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Article

Use of a One-Page Reference Guide in On-Campus Timed Exams: Reflections and Assessment of Its Impact on Students in a Post-Open-Book World

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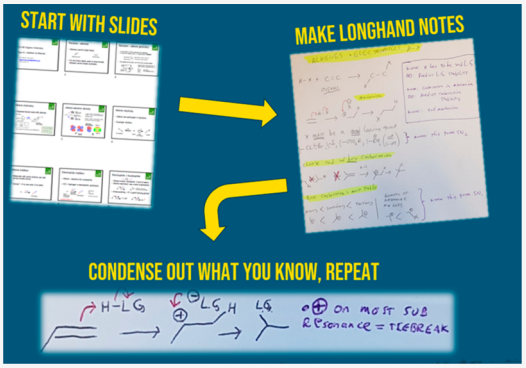
ABSTRACT: Like most higher education institutions in the U.K., the Department of Pure and Applied Chemistry at the University of Strathclyde and the Department of Chemistry at the University of Bath adopted online open-book assessment during the COVID-19 pandemic, before returning to on-campus hall-based exams several years later. Recognizing the potential for issues caused by a lack of student familiarity with closed-book exam techniques, we adopted a limited form of open-book support, inviting students to prepare a single page of notes to bring into each exam. The impact of this open-note support on student anxiety and preparation was investigated through a mixed-methods survey. We observed a marked reduction in reported anxiety, and students also reported widespread uptake of more effective study habits, using the freedom from memorization to prioritise higher-order cognitive tasks.



KEYWORDS: *Assessment, Study Skills, Anxiety, Exam Aids, Teaching and Learning Methods*

INTRODUCTION

A significant global challenge was faced by students and staff when the university education system was disrupted by the COVID-19 pandemic in March 2020.[1,2] The transition to remote learning impacted all aspects of the student experience, with loss of community, changes to assessment, and increased reliance on self-management.[3−7] Unsurprisingly, this led to increased anxiety and mental health issues in students globally.[8,9] A return to on-campus teaching was viewed as a straightforward solution to many of these issues, but when it arrived, that transition brought its own challenges, as well as opportunities to embrace the lessons learned and take best practice forward.[10−15]

There has been extensive prior research into the impact of open-book exams on student performance and anxiety,[16] including some that restricted the length or content of the notes that students had available. These are generally referred to as "open-note" exams. Most notably, Mathew studied the comparative impact of closed-book, open-book and open-note examination on psychology students, observing a decrease in student anxiety and uplift in grades for open formats, but no changes to long-term knowledge retention.[17] Mathew also observed no significant differences on any measure that compared full open-book and partial open-note exams, indicating that the broader body of literature on fully open-book exams may be generally applicable to open-note exams as well. Sato and Kanandale observed little to no impact on grades from open-book assessment in biology, despite students predicting otherwise.[18] Nadarajah observed an increase in grade and marked decrease in anxiety for open-book pharmacy exams.[19] Yuriev observed a marked student preference for formulary-allowed exams in pharmacy, along with similar academic performance even though the formulary-allowed exam content was shifted toward higher-order cognitive tasks.[20] Students explicitly recognized the benefits of moving away from memorization, reporting spending more time preparing for higher-order cognitive tasks, and Yuriev also observed similar effects in open-note assessment in chemistry.[21] Most recently, Gallardo-Williams reported on three comparative studies on student note generation as an inclusive practice, providing structured study and reducing the attainment gap for low-performing students even when notes were not allowed into exam halls themselves.[22]

Overall, prior work suggests that while open-note exams may or may not have a significant impact on attainment, they often incentivise changes in study habits toward higher-order cognitive practices and definitively reduce student anxiety.

