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Can Oral Examinations Replace Written Examinations?

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ABSTRACT

The purpose of any assessment is to determine students' learning. While oral examinations have been adopted in many education systems, such as the PhD thesis viva and medical assessments (Huxham, Campbell, and Westwood 2012), they are rarely used in undergraduate engineering courses (Baghdadchi et al. 2022) which traditionally rely on written papers. This is not surprising given, generally, the large cohort sizes and the need to efficiently conduct such examinations in a timely manner. It has been shown that widening the range of assessments that a student experiences can lead to a more comprehensive development of the student (Rust 2005) and generally increases accessibility to the increasingly diverse student populations we find in engineering.

In this review, the effectiveness of oral exams is discussed and analysed in terms of their historical development, key features and differences from written exams and experience from case studies. The issues of validity, reliability, and fairness are outlined and the feasibility of replacing traditional written exams by oral exams in undergraduate programs, specifically the Mechanical Engineering program, at Imperial College London discussed.

It is recognised that while numerous benefits could be provided by oral exams there are significant hurdles that require careful planning and the review concludes with a number of guidelines for a pilot scheme to be enacted over the coming year.

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1 INTRODUCTION

1.1 History development

An oral examination, also known as viva voce is simply defined as “any assessment of student learning that is conducted by the spoken word”, (Joughin 2010), and is not a novel form of assessment, (Markulis and Strang 2008), widely employed as an assessment tool for PhD studies (Arico 2021). It is also worth noting that the use oral assessment is popular in other European countries as Germany, Italy etc. (Iannone, Czichowsky, and Ruf 2020; Kehm 2001). Nevertheless, oral exams are relatively rarely utilised in English-based undergraduate programs (Arico 2021; Baghdadchi et al. 2022; Huxham, Campbell, and Westwood 2012). Surveying innovative forms of assessment (Hounsell et al. 2006) found that non-written assessments only accounted for 6.7% of all innovative forms surveyed and that formal oral exams for a single student merely takes up 22% of all the oral forms of assessment confirming the low take-up of oral exams.

1.2 Characteristics of oral exams

Oral assessments can, (Joughin 2010), essentially be categorised into three main types: presentations (talking about a prepared subject in class), interrogations (examiners question students face to face in a viva-like context) and applications (students are required to act as a specialist e.g., consultants, lawyers, clinicians, in simulated professional scenarios). Here we are focussed on the latter two forms of oral exams – interrogations and applications, as the utilisation of presentations is already widely used in our own undergraduate programme.

(Joughin 1998) provided six characteristics or dimensions of oral exams (namely Primary content type, Interaction, Authenticity, Structure, Examiners and Orality) for better understanding of the nature of oral assessments; all of which must be carefully defined for a successful oral assessment. In their discussion (Joughin 1998) highlighted the need for validity, reliability, and fairness in oral exams which was further explored by the same author (Joughin 2010) and more recently by (Akimov and Malin 2020).

1.3 Comparison between oral and written exams

Written exams are the most pervasive form of assessment in most subjects, particularly STEM courses (Baghdadchi et al. 2022), whose most common feature is its convenience (Muldoon 1926) allowing for the efficient and effective assessment of large number of students simultaneously (Dicks et al. 2012; Kang et al. 2019) without too much time and effort cost. Furthermore, written exams are regarded as objective since all students are offered the same set of questions in the same time period (Kang et al. 2019). Nevertheless, in recent years, written exams have been criticised for not be able to assess the deep understanding or detect academic misconduct during exams (Dicks

et al. 2012).

In contrast oral exams seem to address the drawbacks of written exams (Dicks et al. 2012) allowing examiners to tell whether a student really understands the knowledge (Kang et al. 2019; Markulis and Strang 2008), and the use of contingent (follow-up) questions is also common to probe students' understanding (Iannone, Czichowsky, and Ruf 2020), allowing the student to express their answers in a more natural way (Huxham, Campbell, and Westwood 2012).

In addition to the above and following the recent pandemic, oral exams should be reconsidered as a possible alternative form of assessment in higher education. Here, the efficacy of oral exams and the feasibility of replacing traditional written exams by oral exams in undergraduate programs, particularly the Mechanical Engineering program at Imperial College London, will be considered.

