Practice Article

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Designing an Online Collaborative Exam: Infusing Opportunities for Regulation of Collaboration

Mariel Miller
University of Victoria

Safoura Askari
University of Victoria

Correspondence:
Mariel Miller
University of Victoria
fgage [at] uvic.ca

Abstract

The ability to collaborate online is an essential skill that allows learners to bring together diverse perspectives to deepen understanding regardless of physical location. As online learning and hybrid workplaces have become more prevalent since the COVID-19 global pandemic, the critical nature of this skill has become particularly relevant for post-secondary graduates. While exams are traditionally viewed as solitary endeavors, collaborative exams offer invaluable opportunities for learners to develop these skills. However, this form of collaborative assessment can be challenging for both learners and educators, and few studies offer guidance for the effective design of collaborative exams. As such, in this paper, we report on the design and implementation of a synchronous collaborative midterm exam in a large first-year undergraduate course. Specifically, we describe how we drew on a theoretical framework of self- and socially shared regulation of learning to design a three-phase exam fostering learners' engagement in key processes of planning, strategic enactment, and reflection on collaboration processes and products. Finally, we discuss key considerations that arose during the design and implementation of the exam, including ensuring an emphasis on process and authenticity, ethical use of video, and equity of access.

Keywords: collaborative testing; collaborative exams; online assessment; computer-supported collaborative learning; online collaboration; self-regulated learning; socially shared regulation of learning

Introduction

Written examinations are one of the most common forms of post-secondary assessment. While exams have traditionally been considered a solitary endeavor, collaborative testing that engages students in a shared assessment experience is becoming an increasingly common approach (Bloom, 2009; Sandhal, 2010). The shift from individual to collaborative testing places peer interaction at the center of assessment, emphasizing collective learning and allowing learners to bring together diverse perspectives to deepen understanding. The emergent research indicates collaborative exams offer numerous benefits, including enhanced learning outcomes and diminished anxiety (Cortright et al., 2003; Eaton, 2009; Mahoney & Harris-Reeves, 2019; Rao et al., 2002). Furthermore, as online collaboration is becoming ubiquitous in learning and professional contexts, this form of assessment fosters critical digital skills for graduates (Rennstich, 2019). However, simply providing opportunities for online collaboration does not guarantee that high-quality collaboration will occur. Collaboration, particularly in online environments, is fraught with challenges (Bakhtiar et al., 2018; Miller & Hadwin, in press; Paterson & Prideaux, 2020). Contemporary perspectives suggest that high-quality collaboration requires groups to regulate their learning at both the individual and group levels (Hadwin et al., 2017). Despite the growing interest in online collaborative exams, little guidance in the literature exists regarding how collaborative assessments can be purposefully designed and implemented to support collaborative learning and the development of competencies for managing collaborative work.

In this conceptual paper, we describe how we drew on theories of self and social regulation of learning to create an online collaborative midterm for a large first-year undergraduate course. First, we describe how this exam unfolded in three phases: (a) a preparation phase where learners familiarized themselves with exam requirements and completed a practice mock exam, (b) a performance phase in which groups worked together to analyze a complex case scenario in an 80-minute synchronous online session, and (c) a reflection phase in which learners were guided in reflecting on their collaboration and adapting for the future. Next, we reflect on key considerations that arose during the design and implementation of the collaborative exam.

Review of the Literature: Collaborative Testing

Online collaborative testing is an approach to assessment that emphasizes students working together on an exam or assessment in a technology-mediated context (Levine et al., 2018; Rao et al., 2002). Testing is often traditionally viewed as a method for assessing individual learning. However, when approached collaboratively, testing can be transformed into a social activity, integrating the benefits of assessment and collaborative learning.

Collaborative testing has been employed in a wide range of disciplines, from statistics (Eastridge & Benson, 2019), computer science (Cao & Porter, 2017), theatre (Bloom, 2009), and psychology (Pandey & Kapitanoff, 2011). Moreover, there is significant variation in how these assessments have been conceptualized and designed. In some cases, students are asked to work together but submit only individual responses, while in other cases, learners submit only a joint product for the group (e.g., Bruno et al. 2017; Helmericks, 1993). Often, collaborative testing includes both individual- and group-level products (e.g., Garaschuk & Cytrynbaum, 2018; Kapitanoff, 2009). For example, Kinnear (2021) described a two-stage exam

in which students complete the exam individually and then form groups to take the exam as a group, with grades based on a weighted combination of the two stages.

