

CASE STUDY

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Portfolios versus exams: a study to gauge the better student assessment tool

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Abstract

Portfolio assessment is a method used by teachers to evaluate their students' academic performance by giving them several assignments and/or projects to work on during the semester. This is one alternative to exams which are an assessment tool seldom questioned for its validity and efficacy. This study seeks to scrutinize both of the mentioned methods of assessment and determine which is more accurate and viable to be adopted in tertiary education. A cohort of sixty 20–22-year-old university students in the College of Engineering at the American University of Sharjah participated in this study. They were required to complete a questionnaire comprising 12 questions concerning the academic, mental health, and professional benefits that students can enjoy as a result of being tested by means of portfolio assessment instead of exams. The research question is as follows: Is portfolio assessment a generally more viable method of evaluating university students' academic performance than exams in terms of the potential academic, mental health, and professional benefits which such an assessment affords students? Overall, portfolio assessment was found to be a much more appropriate method of assessing university students than exams. The results of the study have implications for university professors, education experts, and examiners.

Keywords: Portfolio assessment, Exams, Alternative assessment, Assessment tools, Assessing academic performance

Introduction

Assessment in education is a critical part of students' lives, as it can be a significant turning point that determines the path that they take (Al-Hawamdeh et al., 2023; Bordoh et al., 2015; Dikli, 2003; Sletten, 2021). For a primary or secondary school student, this can be the difference between advancing to the next year or repeating the year, and for a university student, it can be the difference between passing or failing a course. In any case, it is clear that students must be assessed accurately and given a fair chance to demonstrate their best performance (Logsdon, 2022; Nasab, 2015; Vigeant, 2021). This is also true from an educational institution's standpoint, as it strives to bring the best out of its students which can help develop an image of high performance for the institution and can, thus, attract more students to it (Lafuente-Ruiz-de-Sabando et al., 2018; Tamuliene & Murzaite, 2013).

Traditional exams, however, have often been frowned upon as an inappropriate assessment tool (Dikli, 2003). A participant in a study conducted by Vigeant (2021) who criticized exams as an inadequate assessment method said, “A lot of times the stress of an exam makes me do worse because I know it’s my only chance and if I’m wrong that’s it” (p. 6). Similarly, numerous students participating in the present study complained about several flaws and issues with using exams as a tool to assess their academic performance. They mentioned factors that, they admitted, could not be easily controlled, if at all, like stress, lack of sleep, illness, and anxiety, among others, which severely affected their performance on an exam and, subsequently, their final grade. Such a widely used assessment tool, which places so much pressure on a single “exam day” that holds a substantial percentage weight of the final grade, can impact a student’s future since it is used by examiners to determine conclusively their students’ academic level (Ray, 2018). As a result, in this paper, portfolio assessment, an alternative assessment tool, is proposed as a more viable means of evaluating university students’ academic performance than exams.

Portfolio assessment is a method of assessing students’ academic performance by giving them several assignments and/or projects to work on throughout the semester to demonstrate their understanding of the course material (Blackbourn et al., 2004; Vigeant, 2021). In some cases, students may be given the freedom to choose a certain number of their assignments and/or projects out of the total number which go into their graded portfolios (Rodriguez et al., 2022). This contrasts greatly with exams, which are typically given in the middle and/or at the end of the academic year/semester (Reeves, 2000), and include a set number of questions about the course material which must be answered under exam conditions (Ray et al., 2018). Under such conditions, students are only given a specific amount of time to complete the exam, e.g., 1 to 2 h, and are not usually allowed to refer to external resources. As opposed to assignments in a portfolio, an exam normally makes up a relatively large portion of the final course grade (Vigeant, 2021).

Portfolio assessment has become common in the last two decades as an alternative assessment method favored by several educators over formal exams (Daud, 2017; Dung & Ha, 2019; Strijbos et al., 2007). As for the recent developments regarding exams and portfolio assessment, it is to no surprise that the former is still the more popular assessment tool due to the relative recency of the latter (Abrar-ul-Hassan et al., 2021; Ray et al., 2018). Exam proponents claim that exams are quicker and easier to grade (Gomez, 2000). Other exam advocates maintain that in some countries, especially underdeveloped ones, exams may be the only assessment tool that can be used due to limited resources and the educators’ intention to maintain a standardized evaluation of students’ performance in government educational institutions (Daud, 2017). A further group recommending exams as an accurate and valid evaluation tool believes that exams are more suitable for certain courses, e.g., history courses, as such disciplines are heavily based on memorizing facts (Dikli, 2003; Reeves, 2000).

