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Investigating chemical engineering students' perceptions of feedback: A glimpse into current problems and a platform for improvement

Ya He, Olumide Olumayegun, Mohammad Zandi *

Department of Chemical and Biological Engineering, The University of Sheffield, Mapping Street, Sheffield S1 3JD, United Kingdom

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ABSTRACT

Effective and quality academic feedback is essential for student success in engineering education. However, chemical engineering students consistently report lower satisfaction with the feedback they receive based on the results of the UK National Student Survey (NSS) published in recent years. Despite this, there is limited research on students' perceptions of feedback in chemical engineering education. This study investigates the views of chemical engineering students on four key dimensions: knowledge and understanding of feedback, perceptions of effective and quality feedback, preferences for the modes and format of feedback, and experience with the feedback received. To draw meaningful and useful conclusions, this investigation was conducted on a small scale targeting 37 participants from undergraduate (UG) students in years one to four of the Chemical Engineering programmes at the University of Sheffield. The findings confirm that most of the UG students who participated in the study demanded to receive targeted and personalised feedback. Students considered that feedback on how to improve skills, identify mistakes and give specific examples to solve problems were more effective than a simply stated grade. The focused approach in this study allowed for an in-depth analysis of the perceptions of feedback among targeted UG students, leading to an improved definition of feedback for engineering education. It is proposed that feedback can be characterised as the process of communicating the learner's current and expected accomplishments, pointing out areas for improvement, and suggesting possible steps to address them while also requiring the learner to engage with and reflect on the provided comments.

1. Background

Feedback significantly impacts students' academic performance in higher education (Nicol and Macfarlane-Dick, 2006; Boud and Molloy, 2013; Beaumont et al., 2011; Hattie, 2011; Brown and Knight, 2012). A study by Hattie (2011) has shown that feedback has twice the average influence of all other educational factors on learning. Therefore, providing practical and high-quality feedback is considered one of the critical factors for productive teaching and learning (Ramsden, 2003; Mulliner and Tucker, 2017; Hattie and Timperley, 2007). However, it is unfortunate that in the UK, the National Student Surveys (NSS) have consistently shown that undergraduate (UG) students across higher education institutions are generally least satisfied with the feedback aspect of their educational experience (OfS, 2021; Beaumont et al., 2011). Therefore, improving the effectiveness and quality of feedback and student satisfaction with current feedback practices remains a significant challenge for academic departments (Lowe and Shaw, 2019; Glazzard and Stones, 2019). The existing research has relatively limited studies on students' perception of feedback (Weaver, 2006; Pokorny and Pickford, 2010; Poulos and Mahony, 2008). Even less research has been reported explicitly focusing on the perception of feedback among engineering (or chemical engineering) students. Therefore, this study aims to gain an in-depth understanding of students' perception of effective and quality feedback and identify potential changes needed to improve student satisfaction with feedback received in the Chemical Engineering programme. Evidence from the study can provide additional insights into existing research and information on improving feedback practice and enhancing student engagement for educators.

1.1. Definition of feedback

In the context of feedback, some researchers regard it as the concluding part of the assessment process (providing additional information on grades), while others refer to feedback as any comments on student assignments (Evans, 2013; Boud and Molloy, 2013). Askew and Lodge (2004, cited in Retna and Cavana, 2013) provided a broad

* Corresponding author.
E-mail address: m.zandi@sheffield.ac.uk (M. Zandi).

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definition of feedback, considering it as all " dialogue that supports learning," whereas Nicol and Macfarlane-Dick (2006) defined an alternative definition of feedback as " anything that might strengthen the students' capacity to self-regulate their own performance." From the perspective of educational research, feedback is any information given to learners aimed at closing the gap between learners' actual performance and the desired performance (Retna and Cavana, 2013; Mory, 2013; Poulos and Mahony, 2008; Ramaprasad, 1983). Furthermore, Boud and Molloy (2013) adopted a definition which focuses on the learner and argues that feedback is "*.as a process whereby learners obtain information about their work in order to appreciate the similarities and differences between the appropriate standards for any given work, and the qualities of the work itself, in order to generate improved work*". It should be noted that for the purpose of this study, a comprehensive definition characterising the feedback in the context of engineering education was not found, and therefore, this research will attempt to address this.