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BACKGROUND, ONE-PAGE REFERENCE GUIDE (OPRG) DESIGN, AND STUDENT-FACING RESOURCES

Prior to 2020, students registered in chemistry programmes in the universities of Bath and Strathclyde were taught mostly face-to-face, on campus. In March 2020, on-campus activity ceased, and there was an immediate pivot to remote learning and assessment. Summative end-of-module exams were switched to a remote open-book format, with extended assessment duration and online submission. Although implementations varied a little (see Supporting Information for details), our institutional positions remained broadly unchanged until after a definitive end to U.K. public health restrictions.

Early in the summer of 2022, following institutional guidance, both of our departments returned to in-person teaching and on-campus summative assessment, beginning with the winter exam period in December 2022 (Strathclyde) or January 2023 (Bath). This immediately led to queries from students who were anxious about exams, since they had either never sat one at university, or had not done so for over two years. Both chemistry departments independently explored some form of open-book provision as a response, and to capitalize on effective open-book study habits developed during the previous years of remote teaching (as has continued to happen across the U.K. and beyond).[14,15]

Given that full open-book and partial open-note exams conferred many of the same benefits, particularly for anxiety reduction, the decision was made to allow students only a limited amount of notes.[17] This was partly seen as a pragmatic concession to obtain buy-in from staff, but also in response to a widespread observation that fully open-book exams tended to incentivise excessive note-reading and reduced consolidation and revision.

Our implementations had several common features: students would be allowed access to notes in all chemistry exams in both formal exam periods (winter and summer) for all students across all academic years, since all students had just experienced exclusively remote study. The student prepared notes would be limited to a single A4 ($8^{1/2}$ in. × 11 in.) page (single sided and handwritten at Strathclyde, and double-sided at Bath, with no restrictions on text). There were otherwise no restrictions on content, and OPRGs were not required to be submitted or scrutinized at any point. Although some prior literature implementations required submission of student-generated revision aids, we felt that such a requirement could induce anxiety, where students may assume the existence of additional hidden criteria for judging the content of the OPRG.

The preparation and use of notes in an exam were clearly addressed with students as a form of reference or revision, avoiding the loaded term "cheat sheet". It was collectively referred to as the One-Page Reference Guide (OPRG) in both departments. Staff were supported in how to write for, and invigilate, OPRG-supported exams, and students were kept fully informed from an early stage to address queries and pre-empt mounting anxiety. Therefore, exam guidance was set and communicated to students and staff before the start of each OPRG-supported exam period.

To prepare student-facing resources on the OPRG, existing literature and open-note exam guides were reviewed and used to write a "one-page guide to preparing a one-page reference guide", as well as an infographic and short presentation.[21−26] These resources were embedded into start of term inductions, and then publicised toward the end of term and the start of the exam period itself, to set student expectations (see Supporting Information for copies of these resources). Because the resources emphasized the **personal** creation of an OPRG, a wide range of styles were observed, with use of color, mind-maps, lists, and other common note-taking techniques (Figure 1).