Across these variations, a key characteristic of collaborative testing is the focus on the co-construction of knowledge through social interactions (Dillenbourg, 1999). In this way, the purpose of the exam shifts from a sole focus on the assessment of an individual's learning toward "assessment for learning" or "assessment as learning" (Cooper & Cowie, 2010; Roediger & Karpicke, 2006). The exam itself serves as a learning experience and creates a context for learners to jointly engage in reciprocal interaction to construct and maintain a shared understanding of a problem (Barron, 2003; Eastwood et al., 2020; Rochelle & Teasley, 1995).

Benefits and Challenges of Collaborative Testing

A wealth of research indicates that collaboration supports knowledge gain and deep learning, characterized by a proactive, reflective, and analytical approach to learning with intent to achieve meaningful understanding (Chen et al., 2018; Han & Ellis, 2021). Similarly, emerging research indicates that this collaborative testing has multiple benefits for learners. Specifically, collaborative testing has been linked to increased learning, critical thinking, creativity, and performance across a range of disciplines (Cortright et al., 2003; Eaton, 2009; Rao et al., 2002). For example, using a quasi-experimental crossover design, Gilley and Clarkston (2014) compared the effectiveness of collaborative testing and individual testing on student learning in an undergraduate Earth and ocean science course. Findings indicated that students in the collaborative test condition achieved greater learning gains. Specifically, when provided with a surprise individual follow-up test, students in the group condition demonstrated greater individual performance improvement and knowledge retention. Similarly, Mahoney and Harris-Reeves (2019) explored the impact of collaborative testing on overall performance and performance on higher-order thinking questions. Comparison of normalized change scores between the individual and collaborative testing conditions indicated that students who worked collaboratively performed better on higher-order thinking questions regardless of academic ability. As such, collaborative testing appears to offer clear benefits, particularly when assessment tasks are complex.

Previous research has also indicated that collaborative testing is perceived as beneficial by learners (Kapitanoff, 2009). For instance, in an examination of two classroom studies, LoGiudice et al. (2023) reported that students had mostly positive perspectives of collaborative testing. In another study, Zimbardo et al. (2003) found that students who participated in collaborative testing reported reduced test anxiety, increased confidence, and increased course enjoyment.

Finally, online collaborative exams also provide critical learning experiences for postsecondary learners. Online and hybrid learning and work have surged as a consequence of the global COVID-19 pandemic (Cortázar et al., 2022; Dhawan, 2020). Digital skills, including those for online collaboration, have become crucial for participation in society, including lifelong learning and in the workplace (Organization for Economic Co-operation and Development, 2019; Rennstich, 2019). Furthermore, in today's global landscape in which multiple, interconnected crises are impacting the world simultaneously (Homer-Dixon et al., 2021), there is an urgent need to develop and adopt innovative pedagogical approaches that equip post-secondary graduates with the ability to think critically, collaborate effectively, and engage in complex

problem-solving. Consequently, undergraduate students' experiences with online collaboration, such as with online collaborative exams, provide invaluable opportunities not only to foster high-quality learning but also to support the development of essential competencies.

Despite these potential benefits, collaborative tests can pose difficulties for both learners and instructors. It is well-established that online collaboration can be challenging, and learners often require support to collaborate effectively (Hadwin et al., 2018; Järvelä et al., 2016; Miller & Hadwin, 2015). While few studies have examined challenges in collaborative testing, the existing research indicates that students may initially find working with others to be difficult (Dobie & MacArthur, 2022; Le et al., 2017). For example, when collaborating online, students may report difficulties related to poor communication, participation, group cohesiveness, and productivity that can interfere with learning (Fjermestad 2004; Straus 1997; Strijbos et al., 2004). Moreover, learners may encounter socioemotional challenges related to teamwork and communication, metacognitive challenges related to planning and monitoring shared progress, and motivation (Bakhtiar et al., 2018; Koivuniemi et al., 2018). When these challenges are ignored, students' collaborative work may be affected in several ways, such as unequal participation, lower engagement, and lower overall satisfaction (Koivuniemi et al., 2018). Without support, it is possible that learners will not experience the benefits of collaborative learning or experience gains that are less or more short-lived than expected.