1.2. Importance of feedback in higher education

It is clear from the existing literature that feedback has been shown to have numerous benefits regarding motivating learners and boosting their confidence and self-esteem while providing an opportunity for reflection (Clynes and Raftery, 2008). The importance of feedback to teaching and learning in higher education has been highlighted (Watkins et al.,2014; Retna and Cavana, 2013; Glazzard and Stones, 2019; Clynes and Raftery, 2008; McKimm, 2009; Joughin, 2008). It helps students grow by providing direction for improvement and clarifying what is correct and incorrect, enhancing their knowledge, understanding, and skills (McKimm, 2009). Feedback assists teaching by allowing students to evaluate their learning progress and goals, and it provides a tool for maintaining professional standards in academia (Retna and Cavana, 2013; Joughin, 2008). From the perspective of the constructivist and the cognitivist learning theories, feedback can be used to guide students in constructing their own meanings and knowledge instead of telling them directly what to learn (Higgins et al., 2002; Retna and Cavana, 2013; Evans, 2013). Furthermore, feedback can allow instructors to monitor the development of students' deep learning (Higgins et al., 2002). Cognitivists, on the other hand, tend to "use feedback (knowledge of results) to guide and support accurate mental connections" (Ertmer and Newby, 2013). In addition, from the student's perspective, their motivation for seeking feedback is not solely for grades but rather their desire to develop self-regulated, constructive and deep learning (Mulliner and Tucker, 2017; Higgins et al., 2002; Weaver, 2006).

1.3. Different perceptions of feedback between students and staff

Hattie and Timperley (2007) proposed a feedback model that promotes learning, highlighting the specific properties and conditions that make feedback effective. This model identified four levels of feedback that help learners develop self-regulation and guidance, leading to the formation of personal evaluation and influence through understanding and completion of tasks. However, in teaching practice, research on feedback is still primarily teacher-centred and emphasises the input aspect of feedback while paying little attention to the student's perspective. Past studies have shown significant differences in opinions between students and staff regarding the effectiveness, content, process, satisfaction, and preferences of feedback (Carless, 2006; Mulliner and Tucker, 2017; Van Der Kleij and Adie, 2020). Gibbs et al. (2003) also found that while instructors believed they were providing feedback through informal means such as lectures, seminars, and labs, students believed that only written feedback was considered as feedback. Weaver (2006) investigated whether feedback aligned with a student-centred approach and observed that general or vague negative feedback, as well as feedback lacking guidance or consistency with assessment criteria, had a limited impact on improving learning outcomes. Retna and Cavana (2013) reported that they examined students' perceptions of formative feedback and inferred the improvement in students' satisfaction with feedback may stem from how the quality and outcomes of their assignments are enhanced. Another analysis of students' perceptions of feedback effectiveness by Poulos and Mahony (2008) indicated that, in addition to issues related to the delivery and timeliness of feedback, the credibility of the teacher is also an important factor influencing student satisfaction. The study conducted by Hadjieconomou and Tombs (2021) also confirmed this finding, indicating that students do not prefer feedback provided by anonymous raters as they would instead engage in a conversation with the provider. A consensus that can be obtained from the literature review is that there is less research on students' perceptions of feedback compared to other areas of feedback research (Weaver, 2006; Pokorny and Pickford, 2010; Poulos and Mahony, 2008). It is therefore important to consider what forms and quality of feedback students need from their perspective in order further to improve the quality and satisfaction of teaching and learning. In comparison, some previous studies have focused on students' perceptions of certain aspects of feedback, such as written, verbal, or electronic feedback, or students' perceptions of a single piece of feedback. In contrast, in this study, we aimed to advance and complement existing research by exploring chemical engineering students' perceptions and overall satisfaction with feedback practices. In addition, this study tried to improve previous definitions of feedback and proposes a new comprehensive definition in the context of engineering education.