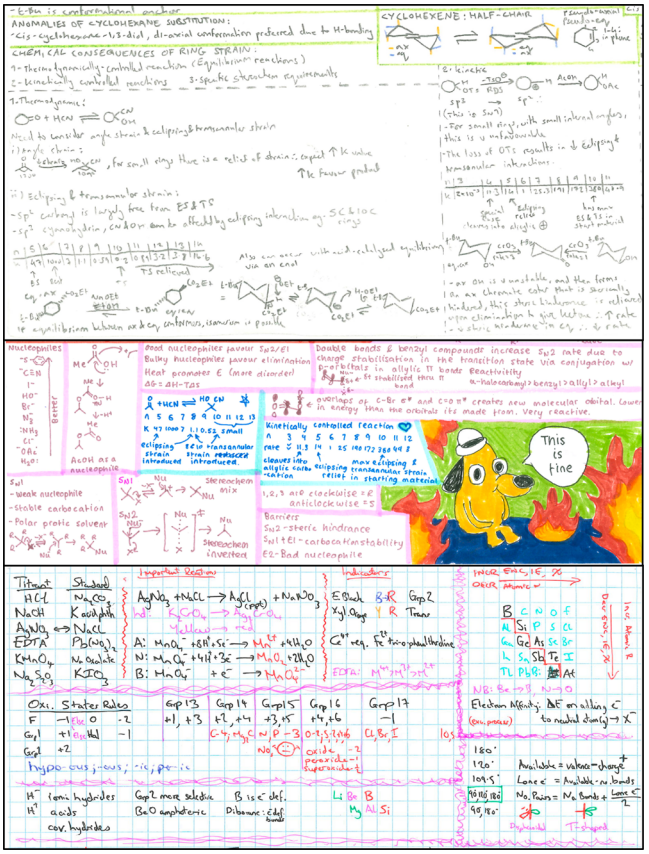

Figure 1. Representative samples of OPRGs prepared by students at two different academic levels, which also show some evidence of exam-induced anxiety.

The introduction of the OPRG was received very positively by students, exemplified by positive feedback at student-staff liaison committees. However, robust evaluation was required, to evaluate its success in reducing student anxiety and to support future discussions about retaining or modifying the OPRG. In both institutions, the initial winter diet of exams was chosen as a suitable time point to evaluate, as this represented the first experience students had of post-COVID on-campus assessment. At this point, both departments began to collaborate on student-facing resources and evaluation.

RESEARCH AIMS AND RESEARCH QUESTIONS

In this article the findings of a recent research project that sought to investigate the impact of allowing students to use a OPRG during on-campus timed exams are presented. The OPRG was developed to address anxiety and incentivise positive study habits, and these aims allowed us to define the following two research questions:

RQ1: Did the introduction of the OPRG alleviate students' self-reported anxiety about the return to on-campus exams?

RQ2: Did the introduction of the OPRG change revision and study habits for on-campus exams?

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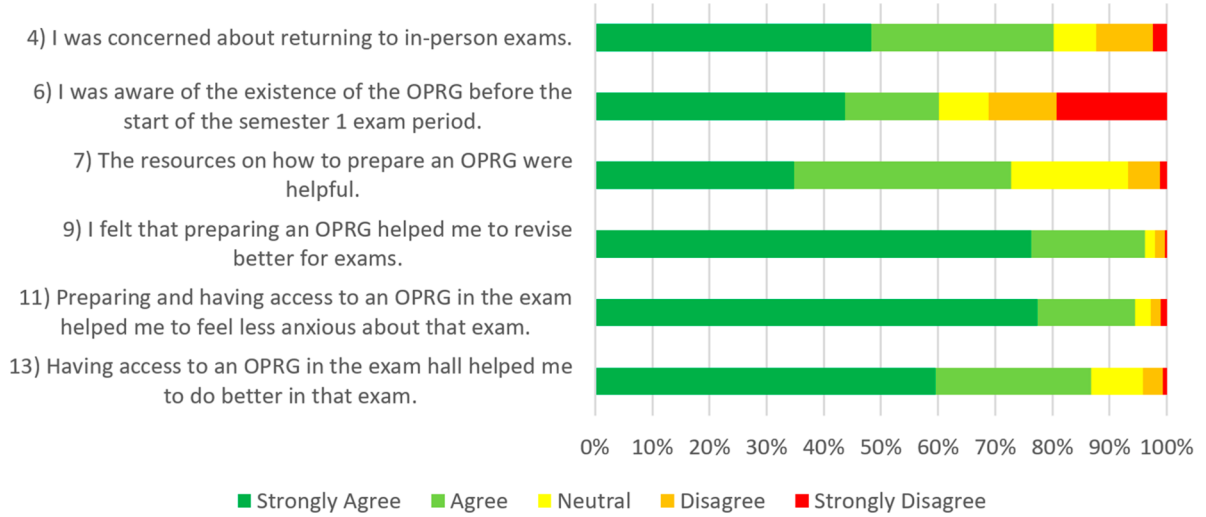

Figure 2. All Likert-scale responses to survey questions across the combined student cohort (Bath & Strathclyde, 287 responses).