Theoretical Framework: Self- and Socially Shared Regulation

In our research, we have emphasized the need to design collaborative tasks and environments in ways that purposefully and directly support collaboration (Järvelä et al., 2018; Miller & Hadwin, in press). As such, to guide our implementation of the exam, we adopted a framework of self- and socially-shared regulation of learning (SSRL).

Over two decades of research have linked self-regulatory processes to enhanced learning and performance (Dignath & Büttner, 2008). When learners engage in SRL, they systematically and actively manage their cognition, motivation, emotion, and behavior in a given task to achieve their personal goals (Winne & Hadwin, 1998; Zimmerman, 1989). As such, effective collaboration requires learners to self-regulate over four phases (Hadwin et al., 2011; 2017). During Phase 1 (task perceptions), learners construct a personal interpretation of the collaborative task. In Phase 2 (goal setting and planning), learners set goals and make plans for collaborative work. In Phase 3 (task enactment), learners strategically approach the collaborative task. Finally, in Phase 4, learners make changes when needed to improve learning within current or future collaborative tasks.

It has increasingly been acknowledged that regulation is a social and contextualized process (e.g., De Backer et al., 2022; Lobczowski et al., 2021). From our perspective, high-quality collaboration also requires groups to regulate collectively as a group (socially shared regulation) by engaging in deliberate and transitive planning, task enactment, reflection, and adaptation (Hadwin et al., 2011; 2017). Socially shared regulation of collaboration (SSRL) unfolds over four phases. During Phase 1 (shared task perceptions), groups negotiate a shared interpretation of the collaborative task. In Phase 2 (shared goal setting and planning), groups collectively define shared goals, standards, and plans. In Phase 3 (shared task enactment), groups coordinate their strategic task engagement. Based on the group's collective monitoring of their learning

progress and products, in Phase 4, groups make changes in the current and/or future tasks as needed to enhance their learning and overcome difficulties.

Creating the Collaborative Exam

In designing the collaborative exam, we drew on previous collaborative testing research and the above theoretical framework for the regulation of collaboration with the goal of providing opportunities for groups to (a) interact and co-construct knowledge about course concepts and (b) actively engage in and develop skills and competencies for regulating collaboration. In this section, we will provide a high-level overview of the instructional context and the exam, followed by a detailed account of each phase of the exam.

Overview of the Context and Exam

This collaborative midterm exam took place in a first-year undergraduate educational psychology course at a university in Western Canada. There were 150 students registered and the course focused on learning to learn in postsecondary education. By participating in the course, students learn skills and strategies for self-regulated learning, including planning, setting goals, choosing strategies, monitoring progress, and evaluating their postsecondary learning and performance. The course had a weekly asynchronous module in which students learned key concepts and a weekly laboratory component in which students met either synchronously online or in person and practiced applying concepts to their learning in other courses.

In this course, the exam took place online during an 80-minute class and covered topics during the first five weeks of the course. The collaborative exam had the dual purpose of (a) promoting and evaluating learners' cumulative understanding and application of course concepts in the first half of the course, and (b) supporting learners in developing competencies for online collaboration and teamwork. Specifically, the exam required groups to analyze a case scenario depicting a study issue experienced by a first-year student and respond to a series of four pairs of questions. Groups submitted a single copy of the exam for the group. Finally, this exam was an open book, meaning that learners could refer to class notes and materials while completing the exam.

Learners were assigned to groups of 4–6 students by the instructional team. In our creation of group composition, we attempted to create heterogeneous groups in terms of gender, language, and course performance to date. While there are multiple ways to assign student groups, this approach was informed by previous research indicating heterogeneous group composition, in terms of factors like ability and background, can promote diversity of perspective and enhance collaborative learning outcomes (Johnson et al., 2007; Nokes-Malach, et al., 2015; Webb & Palinscar, 1996). Furthermore, while small groups of approximately four members are often best for promoting meaningful interaction and enabling learners to participate actively and equally (Johnson et al., 2007), student absences resulted in a small number of five or six member groups.