2. Methodology

A small-scale research has been designed and attempted to get an in-depth insight into UG student satisfaction of feedback in the Department of Chemical and Biological Engineering (CBE) at the University of Sheffield, UK, by seeking volunteer participants from years one to four enrolled in the Chemical Engineering programmes during 2021–2022 academic year. An online survey questionnaire comprising quantitative and qualitative questions was designed to obtain the research data on students' perceptions of feedback.[1] Administering the questionnaire online has the benefit of reaching a volunteer student population quickly and conveniently with minimal disruption to teaching. The survey questions were designed to measure and quantify the following four dimensions of students' perception of feedback:

Dimension 1. - Students' knowledge and understanding of feedback.

Dimension 2. - Students' perception of effective and quality feedback.

Dimension 3. - Students' preferences of the modes and formats of feedback.

Dimension 4. - Open-ended questions on students' experience with feedback.

The students' responses under the above dimensions would provide answers to the following four explorative questions on students' perception of feedback respectively: What is feedback to students? What feedback is valuable and helpful to students? How do students want feedback to be provided? What is currently working or requires improvement regarding feedback? Dimension 1 to Dimension 3 were made up of 5-point Likert scale questions. Under Dimension 4, participants were asked to respond to three open-ended questions on their experiences with feedback and personal preferences.

The student cohorts from different study levels in the department were recruited to participate in this focus study. The invitation email provided the background information and the participant information

[1] The University of Sheffield Ethics reviewers have reviewed this research project and the project was approved on 29/10/2021 on ethics grounds – Reference Number 043733.

sheet, which explained the importance of the study and the participants' rights. Participation in the survey was completely confidential, and all responses were anonymous using a unique link to an online questionnaire designed in Google Forms. The survey was open from November 2021 until the end of January 2022. Overall, 37 students volunteered to participate in this study and all completed the questionnaire.

3. Results

This section presents a concise overview of the student participants' demographics, the student's perception of feedback contents, quality and formats and sheds light on the students' attitudes to the departmental feedback practice. The results contribute to a deeper understanding of UG students' perception of feedback in chemical engineering courses which will lead to improving feedback definition.

3.1. Demographics

This study targeted 37 students out of hundreds of UG students studying chemical engineering in CBE during the period of the research.[2] The study's timeline clashed with the end-of-semester examination, which made it challenging to recruit more students for this study. However, given the focused approach in this investigation, the results of this study are conclusive and meaningful conclusions can be drawn. The demographic information of student participants was examined in four data set categories. As can be seen in Table 1, there were more male respondents than female respondents, and the number of respondents is relatively evenly distributed at each year level. In terms of age distribution, most of the participants were under 25 years old. The largest cohorts of students' ethnic groups that participated were white and Asian or Asian British. Also, there was a relatively even distribution of home and overseas students who responded to the survey.

3.2. Dimension 1: students' knowledge and understanding of feedback

The data were not analysed separately according to different academic years due to the small sample size obtained for this survey. As can be seen in Fig. 1, in terms of whether students have received guidance on understanding and using feedback, 45.9 % of respondents' answers were yes and before their university course started. 43.2 % were yes and received the guidance for the first time when they entered the university. Only a few respondents (2.7 %) mentioned learning about feedback through studying a book on study skills and other means). However, it was worth noting that 13.5 % of respondents still said that they had never received guidance on feedback anywhere or at any time before or after they started the university courses.

For most students, feedback from instructors/teachers (37.8 % were always and 40.5 % were usually) and grades (37.8 % were always and 43.2 % were usually) were what they most often consider good feedback. In addition to these two most traditional forms of feedback, students also often thought the feedback they reflect from themselves (54.1 % usually thought) and their peers (48.6 % usually thought) was one of the good ways to obtain feedback. Furthermore, feedback from an experiment was also recognised by many students (40.5 % were usually) as a good source of feedback. Overall, the result showed a positive view towards students' understanding and perception of the sources of feedback (see Fig. 2). However, a minority of students did not consider any of these elements to be good feedback sources ($\leq$5.4 %).