RESEARCH METHODOLOGY

Immediately after students completed their first set of post-COVID timed on-campus exams in December 2022 (Strathclyde) or January 2023 (Bath), they were invited to complete a survey on the perceived impact of the OPRG on these exams. The survey was a mix of Likert-scale and free-text questions (Table SI1). Ethical approval was granted by both departmental ethics committees, and responses were anonymised at the point of data collection. The survey received 287 responses (~25% response rate), with the breakdown of participants into year groups given in Table SI2.

To evaluate questions which prompted participants to choose a Likert response, numbers were assigned to each response; with 1 being assigned to "strongly disagree" to 5 being assigned to "strongly agree". To evaluate the collected numerical data, mean values were calculated either for the full data set, or for individual student year groups across both departments. Mean values >3 were taken as a positive response to the question posed, indicating a perception of positive impact in response to the OPRG, with all other values considered nonpositive. To compare responses given by individual student year groups across departments, mean values were compared using the *t* test ($\alpha = 0.05$).

The survey asked four free-text questions, which were subject to inductive thematic analysis. Responses were entered into MS Excel, and color-coding used to categorize and sort themes according to the methodology of Bree and Gallagher.[27] This methodology followed a similar six-phase process to Braun & Clarke's thematic analysis guidelines, adapted for physical science education research.[28]

Initially, the lead investigator (PT) read and reread all data, producing initial themes (phases 1 and 2). These themes were sorted and recategorized, frequently identifying new themes, or collapsing two previously distinct themes together (phases 3 and 4). Themes were given placeholder names which were expanded to a rich one-sentence description during coding. Themes were reviewed at this point by a coinvestigator (GS) who had not previously examined the data, and the findings were in broad agreement. Finally, when themes and subthemes had settled, a report was written, supported by appropriate extracts (phases 5 and 6).

Coding was carried out inductively, with no pre-existing themes imposed. Questions sometimes gave rise to weak themes—for example, when asked how the presence of an OPRG impacted their anxiety, some students reported only that it made them "less anxious", so these were not coded. However, the vast majority of responses had one or more strong and clear codes that fitted within one of a small number of themes and subthemes.

One question was analyzed separately, as it probed pre-existing student concerns on returning to in-person exams (130 responses, 169 extracts). The remaining three questions were analyzed together as they all prompted reflection on the use and impact of the OPRG itself in various ways (509 responses, 591 extracts).

RESULTS AND DISCUSSION

QUANTITATIVE SURVEY FINDINGS

Students were asked what proportion of their chemistry exams they prepared an OPRG for (Q8 in Table SI1). Most participants indicated they used the OPRG for **all** exams (with years 1, 2, 3 or final year students responding 91, 89, 100 or 100% at Bath and 91, 94, 97 or 100% at Strathclyde). We also asked for the date of their last in-person university exam (Q3 in Table SI1). About half of the first-year students mentioned school exams in summer of 2022, when U.K. Secondary Education providers had returned to in-person assessment. For higher years, responses were almost always either "never", or a date on or before the winter 2019/20 exam period.

Six survey questions asked students to rate their agreement with various statements on a standard 5-point Likert scale and the results of the full data set are plotted in Figure 2.

Taking a response of Strongly Agree or Agree as indicative, responses to Q4 and Q11 report a widespread prevalence of exam anxiety, strongly addressed by the existence and availability of the OPRG. Q9 and Q13 similarly indicate a very strong perception that the OPRG aided in both preparation for, and perceived attainment in, the exams the students had just sat. The largest spread of responses came from awareness of the guide itself (Q6) and the usefulness of support resources (Q7).