2 CASE STUDIES OF ORAL EXAMS

During the preparation of this paper a number of case studies were identified in STEM and Business related courses. In particular Mechanical and Electrical Engineering (Baghdadchi et al. 2022), Aerospace Engineering (Rouser 2017), Mathematics (Iannone, Czichowsky, and Ruf 2020), Computer Science (Reckinger and Reckinger 2021), Chemistry (Dicks et al. 2012), Anthropology (Kang et al. 2019), Nursing (Rushton and Eggett 2003) and the summary of case studies in Biology, Medical and Business courses in (Akimov and Malin 2020).

The most significant benefit of oral exams is encouraging students' deep and conceptual understanding of knowledge, thus fostering the desire to learn more thoroughly and interact more proactively with teaching staff (Dicks et al. 2012; Huxham, Campbell, and Westwood 2012; Iannone, Czichowsky, and Ruf 2020; Rawls, Wilsker, and Rawls 2015). Deep learning has also been regarded as a necessity for students' development in the new digital era (Baghdadchi et al. 2022). Moreover, from those cases studied other common benefits noted included: communication skills were practised and developed (Huxham, Campbell, and Westwood 2012), cheating was prevented in exams (Kang et al. 2019), social belongingness was enhanced (Reckinger and Reckinger 2021) and inclusivity etc. is enhanced (Huxham, Campbell, and Westwood 2012).

The dominant disadvantage of oral assessments noted over all types of subjects is the increased stress level experienced by students compared to written exams, which is strongly related to the unpredictability of the novel assessment format (Dicks et al. 2012; Kang et al. 2019). The anxiety associated with novelty was significantly alleviated, in most cases, after the first experience, or if mock and practice opportunities were provided ahead of the formal oral exam (Iannone, Czichowsky, and Ruf 2020; Kang et al. 2019; Rawls, Wilsker, and Rawls 2015; Reckinger and Reckinger 2021; Rouser 2017). Additionally, higher anxiety could, in turn, promote students to devote more efforts into deep learning and comprehension for better performance in oral exams

(Huxham, Campbell, and Westwood 2012; Kang et al. 2019). In addition to the high student stress level, some studies reported time constraint difficulty in scheduling oral exams for faculty members (Baghdadchi et al. 2022; Kang et al. 2019; Rouser 2017), as it is not possible to guarantee that large number of students can take oral exams simultaneously with relatively few examiners. (Kang et al. 2019), conversely noted that oral exams would relieve the scoring pressure for examiners compared to written exams possibly outweighing the severity of time organising problem.

Those studies with large student populations (Baghdadchi et al. 2022; Dicks et al. 2012; Kang et al. 2019; Reckinger and Reckinger 2021), tended to use low stakes (around 10%), formative, and pass/fail oral exams, or to replace original low stakes written exams (mid-term) by oral exams, with shorter time, whereas small-class study groups, (Iannone, Czichowsky, and Ruf 2020) implemented high stakes oral exam accounting large portion of the grades. This might be due to time constraint for scheduling with large student cohorts and inability of oral exam to test broad topics covered by each course (Baghdadchi et al. 2022; Kang et al. 2019).

Overall, the case studies identified proved to be successful where most students and staff preferred oral exams to written exams given the considerable benefits, with better performance by students in oral exams. It was notable that there were no studies indicating the implementation of oral exams to be unsuccessful in the end. However, concerns of prejudice and bias towards minorities still existed and were recognised in undergraduate studies (Baghdadchi et al. 2022; Iannone, Czichowsky, and Ruf 2020; Kang et al. 2019) and needed to be addressed. The studies rarely analysed the problems regarding validity, reliability, and fairness of oral assessments systematically, which are major concerns for increased use of oral exams (Baghdadchi et al. 2022; Kang et al. 2019).

3 VALIDITY, RELIABILITY, AND FAIRNESS OF ORAL EXAM

Considering the benefits provided by oral exams as outlined above, they are, still, underutilized largely due to concerns over their objectivity and reliability (Kang et al. 2019). These concerns will be heightened when oral exams are applied to large cohorts of students as found, for example in undergraduate engineering programmes. Therefore, it is necessary to determine whether problems of fairness and objectivity of oral assessments are significant compared to other concerns when implementing oral exams into higher education.