When students received the feedback, the majority of the feedback contents was that they could read, understand and use (see Fig. 3), but still, 5–8 % of the respondents felt that the feedback they received was almost useless. The form and content of feedback varied from different instructors and curricula, and this may, therefore, cause students to have difficulties in reading, understanding and applying the feedback in their subsequent assignments.

3.3. Dimension 2: students' perception of effective and quality of feedback

Across all statements in Table 2, most students agreed that the feedback they received was clear and easy to read, and its content was relevant to the learning outcomes and assignment criteria. Students also felt that the feedback they received should be constructive and encouraging and indicate further improvement. It is interesting to note that the timing of the feedback provided seemed to influence students' ratings of how useful the feedback was. There was a split agreement about the statement '*Feedback given at the end of the module is not useful*', which might indicate students' judgement of valuable feedback by the timing at when it would be given. Most students also tended to receive positive feedback rather than negative feedback. However, some students still felt they did not receive enough feedback or suggestions for further improvement. It is obvious that, for the statements '*Important that students have an opportunity to discuss feedback with lecturer face-to-face*' and '*Lecturers encourage students to discuss feedback face-to-face*', discussing feedback face-to-face with the lecturer did not seem to be valued by these UG students. Yet, on the contrary, they thought that lecturers often encouraged them to discuss feedback face-to-face. These perceptions might appear to conflict and could be explained by assuming that the feedback the students received had been explained in detail, and therefore they would feel less that it was essential to discuss the feedback in person. Additionally, most students agreed that the quality of feedback varied depending on the lecturer (40.5 % strongly agreed and agreed). In general, looking through the students' responses to all statements, about half of the respondents (51.2 % in total strongly agreed and agreed) were satisfied with the feedback they received.

Overall, the seven types of feedback listed in Table 3 were all considered to be helpful and practical by most students, with suggestions for improvement (67.6 %), identifying mistakes (62.2 %) and use of examples (59.5 %) being the three most important. In addition to these three types, specific notes were also considered very important by 51.4 % of the students. By comparison, simply pointing out what was correct and alignment to task criteria were not considered to be a beneficial type of feedback. Some respondents also thought that general/overall comments about their work were the least helpful type of feedback they received.

3.4. Dimension 3: students' preferences of the mode and format of feedback

In order to better assess the student's preferences for the feedback format, a 1–5 rating scale was used in the survey. The score scale is 'very effective' = 5, 'quite effective' = 4, 'somewhat effective' = 3, 'not very effective' = 2, and 'not effective at all' = 1 for question 1 of 'How effective has the feedback been in the following format?' The score scale is 'rate 5 - very useful' = 5, 'rate 4 - quite useful' = 4, 'rate 3 - somewhat useful' = 3, 'rate 2 - not very useful' = 2, and 'rate 1 - not useful at all' = 1, for question 2 of 'Rate the following elements of feedback in terms of usefulness to you personally.' The scores presented in Figs. 4 and 5 were obtained by converting the students' choices into corresponding scores and multiplying them by the number of students in each option.

The top three scoring formats of feedback in Fig. 4 were individual verbal (face-to-face) (159 points), individual hand-written (151 points) and individually typed (148 points). Compared to the other feedback formats with lower scores, it was clear that the students preferred individual feedback over group feedback. The results also showed that the two lowest scores were for feedback from peers or discussion of work in a group (137 points) and verbal feedback to a group (129 points).

Then, as shown in Fig. 5, for the three common elements of feedback used in practicals, most students chose the rate 4–5, indicating that they

[2] The exact number of the students studying at the time are confidential and the authors has no liberty to publish the exact number of the students.

Table 1
Demographic summary of participants.