The data set was then broken down into subgroups to review responses from students in different years of study. Most year-groups were aware of the OPRG guidance and found it helpful

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Table 1. Themes, Subthemes, and Quotes for Student Pre-existing Concerns about the Return to In-Person Exams[a]

Theme	Subtheme	Representative quotes
Changes to preparation techniques	Return to memorization as a preparative technique (45)	*"I had not had to memorise material in 3 years and was worried I had lost this skill"*
		"Concerned regarding being able to memorize necessary information enough to apply them to questions"
Changes to difficulty or level of assessment	Lack of recent or relevant experience of in-person exams; change to exam tasks required (50)	*"Never sat face to face university exams before so I didn't know what to expect and the level of difficulty"*
		"We had, up until now, relied almost exclusively on our notes for exams and had become accustomed to a certain style of exam."
	Concern over difficulty due to retaining the open-book format, or lecturers accounting for the OPRG and making questions harder (9)	*"Completely swapping the format of classes and exams brought a significant amount of uncertainty, including past papers from 2020 and 2021 being designed for open book exams added extra concern over the difficulty of the exam"*
		"I was anticipating the exams would be more difficult to account for having the page of notes during the exam"
Exam day concerns	Unfamiliarity or anxiety around the physical exam environment (28)	*"Also being able to wake up and prepare for an exam in my house is so much less stressful than having to commute to university, I would end up leaving my house at6:50to get there for a 9 am exam because the buses usually fill up and I didn't want to be late"*
		"I was concerned about exam procedure, not knowing how the exams took place in terms of what we needed to bring and whether we could write outside of the lines on the answer booklet etc."
	Running out of time in the exam (23)	*"I wasn't sure I would be able to complete my exams to time as there was no timed assessments under similar time constraints since 2nd year."*
		"I was scared about not having enough time to answer the questions"
	Memory unreliability in the exam (14)	*"It had been so long since doing an exam in person that I thought I'd struggle without having notes in front of me."*
		"I was concerned and having doubts about my ability to remember that much information and apply it in those conditions."

[a]169 extracts were coded. Some responses left this question blank and some gave multiple codes in a single response.

(Table SI3), except for year 1 students who reported that they were less aware of the use of the OPRG in exams. Reported concerns about returning to in-person exams (Q4) were consistently very high (Figures SI1 and SI2), with no statistical significance observed between mean values obtained at Bath or Strathclyde (Table SI4) indicating similar levels of high concern across all years. Lower mean values were observed for first year students in both departments (Table SI4), with mean values being statistically significantly different to most other year groups (Table SI5). This result indicated that compared to other year groups (except for final year students at Bath), year 1 students were less concerned about on campus exams, presumably since most of these students sat school exams the previous year. The perceived impact on revision, anxiety, and academic performance (Q9, Q11, and Q13) was consistently very high across all year groups (Table SI6). Notably, most students strongly agreed that the ORPG helped with exam revision and reduced anxiety; the key aims of implementation.

Although the surveyed students are diverse geographically and temporally (including those with pre-COVID university experience), quantitative survey responses overall indicate a significantly strong and positive perceived impact of the OPRG. In particular, an overwhelmingly high proportion of students reported that they felt that it improved their exam preparation and reduced anxiety (≥95% in each case).

IMPACT ON ATTAINMENT

Previous studies have explored the impact of open-book and open-note exams on academic attainment with mixed findings; even in carefully designed studies, measurement was often complicated by a concurrent switch of question format. For similar reasons, a formal evaluation of academic impact was beyond the scope of the current work. However, informal observation and widespread staff and external examiner views were that attainment and spread in OPRG-supported exams broadly returned to pre-COVID levels, mitigating concerns about grade inflation and contributing to discussions about retaining the guide in future years. This is in line with some literature findings suggesting that attainment holds steady on a switch to open-note exams, even when exams concurrently shift toward a more problem-based format.[20]

QUALITATIVE FINDINGS

Students' Initial Concerns

After students were asked to give a Likert scale response to "I was concerned about returning to in-person exams", they were given a free-text prompt to explain their concerns (if any). From these responses, 169 extracts were coded. Some responses left this question blank and some gave multiple codes in a single response. We identified three main themes of concern: changes to preparation techniques, changes to difficulty or level of assessment, and concerns about the exam day itself. Themes and subthemes are reported in Table 1, with representative quotes.

