-up discussion would ensue to determine where the error was made. Thus, the exam became a teaching and learning tool as well as an assessment tool.

Limitations

While examining the results of the mid-term from year to year, an initial decline was observed. However, this seemed to be more closely related to the development of the exam questions rather than

the students' performance. With each semester, there was a necessary review of the validity of exam questions. The statistics included in the online application facilitated an evaluation of each question in the test and thus a re-write or removal of poorly written questions. There was also observed in the Spring of 2020 a decline in the exam results. This may have been a result of the Covid-19 induced environment in education. All students were entirely online during this semester, and observed participation and engagement were low. One student opened the exam but did not complete the exam, and the score of 0% was recorded. This score certainly lowered the class average in this semester. In this same semester, a score of 98.7% was earned on the same exam.

This study used an online survey instrument, and as such is limited to the students enrolled in the class and further limited to the students who chose to participate. With a response rate of 84.8% to the survey, the research must acknowledge the 15.2% of students who did not participate and could have held differing opinions from the results – and thus influenced the results had they participated. Another limitation is the application of the open-resource examination. In this study, the exam was used in a construction finance course – which lends itself to the ability to create such an examination with sufficient variability in the questions. Those considering an open-resource examination should carefully deliberate the appropriateness of this style of exam with the subject matter of the course. The authors make no statistical claim that this style of examination is better, same, or worse than other options – only that it was effective in this setting over the four-year period studied.

Conclusions

The open-resource examination was explored over a 5-year period, and the students in the most recent 4-year period were surveyed regarding their experience with the exam format. Some very positive results were found throughout the process of designing, administrating, and evaluating the value of this alternative assessment method. This exam format presents a number of advantages for both the student and the instructor – many of which have been discussed. With the increasing number of documented students with disabilities related to exam anxiety – the open- resource examination provides a valuable pressure release for the student. For those students with undocumented exam anxiety – this approach allows the instructor to facilitate a fair and inclusive learning environment. The refinement of the exam in each iteration increases the rigor and variability of the exam. There still exists an opportunity for students to take advantage of other students' knowledge and learning without needing to make an effort for themselves to learn the content. Thus, the exam must continue to be improved. At the same time, many of those students who do not perform well in traditional classroom-lecture settings found that they gained sufficient knowledge and understanding of the material *during* the examination. This fact in itself may warrant the use of this assessment approach. Regardless, the conclusion of this study is that there are sufficient benefits for the student and the instructor to justify continued use and improvement of the open-resource exam method.

References

Allen, T. (2000). Creating community in your classroom. *Education Digest*, 65, 23–25.

Cassady, J. C., & Johnson, R. E. (2002). Cognitive test anxiety and academic performance. *Contemporary educational psychology*, 27(2), 270-295.

Deneen, C. (2020). *Assessment considerations in moving from closed-book to open-book exams. Teaching and Learning Short Guides*. Retrieved from December, 15, 2022, from https://melbourne-

cshe.unimelb.edu.au/_data/assets/pdf_file/0010/3341944/closed-book-to-open-book-exam_final.pdf
Feldhusen, J. F. (1961). An evaluation of college students' reactions to open book examinations. *Educational and Psychological Measurement*, 21(3), 637-646.
Green, S. G., Ferrante, C. J., & Heppard, K. A. (2016). Using Open-Book Exams to Enhance Student Learning, Performance, and Motivation. *Journal of Effective Teaching*, 16(1), 19-35.
Kang, H., & Furtak, E. M. (2021). Learning theory, classroom assessment, and equity. *Educational Measurement: Issues and Practice*, 40(3), 73-82.
MacLeod, J., Yang, H. H., Zhu, S., & Shi, Y. (2018). Technological factors and student-to-student connected classroom climate in cloud classrooms. *Journal of Educational Computing Research*, 56(6), 826‑847. https ://doi.org/10.1177/07356 33117 73399 9.
Mealey, D. L., & Host, T. R. (1992). Coping with test anxiety. *College Teaching*, 40(4), 147-150.
Moore, R., & Jensen, P. A. (2007). Do open-book exams impede long-term learning in introductory biology courses?. *Journal of College Science Teaching*, 36(7), 46.
National Research Council. (2001). *Knowing What Students Know: The Science and Design of Educational Assessment*. Washington, DC: The National Academies Press. https://doi.org/10.17226/10019.
Rovai, A. P. (2000). Online and traditional assessments: what is the difference?. *The Internet and higher education*, 3(3), 141-151.
Rugutt, J., & Chemosit, C. C. (2009). What motivates students to learn? Contribution of student-to-student relations, student-faculty interaction and critical thinking skills. *Educational Research Quarterly*, 32(3), 16.
Theophilides, C. & Koutselini, M. (2000). Study Behavior in the Closed-Book and the Open-Book Examination: A Comparative Analysis. *Educational Research and Evaluation: An International Journal on Theory and Practice*, 379–393, at p. 379.
Trifoni, A., & Shahini, M. (2011). How does exam anxiety affect the performance of university students?.
Mediterranean journal of social sciences, 2(2), 93-93.
Williams, J. B., & Wong, A. (2009). The efficacy of final examinations: A comparative study of closed-book, invigilated exams and open-book, open-web exams. *British Journal of Educational Technology*, *40*(2), 227-236.