However, owing to the COVID-19 pandemic, exams were placed under the spotlight as educators began to pose the question of their reliability and validity as an assessment tool (Smith, 2021). This is because when lockdowns were first imposed in many countries in the spring of 2020, many schools around the globe were forced to cancel their final exams as students could not sit them (Syafei et al., 2021). Consequently, schools

had to come up with an alternative method of assessing students to give them their final grades (Tang et al., 2021; Telyani et al., 2021). One common method that was used was collating works that a student had produced throughout the school year and giving him/her an average grade, similar to portfolio assessment (Revilla-Cuesta et al., 2021; Rodriguez et al., 2022). This placed alternative assessment tools in the limelight, and many began to scrutinize exams as an assessment tool. Cairns (2021) discusses this state of affairs, stating that “extensive discourse about disruptions to the standardized examinations students take (...) is symbolic of their high-stakes status worldwide. The interruptions provide an opportune moment to question the efficacy of exams as a measurement of achievement” (p. 331).

With this in mind, in this paper, the reliability and efficacy of exams as an assessment tool will be questioned, and portfolio assessment will be proposed as a potential alternative form of assessment for university students (see the “[Methodology](#)” section). Accordingly, the research question is as follows: Is portfolio assessment a generally more viable method of evaluating university students’ academic performance than exams in terms of the potential academic, mental health, and professional benefits which such an assessment affords students?

Sixty students at the American University of Sharjah participated in the present study. They were required to complete a questionnaire consisting of 12 questions investigating the potential efficacy of portfolio assessment as opposed to exams. The questions investigated specifically whether factors such as stress, anxiety, illness, and lack of sleep affected their performance in exams. The questionnaire also investigated whether portfolios, as an alternative to exams, can equip students with the professional skills they need to succeed in their future careers and, therefore, whether portfolios are in general a more viable and appropriate method of assessing students’ academic proficiency.

This study comprises five sections. First, the “[Literature review](#)” examines several research studies and discusses the state of portfolio assessment as adopted by various educational institutions. Second, the “[Methodology](#)” sheds light on the data collection, instruments, and procedures involved in the research process. Third, the “[Results](#)” section highlights the findings of the study after the participants’ responses to the questionnaire were scrutinized and statistically analyzed. Fourth, the “[Discussion](#)” section presents an analysis of the results; pinpoints the efficacy of portfolio assessment, as opposed to exams; and compares the results of this study with those reported in similar studies. Finally, the “[Conclusion](#)” adds a final note to the findings of the research; offers some recommendations for university professors, education experts, and examiners; and provides some insights into future research investigation.

Literature review

History of assessment

According to O’Sullivan and Cheng (2022), the concept of exams originated in China in the Sui Dynasty in 605 AD when Emperor Yang of Sui used an imperial examination system to hire government officials. However, the more modern concept of exams known today was invented by American businessman and philanthropist Henry Fischel in the late nineteenth century (Britannica, 2019). The first real implementation of this was in the form of public exams that were administered in schools in England in 1858,

as schools demanded a way to measure students' academic performance. At the time, they made this request to the University of Cambridge and the University of Oxford, which produced these exams for local schoolboys to take. Only when the year 1867 came around were girls allowed to sit public exams ("How have school exams," 2008, para. 1). To this day, as stated earlier, exams are used to assess students' academic performance in primary, secondary, and tertiary education, and they remain the most widely used assessment tool as once expected by educators (Ray et al., 2018; Struyven et al., 2006).

On the other hand, the concept of portfolios is relatively much more recent than the origin of exams. According to Farrel (2020), this concept was initially seen in Renaissance Italy in the 1400 s, as artists collected and kept their works of art to form a portfolio (p. 2). It was only in the 1970s that portfolios made their way into higher education, as there was "a move away from standardized testing, increased focus on quality assurance, and new research and theories of learning" (p. 2). Lam (2018) elaborates on this in his book about the use of portfolio assessment for teaching and learning writing, stating that in the early 1970s, the writing exam in the General Certificate of Education in the UK was replaced by a writing portfolio which was assessed instead (p. 4). He also mentions how, earlier on, portfolio assessment was used in the fields of medical education, photography, and architecture, among others (p. 2). Portfolio assessment remains, to this day, one of the assessment tools used in these fields, as well as others, albeit not as widely as exams (Ardjmand et al., 2020; Lam, 2019).