The first main theme related to the use of memorization as a preparative technique. Students were either concerned about the skill of memorization itself, or the sheer quantity of material they had to memorize. This was not surprising, since none of the participants had sat an in-person university exam, at any level, for over two years and were accustomed to open-book study.

The second main theme related to changes in difficulty or level of assessment. In one subtheme, students frequently cited the length of time since their last exam as a source of anxiety, mostly because their prior exam experiences were at a lower academic level or in a different context. Students frequently stated that they preferred open-book problem solving assessment, although there was also a small but significant subtheme noting students' concerns about difficulty due to retention of open-book practices. Although students had been told that exams would move toward a pre-COVID format, this was not always fully embodied in course material (for example, available past papers were all open-book style). A few students even feared that lecturers would punitively make exams "harder" to compensate for OPRG availability.

The third main theme revolved around sources of concern on the day of an exam itself, with the major subtheme focused on the exam hall environment. Concerns usually centered on lack of

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Table 2. Themes, Subthemes, and Quotes for Students Perceived Impact of the OPRG on Their Exam Revision, Anxiety, and Performance[b]

Theme	Subtheme	Representative quotes
Impact on the revision processes	Preparing an OPRG provided structure, caused changes to revision processes or techniques, or helped to identify areas of weakness (109)	*"The need to make an OPRG almost forced me to revise the topics for the exam because I needed to revise them to make my sheet. Helped to motivate my revision"*
		"It made me consider what parts of the material I actually knew. This helped when revising as it gave me areas to focus on"
	Not having to memorize freed up time for other revision tasks, or reduced memory-based anxiety during the revision period (96)	*"It meant that you could focus on applying your knowledge to different questions or situations rather than spending all of your time on learning the equations etc"*
		"Due to my learning disability I struggle with recall ability and it made me feel less anxious to know that I didn't have to memorise information"
	Preparing the OPRG itself caused learning to occur (53)	*"Condensing down notes into a page is good for understanding and getting the whole module in your memory, I used to do it anyway for exams."*
		"Helped the knowledge to go in and made me think about how things went together"
Impact on the exam day itself	Awareness of OPRG availability was reassuring, and alleviated panics or "mind blanks" (140)	*"The OPRG helped me to rest assured that the important concepts/definitions were within my reach at the exam and I could focus on answering the questions without my memory being a factor in my success. "*
		"It took away that fear of having a blackout in an exam."
		"Stress and adrenaline in exams helps a lot but also can cause my brain to fire on all cylinders and move faster than I can keep up sometimes - having a note sheet slowed the panicking, focused my brain and helped with the mind blanks"
	Provided memory support, prompts, or confirmation of facts (103)	*"It provided a reference such that greater confidence could be had in the answers put down."*
		"I mainly referred to my ORPG to check my answers and refer to particular equations/obscure facts. It was useful to have as a reference point, like a periodic table, but not necessary for completing the exam."
	The OPRG was rarely referred to in the exam, usually because preparation had already caused memorization (47)	*"Decreased my anxiety a lot, even though I barely referred to the notes"*
		"I felt before the exam I would be very reliant on the OPRG, but in fact, I believe I only checked a few times just to double-check."
Negatives	OPRG was time-consuming to prepare or use, gave a false sense of security, or was not useful (36)	*"As the exams were close together it was time consuming to create the sheet a day before. Perhaps doing it at the start of revision would've been better."*
		"Sometimes the information on the OPRG was irrelevant to the exam, which is just down to chance of the questions asked."
	The student felt that there was actually a difficulty spike in the exam, specifically caused by the OPRG being made available (7)	*I believe that some of the lecturers took the presence of the OPRG as a substitute for having the whole of our notes in the exam and so purposefully made the exams more difficult to understand and took concepts that were not quite covered in the lecture content. This made the OPRG effectively useless for some of the exams.*

[b]591 extracts were coded. Some responses left some of the questions blank, and some gave multiple codes in a single response.

familiarity with invigilation rules or logistics around transportation. These reflect typical exam stressors but were exacerbated by the extended time and increase in academic level since their last exam.[29] The second subtheme was running out of time, frequently citing the extended length of online open-book assessment by comparison. Many remote open-book implementations allowed extra time for uploading, or even 24-h completion windows, and students had become habituated to using all available time even at the cost of their own sleep or health.[30] Lastly, a small number of codes were concerned about forgetting things but most students instead reported memory concerns during revision, as a part of a process they had control over.