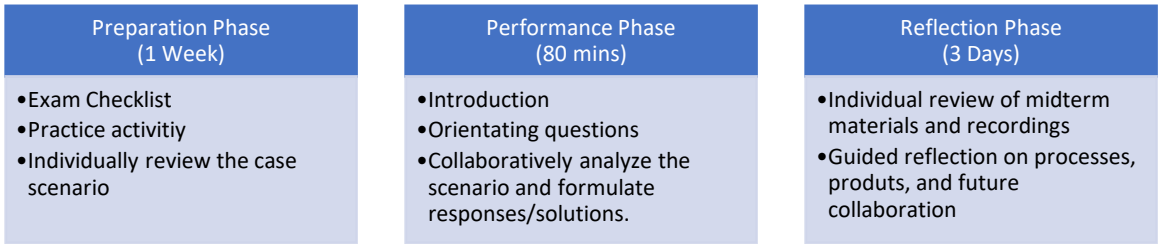
Designing a Three Phase Exam

To support learners in fully benefitting from this exam, we drew on theories of self-regulation and shared regulation of learning to purposefully design a collaborative exam to unfold over three phases (Figure 1). These phases aimed to support learners to regulate their learning both individually and together (Hadwin et al., 2017; Miller & Hadwin, 2015). In the *preparation phase*,

students were supported in developing a deep personal understanding of what the exam entailed. During the *performance phase*, groups met online to complete the exam itself. Finally, in the *reflection phase*, students were guided to critically reflect on how the exam went, what challenges they encountered, and how they might address these going forward

Figure 1

Overview of the Three-Phase Collaborative Exam



Preparation Phase

Planning, including constructing a personal interpretation of the assigned task, is critical to regulating learning and collaboration (Lee et al., 2015; Malmberg et al., 2017). When learners understand what is needed in an assessment, they can prepare and approach the task effectively. This is particularly important in the context of collaborative testing as learners may arrive at the exam with different understandings of what is required or how to go about the exam. When planning is inadequate, collaborative groups can encounter challenges with task execution, monitoring their progress, and working together (Hadwin et al., 2017). As learners may skip over these processes (Rogat & Linnenbrink, 2011), incorporating planning or preparation activities into tasks can support learners to fully understand the task requirements, expectations, and demands. As such, we included a preparation phase that occurred one week before the collaborative exam with the aim of helping learners develop a complete understanding of what was required by the task and ensure they were adequately prepared. This phase consisted of two major activities.

First, learners were asked to complete an *Exam Checklist* prompting learners to review the exam requirements and confirm that they had the basics required to participate. Items included links to the exam description and syllabus, links to study resources (e.g., how to prepare for an open book exam), a list of technology required (e.g., a computer or laptop, a stable internet connection with sufficient bandwidth for videoconferencing, and a webcam and mic to participate with the group), items regarding location (e.g., a quiet, private space in which to write the exam), and considerations for protecting privacy (e.g., using a virtual background, preparing the environment). This checklist prompted learners to explore and familiarize themselves with the basic task instructions and requirements. Learners were also asked to contact the instructor if they had concerns about their ability to meet these requirements for the exam so that alternative arrangements could be made.

Second, learners participated in a *Practice Activity* that simulated the exam to support them in developing more in-depth expectations for the exam. This ungraded activity took place the week before the exam during class time. In this activity, learners were tasked with analyzing a short scenario depicting student encountering a common time management issue, which was the

topic of focus for the week. Working in small groups, learners were asked to apply course concepts to identify the problem and identify an appropriate time management strategy.

The format of this preparation activity was identical to that of the upcoming online exam. However, the practice task focused exclusively on that week's topic rather than the full range of concepts covered on the exam. As such, this activity simulated the exam experience for learners with the goal of helping them more deeply consider what was required, their personal strengths related to the task, and areas where further preparation might be required. Furthermore, it allowed learners to try out the technology and meet their groups. At the conclusion of the practice activity, learners were reminded to review the exam instructions and materials, including the exam scenario available in advance.