At this stage, it should be noted that there is not much research conducted on the potential advantages of portfolio assessment over exams as a method of assessing students. However, the amount of literature currently available examines portfolio assessment in terms of the frequency and quality of feedback given, grading, detecting, and reducing academic dishonesty practices, the range of skills assessed, mental health and well-being, and the advancement to the world of work. These elements are discussed in the following sections.

Frequency and quality of feedback

Portfolio assessment provides opportunities for more frequent and more meaningful feedback than exams (Mathews, 2009). In this respect, the instructor can provide suggestions for improvement when grading an assignment, and these tend to be more detailed and helpful for the student's self-reflection and improvement process (Lahmer, 2015; Nasab, 2015).

Williams (2002) states "portfolios offer students the opportunity to reflect on their learning" as opposed to exams, the traditional method of assessment in which, he adds, "students are rewarded for memorizing formulas and spitting back the lecture notes, rather than making connections, reflecting on what their learning means, and deciding which areas in their learning need development" (pp. 204–205). Odabasi (2011) also emphasizes the advantages of portfolios which he believes assist in "guiding students both at the beginning of and during the process, providing continuous and prompt feedback during the process and making self-reflection (...) an essential part of the process" (p. 161). Lahmer (2015) reiterates this view, maintaining that portfolio assessment is a tool for alerting students to work harder to avoid failure.

This is easy to see when contrasted with exams, where the most a student can see, assuming he/she requests a paper view, is a cross, rarely accompanied with the correct final answer written next to it or a comment, if the instructor is feeling generous (Ray et al., 2018). This may not be very helpful for the student, if at all, when trying to pinpoint areas of weakness that need improvement. Whereas with portfolio assessment, the instructor cannot justify deducting marks from an assignment or project simply by drawing a cross, which means he/she is much more likely to provide more substantial feedback in the form of a comment that details what exactly went wrong and what needs improvement (Mathews, 2009). Such valuable comments also come much more frequently than feedback from exams, as the nature of portfolio assessment entails that a student completes several assignments and/or projects that go into the portfolio, which allows students to continuously improve throughout a semester (Syafei et al., 2021).

In a study conducted by Rodriguez et al. (2022), 6 groups of approximately 20 students each were tasked with creating projects presented through portfolios to their professor. The professor provided regular written feedback, which students found instrumental in enhancing their projects through the professor's "constructive approach" (p. 5). This approach facilitated collaborative idea exchange among students and instructors, significantly enhancing their learning. After achieving success with their task, the students decided to use their portfolio model as a guide for their future assignments.

The benefits of using portfolio assessment were further emphasized in a study carried out by Obeiah and Bataineh (2016). In this study, two groups of students taking a writing course were assessed: one using a traditional timed exam and the other using portfolio assessment. The findings showed that the portfolio-assessed group not only had much better writing performance but also had better focus and organization skills. One reason for this was that they benefited from the feedback that they received during the writing process by reflecting on their work to improve their first draft.

Lahmer (2015) also recognizes the benefits of portfolios to learners. She maintains that "portfolios enable learners to see possibilities for reflection, redirection, and confirmation of their own learning efforts" (p. 170). Dalziel (2008), therefore, recommends this method, suggesting that students submit work that is still in development, which allows the instructor to monitor their progress and provide them with guidance to further develop their work into the final product (p. 207). To sum up, it is clear that portfolio assessment, as opposed to exams, potentially presents far more opportunities for meaningful feedback, from which students can immensely benefit for improving their work.

Grading

As previously mentioned, portfolio assessment often offers much more detailed feedback compared to exams, which greatly benefits students (Mathews, 2009). However, Law and Eckes (2007) argue that this comes at a cost to the instructor who grades them: time and energy. While this might be true in the context of grading a single assignment or project in a portfolio (Gomez, 2000), this argument may not hold true when considering the total amount of time spent grading in a semester compared to grading exams, especially if there are exams at both the middle and the end of the semester (Ray et al., 2018). This is because an individual exam may be as long as 10 pages, if not more, which may be longer than several assignments combined.

With that said, it is important to note that it may be difficult to precisely quantify the time taken grading exams versus grading assignments, as their lengths may differ from one educational institute to another. However, it can be said with much more certainty that what students learn from the feedback given is reflected in the fewer mistakes that they make in their later assignments, which can reduce the time taken to grade them (Vigeant, 2021). Without a doubt, a paper that has all the right answers is much easier and quicker to tick through than a paper riddled with mistakes or half answers that may or may not deserve partial credit, which can only be determined by careful inspection and consulting the rubric or mark scheme. This is also the case with more writing-heavy exams or assignments, as papers that have few to no mistakes tend to have much shorter comments written when grading them like “good point,” rather than longer comments that have to point out any mistakes or anything missing from the written response. With portfolio assessment’s more detailed feedback, it alone can benefit from the mentioned time savings when grading assignments (Nasab, 2015). However, even if portfolio assessment were to consume a considerable amount of time to grade, it may not require substantially longer time than exams.