Overall, the findings from this theme reflected recent prior literature which examined transitions **toward** open-book examination, where students frequently experienced anxiety due to a lack of prior experience with the open-book format.[16] Rather than the choice of format, change itself can significantly induce anxiety.

Students' Perceptions of OPRG Impact

For the rest of the textual data, students were given three separate free-text prompts to "tell us more about how the OPRG affected your exam revision/anxiety/performance". The responses to these prompts were analyzed together as 591 total extracts. Some responses left some of the questions blank, and some gave multiple codes in a single response. We identified two main themes: how the OPRG positively impacted the revision process, and how it positively impacted the day of the exam itself (see Table 2).

Students reported a wide range of changes to their revision processes. Some viewed the OPRG as a useful time-saver that allowed them to prioritise more effective revision techniques, over what they viewed as time-consuming and ineffective memorization. There was also a widespread view that preparation of a OPRG was beneficial to revision. In some cases, this was by structuring or motivating revision, and in other cases, students were able to more easily identify areas of weakness. Most interestingly, we saw a strong subtheme where students felt that preparation of the OPRG facilitated learning, either by catalyzing memorization or forging a deeper understanding of the material. This was one of the key motivations for implementing the OPRG, as the recommended preparative process of repeatedly condensing down lecture notes is a widely used and effective revision technique.[23] Significant cognitive benefits have been reported for students who prepared similar condensed notes this way, even when not used in exams.[22] Students were informed of these benefits in the OPRG guidance, and it seems that many recognized them in their own practice.

Within the theme of impacts to the exam day, there were several subthemes, with the largest relating to anxiety. Specifically, simply knowing that the OPRG was available reduced students exam-related anxiety. Comments in this subtheme frequently referred to "blackouts" or "mind blanks" as a pervasive fear underpinning all exam experiences. Being aware that they could use the OPRG in exams alleviated this fear, and reduced anxiety was then causally linked to better exam performance by some students. This subtheme reflected a trend in the literature, which was our main motivation to implement the OPRG: reduction in exam-induced anxiety. Another subtheme had students describing the OPRG as a reminder, memory cue, or as a way of checking facts rather than providing

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material verbatim. Comments frequently cited positive affective terms like "reassurance" or "confidence".[29] Some students viewed the OPRG as a useful reference, functioning like a periodic table or equation sheet. Finally, we saw a subtheme of students relying on the OPRG much less than they had expected, usually due to the aforementioned memorization. This was a key aim of the original design, and observed in institutions that already use open-note exams.[31]

The vast majority of comments were positive, but there were also a small number of neutral or negative comments that were useful to examine, especially in making recommendations for future improvements. Most commonly, students reported neutral or negative experiences when neglecting OPRG preparation until shortly before the exam. Mostly these comments recognized that the OPRG would be more useful had it been integrated into the start of their revision process, or that they should have allocated more time for revision. There were also a few instances where students attempted to use the OPRG as a way of selective nonrevision, by using it to "open-book" a single topic. If that topic was not assessed, they felt short-changed. Finally, there were a very small number of responses (<1%) that perceived that an exam they just undertaken was harder as a result of the lecturer knowing about the OPRG.