3.1 Problems of validity, reliability, and fairness of oral exam

The three fundamental attributes aligned with any types of assessments: validity, reliability, and fairness (Memon, Joughin, and Memon 2010) are defined as:

Validity refers to the extent to which the assessment would test what it is intended to examine. For example, the design of an oral exam should concentrate on assessing

students' mastery of technical knowledge rather than their language expression skills, (Joughin 2010; Memon, Joughin, and Memon 2010).

While (Simpson and Ballard 2005) highlighted the importance of oral exams being well designed to allow comprehensive demonstration of examinees' knowledge it was noted that the case studies identified in Section 2 covered the right content and further stimulated students to adopt deep learning approaches instead of pure memorisation. Nevertheless, the cases studies identified suggested that programs with large student population tend to use low-stakes short oral exams suggesting that it is hard to design oral exams to cover breadth of the whole course, which questions the validity of oral exams to some extent.

Reliability requires the performance of students or results of oral exams should be consistent when (a) exam setting context changes (inter-case reliability), (b) different contingent questions are posed (inter-item consistency), (c) students face different examiners (inter-rater reliability), and (d) judgement from examiners varies as more students are assessed (intra-rater reliability) (Akimov and Malin 2020; Joughin 2010; Memon, Joughin, and Memon 2010).

Reliability is a significant issue in oral exams with different examiners or contingent questions tailored to each student (Memon, Joughin, and Memon 2010), which is normally the case in universities with numerous students. Judgement from examiners might vary as well throughout testing of large student population (Memon, Joughin, and Memon 2010).

Fairness suggests scores should be graded the same if two undergraduates understand the content equally well regardless of any other factors. The face-to-face nature of oral exams might disadvantage student groups due to bias and prejudice from factors such as gender, ethnicity, class level etc. (Joughin 2010; Memon, Joughin, and Memon 2010).

Fairness problems in oral exams are also concerning. Based on a summary of previous research (Davis and Karunathilake 2005), they demonstrated that examinees' features of personality would influence the scores in oral exams. Particular points of concern highlighted ranged from the way of dressing and expression would affect the final grade in oral exams (Burchard et al. 1995; Rowland-Morin et al. 1991). Students from ethnic minorities trained internationally (also people of working class, female students etc.) would experience discrimination in oral exams due to a number of reasons with the authors emphasising that this problem might become more significant with larger populations of international students (Esmail and May 2000; Roberts et al. 2000). These conditions exist in most undergraduate departments in the world with high numbers of students from diverse backgrounds as confimed by (Kang et al. 2019).

3.2 How to ensure validity, reliability, and fairness of oral exam

To ensure validity, reliability, and fairness the multiple suggestions of (Davis and Karunathilake 2005; Joughin 2010; Memon, Joughin, and Memon 2010) are summarised below:

- Increase the number of oral exams for each student and offer adequate questions each time – when more opportunities and questions are provided covering breadth of courses, students' performance is less likely to vary accidentally, which improves the reliability of oral exams.
- Incorporate a panel of administrators or increase number of examiners – administrators or additional examiners could supervise the progress to spot any potential bias to ensure the fairness of oral assessments.
- Formally train the examiners in advance – all the examiners should be familiar with the purpose and rationale of oral exams and be consistent in marking process, especially when additional examiners were from other departments or institutions, to improve oral exam's reliability.
- Use explicit rubrics and criteria – examiners should adhere to rubrics strictly to validate any point afforded for each student rather than their subjectivity. A sample of rubrics is shown in (Markulis and Strang 2008, Table 4).
- Standardise the questions between students – making the styles and difficulty of questions similar across all the students to refine reliability and fairness problems, so that some students would not be disadvantaged by receiving much harder set of questions than others.
- Involve a panel of relevant professors to design the oral exams – the content of oral assessments should only focus on technical knowledge or skills under the scope of courses to ensure the validity.
- Define the language level required for assessments – oral exams should specify the required language level with respect to the learning outcome, avoiding any assessment required for sophisticated speech skills if not obligatory in the aims of courses.
- Post results analysis – the clustering of higher or lower scores in particular student groups need extra attention to avoid discrimination or prejudice and develop model answers based on best performance to examiners to enhance their understanding of marking process.