Overall, these preparation activities aimed to support learners in considering both basic task instructions and deeper expectations of the task that lay the groundwork for learners' goals and strategic engagement (Lee et al., 2015; Malmberg et al., 2017). Furthermore, they provided timely opportunities for learners to identify needs and overcome challenges prior to the exam, including technology barriers. As such, we expected that the preparation phase would support learners in arriving at the collaborative exam more ready to productively engage with their groups.

Performance Phase

When learners collaborate effectively, they actively manage their thinking, behaviours, motivation, and emotion in the task both individually and together (Hadwin et al., 2017). For example, groups draw on individual and shared plans to coordinate their strategic task engagement in novel collaborative tasks. When challenges arise, group members engage in active participation to coordinate their activities and resolve difficulties (Isohätälä et al., 2017). While joint regulation of strategic enactment of collaboration is critical to gleaning the benefits of working together, it may not always occur without support.

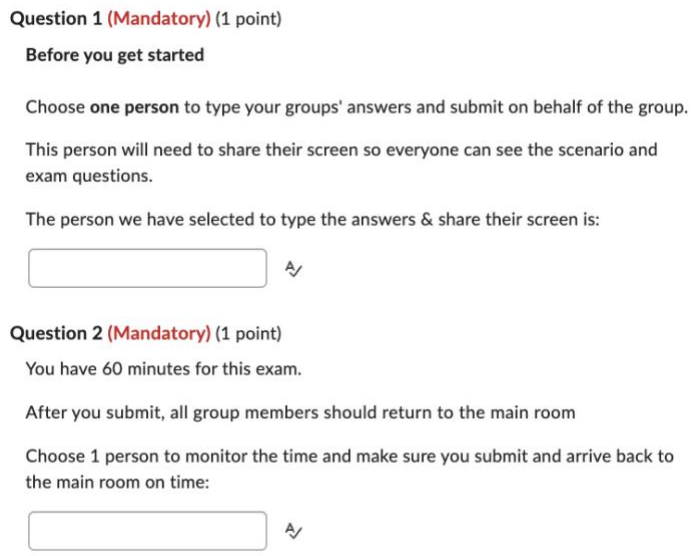
While research is emergent, a high level of joint participation in social interactions (Vuorenmaa et al., 2022) as well as questions prompts directly supporting regulatory processes appear to be a key contributor to the regulation of collaboration in group settings (Miller & Hadwin, 2015). For example, Michalsky and Cohen (2021) compared three types of learner support in a problem-based learning STEM task, including question prompts designed to promote SSRL processes, including task performance, creative thinking, or both. Findings indicated that groups receiving SSRL support demonstrated increased participation in regulatory processes compared to groups receiving no support or other forms of support. The authors interpreted these results as further evidence that SSRL-directed question prompts can enhance student engagement in problem-solving.

As such, we structured the performance phase of the task in ways that not only allowed for collaborative co-construction of exam responses but also emphasized joint engagement and prompted shared regulation of the collaborative task. Specifically, the performance phase of the collaborative exam occurred via videoconferencing session in one 80-minute lab class. The class began with an *introduction* where the course instructor supported group members to be aligned in terms of their expectations and goals by reviewing the information covered in the preparation phase. For example, the instructor reminded learners about the length of the exam,

the open-book nature of the exam, and how to access help if needed. We also provided a brief review of technology requirements, including how to open the exam materials and share screens. Students were also reminded that their group meeting would be recorded for their personal review during their individual exam reflection later during the week, but that the instructional team would not be using recordings for invigilation or surveillance purposes.

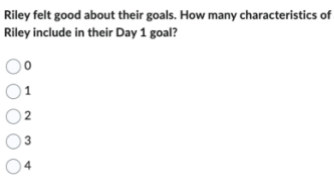
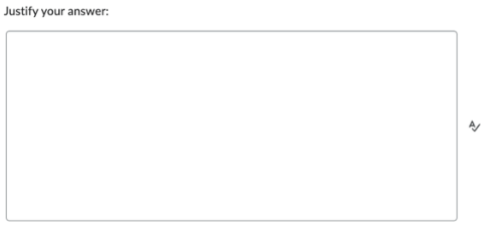
The group members then entered their respective online videoconferencing rooms to begin the exam through the university's learning management system. The first three exam items were a series of ungraded *orienting questions* (Figure 2). Orienting items asked learners to record the names of all group members attending the exam, select one person to monitor time during the exam and choose another to record answers on behalf of the group. This person was also asked to share their screen so others in the group could view responses as they were being recorded. Although these questions were ungraded, they served the important function of prompting groups to discuss how to best approach the task.