Vigeant (2021), for example, reports an instance at Bucknell University where students took an online chemical engineering course in the spring semester of 2020 and were given the choice to create a portfolio of materials demonstrating their mastery of the taught syllabus instead of taking a final exam. The instructors of the course stated that “grading the portfolios was not significantly more time consuming than for the typical final exam, although it should be noted that exams were graded in detail and checked for partial credit, rather than being single answer rapidly-gradable questions” (p. 6). This goes to show that grading portfolios is not deemed a major concern, especially when considering the multiple benefits it provides.

Detecting and reducing academic dishonesty practices

Portfolio assessment can both detect and reduce academic dishonesty practices, including cheating and plagiarism, better than exams (Bishop & Cini, 2017). In one study of the biggest contract cheating database that exists, Harper et al. (2021) report that students were found to cheat the most in exams, especially in the multiple-choice format, even though this was detected the least by staff. This was almost in complete contrast with the results reported about written assignments, like essays and reports, where they found that students cheated less, but staff were much more successful in detecting their cheating attempts (p. 263). This goes to show that attempts of cheating in assignments that are given as part of portfolio assessment can be much easier to detect than those done in exams. This makes sense, as exam questions, in many cases, tend to have either a multiple-choice format or a short answer format that is either right or wrong (Reeves, 2000). Thus, if a student were to copy the correct answer from a friend, assuming he/she was not seen by an invigilator, then it would be very hard to detect. Whereas in assignments, or even projects, students’ answers tend to be much more subjective and personalized, making it a lot easier to detect any attempt of copying another student’s work, as it is almost impossible for two students to produce the same answer with the same wording used (Ray et al., 2018). Therefore, it is clear that portfolio assessment can well make it a lot easier to detect attempts of cheating than exams.

Furthermore, Dalziel (2008) contends that portfolio assessment can be effectively used to reduce plagiarism. This can be done by preventing one of the causes of plagiarism, being last-minute panics. These can be avoided by making work-in-progress drafts a mandatory part of the assignment submission, which forces students to begin working early on and avoid procrastinating until the last minute (p. 207). Instructors may even decide to only give feedback on these drafts and not grade them, further reducing the aforementioned last-minute panics due to the lower-risk nature associated with ungraded work. Moreover, instructors can encourage students to produce original work by allowing them to add their personal experience with the topic as part of the assignment (p. 208). All in all, it can be seen that portfolio assessment can be much more effective than exams at reducing plagiarism in works submitted.

Range of skills assessed

When it comes to the range of skills that can be tested, portfolio assessment can assess a much wider range of skills than exams where students are largely tested on their ability to commit teaching material to memory (Williams, 2002). In portfolio assessment, students' skills are much better represented, beyond just memorization skills. Skills like creativity and innovation, which are just as important, can be effectively demonstrated by students in the assignments or projects that they complete (Cunningham et al., 2016; Rodriguez et al., 2022). Whereas when traditional exams are used, students with such skills who may have weaker memorization skills than their peers tend to perform badly and are often considered outcasts or failures compared to them (Leon & Elias, 2016, p. 21). This may cause these students to have lower self-esteem and may even cause their performance to decline (p. 22).

Mental health and well-being

A decreased level of stress and improved mental health and well-being are usually associated with students who are tested by means of portfolio assessment instead of exams, which can lead to better grades (Howard, 2020; Jerrim, 2023). A study carried out by Slater et al. (1997) found that students tested using portfolio assessment were less anxious and enjoyed the learning experience more (p. 255). Moreover, due to the lower final grade percentage weight allocated to each assignment in a student's portfolio, the risk associated with each assignment is minimized, and thus, the stress and anxiety levels of students can be reduced, which can help them perform better (Vigeant, 2021). Conversely, Trifoni and Shahini (2011) maintain, in a study involving a questionnaire completed by university students, that test anxiety has several unfavorable impacts. It "affects motivation, concentration and achievement negatively, increases errors during the exam, creates problems recalling the material previously learned and prevents efficient study" (p. 99). They, therefore, propose replacing exams with alternative assessment tools that create less anxiety in students.