4 ORAL EXAMS IN UNDERGRADUATE MECHANICAL ENGINEERING

There was very limited literature identified comparing the efficacy of suggested methods in oral exams in undergraduate studies. Therefore, it is hard to determine which method

is the most or least effective in undergraduate programs to ensure the validity, reliability, and fairness without any authentic practise. In this section, the feasibility of introducing oral exams in the Mechanical Engineering Department (MED) at Imperial College London (ICL) is explored and described.

4.1 The feasibility of oral exams in Mechanical Engineering

In the MED at ICL, each year group has approximately 200 students from diverse cultural backgrounds. The students take four years to complete a masters level programme, completing 7-10 modules in each year. Currently the majority of modules in each year are assessed by one high-stakes final written exam in the summer term.

Presently, our engineering students are expected to master a new skillset such as active learning, analytical thinking, teamwork, innovation, technical communication, cultural awareness etc. (Baghdadchi et al. 2022; Kamaruzaman et al. 2019), whose prerequisite is deep and conceptual learning approach, which can be greatly consolidated and improved by using oral exams, rather than memorisation (Baghdadchi et al. 2022).

As stated by (Dicks et al. 2012), interaction between students and instructors is “invaluable” in large departments, whereas the engagement and attendance in lectures and tutorials seems to be particularly low in the UK (Iannone, Czichowsky, and Ruf 2020) and the authors have observed that this is an issue in the MED at ICL.

It is thus felt that the implementation of oral exams in ME can help solve this problem because oral assessments could foster students’ engagement as discussed in section 2. Additionally, students are likely to miss synchronous connections in programs with large student population following pandemics (Reckinger and Reckinger 2021), and this has been found during remote learning in 2020-2021 and some current online courses in the MED. With the help of oral exams, students would be more likely to interact with their peers for oral practise (Iannone, Czichowsky, and Ruf 2020; Rouser 2017) and, minorities in particular, would feel more belongingness (Reckinger and Reckinger 2021), further establishing a more friendly atmosphere in the ME department with its large and diverse population. Furthermore, there are always a number of students with disability or learning difficulties in the MED given a large population, oral exams can be more inclusive for students with disability such as dyslexia (Huxham, Campbell, and Westwood 2012) and provide opportunities for instructors to reach out and help those students with difficulties (Baghdadchi et al. 2022).

Considering most modules in ME only have single exam at the end of the module, the feedback is valuable for students. Currently students do not receive feedback from their exams until at least one month after the exam when marks are published and later still once the solutions are released by which time most students have moved on academically. On the contrary, during most oral exams, students could receive their feedback immediately after their exams (Baghdadchi et al. 2022), which offers a valuable opportunity to receive official feedback from instructors if oral exams were to

be used in ME department.

Extra stress generated in oral exams seems to be a major concern, but it is the most significant during the first experience, after which would be relieved (Reckinger and Reckinger 2021), and some methods proved to be effective alleviating stress, as discussed in section 2. Additionally, extra stress could be adopted by some students as the motivation to learn more deeply and thoroughly (Huxham, Campbell, and Westwood 2012). "All examinations are stressful" (Davis and Karunathilake 2005), so anxiety should not become a reason for not introducing oral exams to ME department. While time costs could be problematic this can be alleviated utilising the existing tutorial system in the department where each academic tutorial group (around 20 students) has 1-2 tutors, who could be the examiners.

Referencing the successful case studies conducted by (Baghdadchi et al. 2022), (Dicks et al. 2012), (Kang et al. 2019), and (Reckinger and Reckinger 2021), which have similar size of large undergraduate enrolment of students, especially that of (Baghdadchi et al. 2022), whose subject is also undergraduate mechanical engineering, and considering the discussion above in this section, it can be concluded that oral exams are feasible if properly designed.

4.2 How to implement oral exams in Mechanical Engineering effectively

In this section methods for implementing oral exams are considered in terms of the pre-exam preparation, exam conduct and post-exam follow up.