Figure 2
Ungraded Orienting Questions



Once these orienting questions were complete, the students reviewed a short case scenario depicting a student encountering a studying challenge. While students had received access to the scenario ahead of time as part of the exam instructions and materials, the scenario was also embedded directly within the exam for ease of reference. Groups then responded to four graded pairs of questions. The first question in each pair was a multiple-choice question targeting a central key course concept from the prior weeks. The second question in each pair was an open-ended item asking groups to justify their response using course concepts. An example item is provided in Table 1. The instructional team circulated through exam rooms throughout the exam to answer questions or address issues as needed. After completing the questions, one member of the group submitted a single copy of the responses on behalf of the group and the students returned to the main room.

Table 1
Example Question Pairs in the Collaborative Midterm Exam

Item Pair	Exam Question 1	Exam Question 2
Item Focus	Multiple choice question testing knowledge of course concepts	Open format item asking groups to justify response to Part 1 question
Example Item		
Scoring	*1pt for correctly identifying the number of CAST characteristics in the Day 1 goal described in the scenario.*	*2 pts for justification for Part 1 response: (a) demonstrates knowledge of each CAST criteria with proper terminology, (b) correctly evaluates whether the goal displays each characteristic.*

While there is great variation in the format of collaborative testing in the literature, in this exam we aimed to (a) create opportunities for learners to work together on a joint problem solving task, including submission of one product for the group, and (b) embed direct prompts for group discussion and coordination within in the exam. In doing so, we aimed to support groups to effectively engage in jointly coordinating their strategic task engagement.

Reflection Phase

A hallmark of successful collaboration is the ability to monitor collaborative progress and products and make changes as needed to enhance learning and overcome difficulties (Hadwin et al., 2017; Janssen et al., 2009). When learners engage in self-monitoring after a task, such as an exam, it allows them to assess their progress and products relative to expectations and their own personal goals and make changes necessary in the future (LaCaille et al., 2019; Winne & Hadwin, 1998). As such, in the week following the exam, students had the opportunity to individually revisit, review, and reflect on how things went on this exam.

In the week following the collaborative component of the exam, the learners were asked to individually review their collaborative work and reflect on their collaborative products and processes. A private recording of the collaborative session was made available to each learner to stimulate recall. Video feedback and video self-assessment are commonly used techniques for developing skills such as communication (Dohms et al., 2020; Mort & Hansen, 2010). In this case, reviewing the video allowed learners to review the task closely and evaluate the quality of collaborative processes and products without having to depend solely on potentially faulty recollections of these processes.

In this review, learners were guided to reflect on their preparation for the task, their satisfaction with the product, and the challenges they encountered. Specifically, learners were asked to identify a critical moment during collaboration where they experienced a significant challenge that affected their group. Learners were then encouraged to consider what contributed to the

challenge, what strategies they used to overcome it, and what they might do differently to avoid this difficulty in the future. Reflections were scored on the basis of completeness and depth of reflection. For example, exceptional reflections included thoughtful analysis of both individual and group engagement during the collaborative exam, with specific examples provided to back up claims and insights for future collaboration. On the other hand, low-scoring reflections were more superficial, evidencing limited analysis of individual and group engagement, few specific examples to back up claims, and few insights for future collaboration. While it is common for collaborative testing to include an individual component, our approach differed in that the focus was on the quality of teamwork and collaboration. By guiding learners to engage in metacognitive monitoring and evaluation of their individual and group processes during the collaborative test, this phase of the exam aimed to directly support learners in developing critical competencies for online collaboration.

Discussion

In the following section, we reflect on key considerations that arose during the design and implementation of the collaborative exam, including the emphasis on process and authentic contexts, ethical considerations around the use of video, and choices to incorporate flexible access to the exam. These considerations were based on the reflections and notes made by the authors, as the instructional team, during and after the design and implementation of the exam.