Advancement to the world of work

Considering that the end goal of most students who partake in the journey of education is to secure a good job, it is crucial to consider which method of assessment better prepares them for achieving that goal. Since portfolio assessment is based on doing

assignments and/or projects where students are allowed to refer to external resources, like the Internet, it much more resembles the type of work typically done in jobs, being tasks and projects (Eliot & Turns, 2011). Therefore, the type and style of work experienced through portfolio assessment are much more practical and realistic than those seen in exams, which can facilitate students' transition into the world of work (Dung & Ha, 2019). Furthermore, portfolio assessment teaches students how to become autonomous learners since now they are usually given the opportunity to select their own topics and references, collect data, and discuss the results from their respective perspectives (Hancock, 2004). This is essential, as autonomy at work is sometimes deemed an asset added to the job seeker's qualifications (Rodriguez et al., 2022).

Methodology

As stated in the literature review, several scholars have previously discussed portfolios as an effective tool for assessing learners' academic performance (Janssens et al., 2002; Tiwari & Tang, 2003). However, little evidence, if ever, has been provided on the actual value and efficacy of such an assessment method (Rodriguez et al., 2022), hence the originality of this study, which seeks to evaluate the potential efficacy of portfolio assessment and the extent to which this method can be considered a better assessment tool than exams. To this end, a questionnaire was devised and distributed to a cohort of sixty 20–22-year-old students in the College of Engineering at the American University of Sharjah in the United Arab Emirates. The questionnaire contained 12 questions concerning the positive or negative effects of these two methods on the students' academic performance. The questions were specifically related to the social circumstances under which students' proficiency is assessed and the practical skills they acquire as a result of the assessment method used.

To ensure clarity and completeness in responses, researchers maintained frequent communication with participants, urging them to address all questions thoroughly. Additionally, participants were provided with a detailed explanation of the portfolio assessment concept, despite their familiarity with it due to prior exposure in other courses. Creating a comfortable environment further facilitated honest responses, with students assured of anonymity and encouraged to take their time. Some respondents returned completed questionnaires promptly, while others took additional time for thoughtful reflection. The questionnaire is presented in Appendix I with a numerical summary of the students' responses provided in Appendix II.

The analysis of this study is based on the proportion of students who responded to the questionnaire. A binomial distribution was utilized to assess the proportion of students favoring specific responses over others. Then, hypothesis tests were carried out to determine if this proportion was at least 50%, with a 95% confidence level ($\alpha = 0.05$), supporting the study's proposition that students prefer portfolio assessment to exams. The results of the analysis are presented in Appendix III.

Results

The first section of the questionnaire entailed seven questions in relation to exams. As demonstrated in the table in Appendix III, when students were asked about the fairness of using final exams to evaluate their performance, 53.3% responded negatively, while

46.7% responded positively. The p -value of the Z -test, 0.699, showed that students were indifferent regarding the fairness of exams as an assessment tool. Concerning the accuracy of exams, 76.7% of students believed exams were inaccurate, compared to 23.3% who found them accurate (p -value < 0.001). This finding supports the proposition that exams are not perceived by students as accurate indicators of their performance. Moreover, exam-induced stress was a notable concern, with 95% of students reporting that exam anxiety had adversely affected their performance (p -value < 0.001), underscoring the negative impact of exams on students' well-being and academic outcomes. Further investigation of the adverse effects of exams revealed that a significant 77.2% of students believed that their performance on some, most, or all of their exams was negatively impacted by exam-induced stress or anxiety (p -value 0.033). Additionally, 83.3% attributed poor performance to illness or lack of sleep, with a significant p -value of < 0.001, and 80.8% acknowledged that this issue arose during some, most, or all exams (p -value < 0.001). When asked if exams should contribute to 35% of a student's overall performance, 83% of students believed this contribution proportion should be lower (p -value < 0.001), indicating their dissatisfaction with the overreliance on exams as a means of assessment.

In the second section of the questionnaire, students were asked five questions pertaining to the topic of portfolio assessment. When asked which assessment method would assess a broader range of skills, 91.7% of them advocated for assignments/projects as better alternatives to one or two exams (p -value < 0.001). Regarding academic dishonesty, 41.7% of them indicated that they would cheat in both assignments/projects and exams, and the p -value of 0.052 confirmed their indifference. In terms of preparation for the labor market, 95% of students believed that portfolio assessment better equipped them for future careers compared to exams (p -value < 0.001). Overall, in support of portfolio assessment, 90.0% of students believed that some, most, or all of their courses should utilize portfolio assessment over exams, with a p -value of 0.519 indicating an even split among students who believe few, some, most, or all courses should use portfolio assessment. Lastly, all the above findings were reinforced when 76.7% of students finally expressed a preference for portfolio assessment over exams as an assessment method (p -value < 0.001).