To put these negatives in context, the combined student body was examined by at least 50 different question setters. Under these circumstances, several questions will be particularly challenging by subject material requirements or even random chance, and the OPRG was sometimes seen as the most immediate causal explanation for difficulty. These issues are not new: Valdermo and Eilertsen observed, almost 25 years ago, that students would sometimes underestimate the amount of preparation needed for open-book exams, and that teachers would occasionally overcompensate with higher-level questions.[32] These findings highlight an important factor for any potential adoption, around the need for consistent supportive communication and appropriate question-setter training. In our case, we did occasionally see overly difficult open book questions in the first year of fully open-book assessment, but this issue was addressed before the introduction of the OPRG.

CONCLUSIONS AND ADVICE FOR IMPLEMENTATION IN YOUR OWN CONTEXT

Motivated by a desire to learn from COVID-era innovation, avoid a return to heavily memorization-reliant practices, and mitigate change anxiety, we implemented open-note exams in two chemistry departments in the U.K. We surveyed our students in pursuit of two answers: did the introduction of the OPRG alleviate anxiety about the return to on-campus exams, and did it change revision/study habits? The OPRG was found to provide a significant source of reassurance and support during revision and exams. We also observed major positive changes to reported study and revision habits, retaining a focus on higher-order cognitive tasks, initially observed during COVID-era remote exams.

Because the OPRG impacts exam practices, widespread staff buy-in is crucial for a successful implementation. In both institutions, implementation was discussed in open meetings, aiming to build a broad consensus across all who teach or deliver learning. We found it was important to carefully recognize and address the position of those who were initially resistant to the idea. Mostly, concerns were pastoral in nature, often expressing that students may not really "learn" anything, or concerns about grade inflation. Making sure colleagues felt heard was important to minimizing antagonism, which could negatively impact the students' learning experiences. Concerns can be addressed within the design of the implementation. For example, the one-page limit was seen as a compromise when moving away from a fully open-book assessment, even though the cognitive and antianxiety benefits were similar. Variation between our departmental implementations can be credited to these discussions (e.g., single or double-sided notes, or the varying requirement for handwritten-only notes). In some cases, these differences gave rise to specific further concerns, which were evaluated in turn. For example, at Bath, the lack of restriction on typed notes did not give rise to widespread sharing or copying, perhaps since guidance explicitly emphasized the value of personal creation. Strathclyde similarly observed no instances of students attempting to pass off scanned or photocopied notes as handwritten. Peer discussion of OPRG content was observed in both departments but seen as a positive source of peer interaction.

Staff also recognized the value of problem-solving question types to test higher-order understanding, and that retaining the move away from rote-learning was a positive step for education overall. These pragmatic considerations have been also shown to aid buy-in elsewhere, with our implementation already adopted by other departments in our respective institutions.

In both departments, the implementation of the OPRG was initially treated as a one-year bridging support. The early results of this current research contributed to all-staff discussions in both departments, and informed the decision to retain the OPRG in future. If implementing in your own context, it may be easier to initially run as a pilot and collect impact evidence through existing student satisfaction surveys or small-scale action research.

LIMITATIONS

As with all education research, it is necessary to consider the generalizability of our resources and findings. While our implementation could be used by others, it was specifically designed around our degree structures and content and will likely require modification to other contexts. For example, weighting and distribution of grades may already favor nonexam assessment, or institutional policies may mandate or prohibit certain exam arrangements. Our findings are based on students working toward a chemistry degree in two different U.K. universities. Only 25% of them completed the evaluation, and findings may not be representative of the whole cohort. Our methodology relies on self-reported scales; while this is a valid way to measure anxiety, the actual change to study habits may be modest. The survey was administered immediately after exams, to capture a snapshot of feeling, but it meant that students did not have their results and could not accurately evaluate their own performance. We have some confidence that our findings may be relevant to similar U.K. institutions with chemistry programmes, but contexts outwith this scope may require further consideration of relevancy.

ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available at https://pubs.acs.org/doi/10.1021/acs.jchemed.4c00472.

Context statements, further quantitative analysis, survey instrument (PDF, DOCX)

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One-page guide to the OPRG (PDF, DOCX)

Student-facing infographic (PPTX) and presentation (PPTX)

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Notes

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