Emphasis on Authenticity and Process

Although collaborative testing varies widely in type and format, we placed an emphasis on authenticity and processes in this exam. Examinations in large undergraduate courses can often lack the richness of more authentic approaches to assessment that not only evaluate students' disciplinary knowledge but also their ability to apply this knowledge in meaningful ways (Biggs & Tang, 2011). However, we aimed to incorporate a degree of authenticity into the exam by grounding all questions in a realistic case scenario based on students' own accounts of common studying challenges. Furthermore, while individual exam grades are often of central concern to students, we emphasized to students that this exam provided an opportunity to develop competencies for collaborating with others identifying current strengths and considering areas for improvement. For example, each question prompted groups to pool ideas to explain and justify their answers and a portion of the exam grade (5%) was dedicated to the post-exam reflection.

We hoped this approach would support learners by promoting more meaningful discussion and a deeper understanding of the course concepts as well as the development of collaboration skills. However, one limitation was that our emphasis on group processes and products may have been more vulnerable to phenomena such as social loafing and free riding in which group members contribute inequitably to the collaborative product (Cooper, 2017; Hall & Buzwell, 2012; Moore, 2010).

To mitigate this issue, we put several safeguards in place to boost individual accountability for the exam. For example, as the concept of a collaborative exam was relatively novel to students, we found the preparation phase to be critical in helping learners to understand they were expected to actively participate and demonstrate personal responsibility during the task. Furthermore, during the exam, teaching assistants rotated through the online rooms, periodically checking on groups and their progress. In doing so, teaching assistants were able to

lend assistance for circumstances that may have hindered participation. Finally, learners were aware that after the exam, they would be asked to (a) reflect on their personal preparation and contributions to the group, and (b) identify other group members who played a particularly important role in the task. However, it is important to note the primary goal of our collaborative exam was not summative individual assessment, but rather opportunities for joint knowledge construction and formative feedback (Cooper & Cowie, 2010; Roediger & Karpicke, 2006).

Role of Recording in Collaborative Testing

Another consideration for the instructional team was the value of recording the collaborative exam. Video feedback has been demonstrated to support the development of complex skills such as communication and teamwork (Lavric, 2024). For example, presenting a video recording to a learner upon task completion can better support learners' review of complex processes at their own pace. Furthermore, video observation allows learners to reflect on their processes without depending entirely on memory, which can be unreliable and misaligned with the event (Bannert et al., 2014). As such, presenting learners with a recording of their collaboration served as a key strategy to support learners' self-reflection on collaboration in Phase 3 of the exam. Through engaging with the recording and the guided reflection, we expected learners would construct invaluable metacognitive knowledge about working collaboratively online.

However, video recording is not appropriate or useful in all instructional contexts (Edwards & Clinton, 2018). There are important drawbacks to recording that needed be carefully considered when taking this approach ethically. First, recording can pose privacy concerns for learners. It may also inhibit participation, particularly for historically marginalized participants or those who feel hesitant to participate. As such, we took deliberate steps to mitigate these issues. For example, in the preparation phase, information about the recordings was available directly in the exam instructions, with particular emphasis on the purpose of the recording as being for learners' own personal review and <u>not</u> for instructor surveillance of the examination.

Furthermore, care was taken to inform students that recordings were stored on the university's video platform, which had undergone appropriate privacy and security reviews. Students were also provided with tips for safeguarding their privacy (e.g., blurring their backgrounds). Space to join on campus was also made available for students in acknowledgment that not all students have a fully private space to join. Finally, in the preparation phase, learners were invited to discuss any concerns with the instructor so that alternative arrangements could be made if necessary. Learners were reminded at the outset of the exam that access to the exam materials and recording was limited only to students who attended their group meetings (view-only) and that it was not permitted to share information about the exam beyond the group.

Overall, when making decisions about whether to include a recording of the collaborative exam in our design, we required there to be a strong pedagogical justification within the course context (e.g., to support reflection critical for developing knowledge and skills for regulating online collaborative learning). In addition, we incorporated careful measures into each phase of the exam to address potential drawbacks, including impact on discussion, availability of equipment, and concerns regarding privacy.