Discussion

The questionnaire results reveal a strong student preference for portfolio assessment over exams. While opinions on the fairness of exams are split, the majority of students perceive exams as inaccurate and stress-inducing, negatively impacting their performance and well-being. In addition, students overwhelmingly support portfolio assessment, believing it better evaluates a broader range of skills and better prepares them for the labor market, and that it should even be used in some, most, or all of their courses over exams as an assessment tool. Despite concerns about academic dishonesty being similar across both methods, 76.7% of students favor portfolio assessment, indicating a clear preference for this method of evaluation.

The findings of this study align closely with those highlighted in the "[Literature review](#)." They are consistent with the results of the study by Rodriguez et al. (2022), which revealed that portfolio-based projects benefit significantly from ongoing, timely

feedback from instructors, which fosters skills such as creativity and problem-solving. They, moreover, maintained that the portfolio assessment methodology encouraged peer idea exchange, facilitated the utilization of students' prior knowledge, and contributed to overall enhancements in learning outcomes. Also, in line with our study's findings are those reported in Obeiah's and Bataineh's (2016) study. They highlighted that students assessed through portfolio assessment outperformed those evaluated via traditional exams in writing assignments. This was attributed to the former groups benefiting from regular feedback and guidance throughout the writing process. Consistent with the findings of this study are also those stated by Trifoni and Shahini (2011) who observed that anxiety impairs students' concentration and academic performance, leading to increased errors and lower grades. All this emphasizes the value of employing portfolio assessment as a method for evaluating students' academic performance, rather than relying on formal exams.

Conclusion

Overall, it is apparent that portfolio assessment is a more viable tool to assess students' academic performance than exams due to several advantages. Firstly, it allows instructors to monitor students' performance throughout a semester, which allows them to provide valuable feedback for improvement. Secondly, the use of portfolio assessment instead of exams can reduce students' stress and anxiety levels that are caused by the high-stakes nature of exams, which translates into better performance for the students. Thirdly, portfolio assessment is capable of assessing a wider range of skills than exams, beyond just memorization skills, which better represents students' skills. Moreover, despite concerns over cheating attempts still being prevalent among students with regard to portfolio assessment in a similar fashion to exams, the overwhelming majority of students still prefer the former over the latter. Furthermore, the assignments and projects given as part of portfolio assessment much more closely resemble what the work is like in the world of work, which facilitates students' transition to it.

All the above goes to show that portfolio assessment is a more viable method for assessing students' academic proficiency than exams. Accordingly, universities and other higher education institutions are advised to adopt this assessment method if they are to establish a reliable and effective assessment system that enables students to learn effectively and be evaluated in a more relaxed, fair, academic, and professional environment. Future research could focus on pre-tertiary education by exploring whether portfolio assessment could also serve as a superior assessment tool compared to exams in schools considering the various unfavorable effects that exams impose on students.

Limitations of the study

As outlined in the "Methodology" section, the study included 60 participants aged between 20 and 22, all enrolled in the College of Engineering at the American University of Sharjah. Notably, variables such as gender, academic major, employment status, and pre-university education background were not factored into the data collection process. Additionally, due to the study's focus on engineering, it remains uncertain whether the findings can be extrapolated to students in humanities disciplines. Furthermore, the questionnaire used in this research was exclusively completed by students; assessing

instructors' responses was outside the study's scope. For future investigations, incorporating instructors' input could offer valuable insights, allowing for comparisons between student and instructor perspectives and exploring potential overlaps.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s40468-024-00296-y>.

Appendix I: Questionnaire
 Appendix II: Questionnaire Results Numerical Summary
 Appendix III: Questionnaire Results Statistical Analysis

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Authors' contributions

RZ conducted the major part of the research, provided all relevant citations after reading all the works consulted, and drafted the reference page. JZ devised the questionnaire and interpreted the data. Both discussed the results and concluded the article. Finally, both read and approved the final manuscript.

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Availability of data and materials

The questionnaire is included in Appendix I, a numerical summary of the data in Appendix II, and the study's statistical analysis in Appendix III.

Declarations

Competing interests

The authors declare that they have no competing interests.

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