Pre-exam preparation

Given the large cohorts of students in the department it is felt that an individual oral exam cannot take too long without incurring an extremely high workload for faculty members and creating a timetable log-jam. The case studies discussed in section 2 suggest a period of 10-20 minutes for single student in order to both ensure enough time for fully testing the understanding and avoid high workload and management. Clearly the testing of the full coverage of learning outcomes of each module is then not practical and, therefore low-stakes assessments counting towards 5-20% of the final grade in each module is reasonable. This will, additionally relieve the potential stress experienced by students during oral exams and they in turn would still invest in the preparation of oral exams since they still count as "part" of the course.

To ensure the reliability over our large cohort all 10 tutorial groups (20 students in each) should be examined in parallel with the same set of questions or selection of questions. The scope of the exam should be clearly defined and conveyed to the students before hand. To ensure the validity of the exam it should be designed by each module leader/lecturer having the deep comprehension of the topic and the oral exams "fit" with the final written exam. The rubrics and marking criteria should be made clear to improve fairness and reliability, and arrange a training meeting between all the examiners to ensure consistency

Mock exam opportunities or video examples should be available to students during normal or clinical tutorial sessions before the formal assessment, (Baghdadchi et al. 2022), as in the case of past papers in written exams, to familiarise them with new format and mitigate the high level of stress experienced. Providing advice on how to prepare and approach this assessment effectively, such as practising with peers, for students can prove to be effective in alleviating the anxiety, (Rouser 2017).

Exam conduct

At the start of the exam all students in one tutorial group should sit quietly in designated room. Once a student is called, the student will enter another room to start the exam which will last 10-20 minutes. After the student finishes exam, they would be allowed to return to original seat without speaking to others to ensure the content of exam is not leaked to other as yet unexamined candidates. Once the last student finishes exam, all the students in the tutorial group will be allowed to leave the exam room. This type of arrangement not only prevent cheating in exams but remove the opportunity of students speaking in public, which (Rouser 2017) found to be stressful. A similar arrangement could be used to assess a group of students on a collaborative question, (Baghdadchi et al. 2022).

Examiners should employ an informal relaxed tone to relieve the anxiety of students (Huxham, Campbell, and Westwood 2012). In the case of particularly anxious students more innovative methods could be adopted, for example (Kang et al. 2019; Koh, Tai, and Fung 2021) suggest that examiners could sit behind a screen or desk when posing questions. There should be one or two main examiners with an administrator in place to record the details of the exam to maintain the reliability and fairness. Examiners should initially articulate the questions to students and only provide hints, with points deduction accordingly (Dicks et al. 2012), if they seem to be stuck during the question. After answering all the questions the examiners should strive to provide some feedback to students even if scores are not ready yet.

Consideration is being given to audio and/or video recording of the oral exam for future reflection, training of examiners, the demonstration of example solutions and as evidence for possible appeals (Joughin 2010). However we recognise that this may increase stress levels amongst students and at the very least will need the agreement of the student taking part.

Post-exam follow-up

The scores of entire year group should be analysed statistically, to identify if particular groups of students perform consistently well or badly requiring further analysis or investigation to identify the potential cause, (Memon, Joughin, and Memon 2010).

The lack of experience of oral exams in the department by staff and students necessitates a survey of the students' perspective of the oral exam process for further modification and improvement as conducted in many case studies identified in section 2. The survey derived from (Iannone, Czichowsky, and Ruf 2020) can be adopted that queries

students' perceptions of their impressions of the process, comparison with written papers, pre-exam preparation (e.g. mock exam), the conduct of exam and the role of the exam in their learning process.

5 CONCLUSION

A survey of case studies revealed the effective and successful introduction of oral assessments, highlighting the considerable advantages of oral exams, such as fostering deep learning and communication skills. Problems of validity, reliability, and fairness of oral exams, however, could become barriers to the introduction of oral assessments if not considered properly; none of the literature surveyed systematically ascertained the validity, reliability, and fairness of oral exams.

While it is recognised that oral exams could not fully replace written exams, the benefits provided by oral assessments outweigh challenges such as stress, fairness, staff/time cost etc. Specific, initial steps on how to incorporate oral exams in the department are proposed and will form a basis for future reflection and publication following a trial.

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