Equity in Online Assessment

Online delivery of learning, including collaborative learning, can afford learners with greater flexibility, convenience, and access than solely in-person delivery (Goodman et al., 2019; Xu & Xu, 2019). However, students can encounter challenges with online learning, including lack of access or skills for required technology, and difficulties self-regulating learning and connecting effectively with peers (Kofoed et al., 2021). As such, consideration of students' diverse backgrounds, abilities, and access to resources was critical for our design. Specifically, in each phase of the exam, we strived to minimize barriers and support a more equitable assessment experience.

First, in acknowledgment that technology is a key contributor to the digital divide, we ensured that the technical requirements of the exam did not exceed the technology required to participate in the online course. These requirements were communicated in the course syllabus and the exam instructions and included a computer or laptop to access the exam materials, a stable internet connection with sufficient bandwidth for videoconferencing, a webcam and mic to participate with the group, and a private and quiet space to attend. Furthermore, we selected technology that was available to all learners at the university, supported by resources at the university, and compliant with web accessibility standards.

Second, the concept of a collaborative exam was novel to many students. Therefore, we aimed to help students build awareness of the exam components and their needs for succeeding in this exam in advance. The Phase 1 practice exam was especially powerful in this respect because it allowed learners to "try out" and experience the exam format and identify potential barriers. After the practice exam, we encouraged students to contact the instructor with any questions, including concerns regarding their ability to fully participate in the exam, academic accommodations, or technical difficulties.

Third, we strived to create opportunities for flexibility in Phase 2 of the exam. For example, we provided students with a choice of location for writing the exam. Students could write the exam at home, in a computer lab on campus with a member of the instruction team present, or in "Tech Booths" on campus. Tech Booths were private, enclosed booths reservable by students for attending online classes equipped with wireless Internet and an ergonomic work surface. We found these on-campus options important, as some students reported having unpredictable access to quiet areas, and others had in-person classes scheduled before or after the exam.

Overall, with this combination of approaches, we were able to take proactive steps to support an equitable exam experience and work with students' concerns related to participation in advance of the exam. An important constraint is that the approaches above partially reflect the context and composition of the course and may not be equally applicable to other contexts.

Conclusions

In this article, we described an approach to online collaborative testing anchored in theories of self- and socially shared regulation of learning. The structured three-phase approach to the online exam (e.g., preparation, performance, and reflection) was designed to support learners in managing their collaborative efforts, leveraging their diverse perspectives and knowledge to address the provided case scenario. As effective collaboration does not happen automatically,

we hoped the three-phase approach would support learners in engaging in key regulatory processes for the task and develop competencies for regulation collaboration going forward (e.g., Hadwin et al., 2017). Furthermore, while our theoretical framework provided an invaluable structure, we discussed key issues regarding equity, privacy, and authentic assessment that also need to be considered to support the learning experience.

While collaborative exams are not a new phenomenon, few studies provide a detailed account of how collaborative exams can be created and implemented to support students in this regard. As such, this paper extends prior research by providing a detailed description of how a collaborative exam can be designed that (a) creates a context for learners to co-construct knowledge through reciprocal interaction, and (b) provides support for the development of competencies for managing collaboration. These skills are critically important as the ability to engage in technology-mediated collaboration has become increasingly important in post-pandemic hybrid workplaces.

It is important to note, that while this article addressed the need to critically consider how collaborative testing can be designed to truly support learners, an important next step is to rigorously evaluate its impact. As such, future research is needed to examine diverse learners' perceptions of the collaborative exam and the influence of this format on short and longer-term learning. Ultimately, innovation in post-secondary online testing practices is critical because education continues to evolve in the face of technological change. While this article provides only one account, collaborative exams offer a powerful way to transform testing into a powerful opportunity to co-construct knowledge and skills. The lessons learned from this endeavor highlight the potential for future refinement of this approach in diverse educational settings and today's hybrid and online learning environments.

Author's Contributions

MM: Oversight and direction of the project, conceptualization of the article, and writing the manuscript.

SA: Contributed to the literature review, drafting of the initial literature review, and editing of the manuscript.

Open Researcher and Contributor Identifier (ORCID)

Mariel Miller https://orcid.org/0000-0002-1705-4350

Safoura Askari https://orcid.org/0009-0000-1979-2405

Ethics Statement

This paper reports on a practice innovation and does not report on research conducted with human subjects.

Conflict of Interest

The authors do not declare any conflict of interest.

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