	Undergraduate Year 1 (11 students)	Undergraduate Year 2 (4 students)	Undergraduate Year 3 (9 students)	Undergraduate Year 4 (6 students)	Total (37 students)
	%	%	%	%	%
Gender					
Male	18.9	21.6	10.8	10.8	62.2
Female	10.8	0.0	18.9	8.1	37.8
Age					
18-20 years	18.9	13.5	13.5	0.0	45.9
21-25 years	5.4	5.4	10.8	16.2	37.8
26-30 years	5.4	0.0	2.7	0.0	8.1
30 years and above	0.0	2.7	2.7	2.7	8.1
Ethnic Group					
White	2.7	13.5	18.9	8.1	43.2
Black, African, Caribbean or Black British	2.7	0.0	0.0	0.0	2.7
Asian or Asian British	21.6	5.4	5.4	8.1	40.5
Other ethnic group (Arab or any other ethnic group)	2.7	0.0	2.7	0.0	5.4
Mixed or Multiple ethnic	0.0	2.7	2.7	0.0	5.4
Prefer not to say	0.0	0.0	0.0	2.7	2.7
Home students	8.1	16.2	13.5	10.8	48.6
Overseas students	21.6	5.4	16.2	8.1	51.4

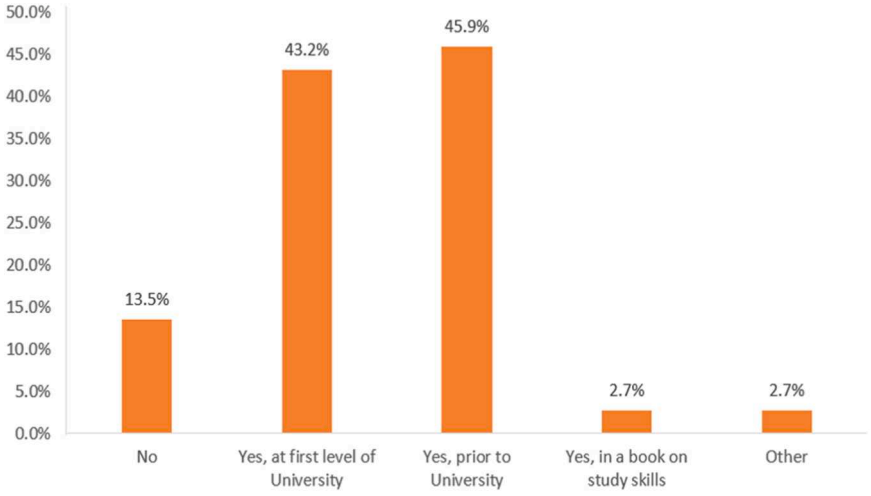

Fig. 1. Students' perception of receiving guidance on how to understand and use feedback before they enter the university.

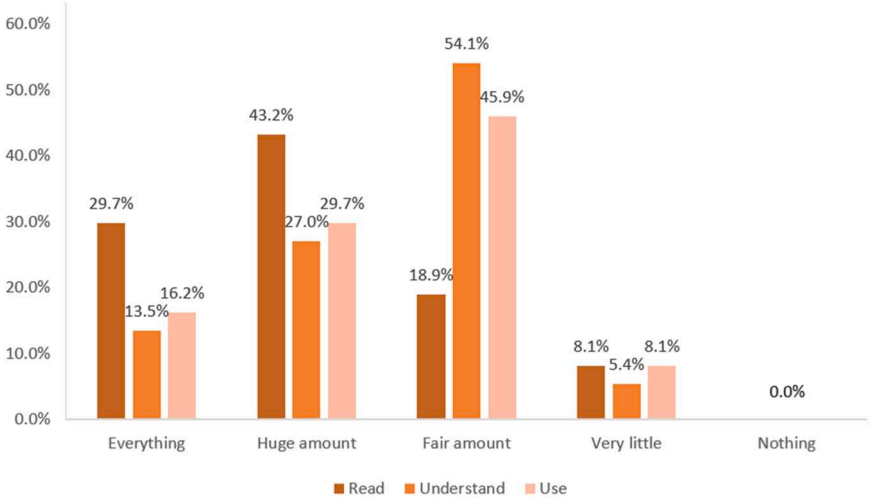

Fig. 2. The student perceptions of feedback elements: Instructor/Teacher, Grades, Results from an experiment, Peers and Myself as good sources of feedback.

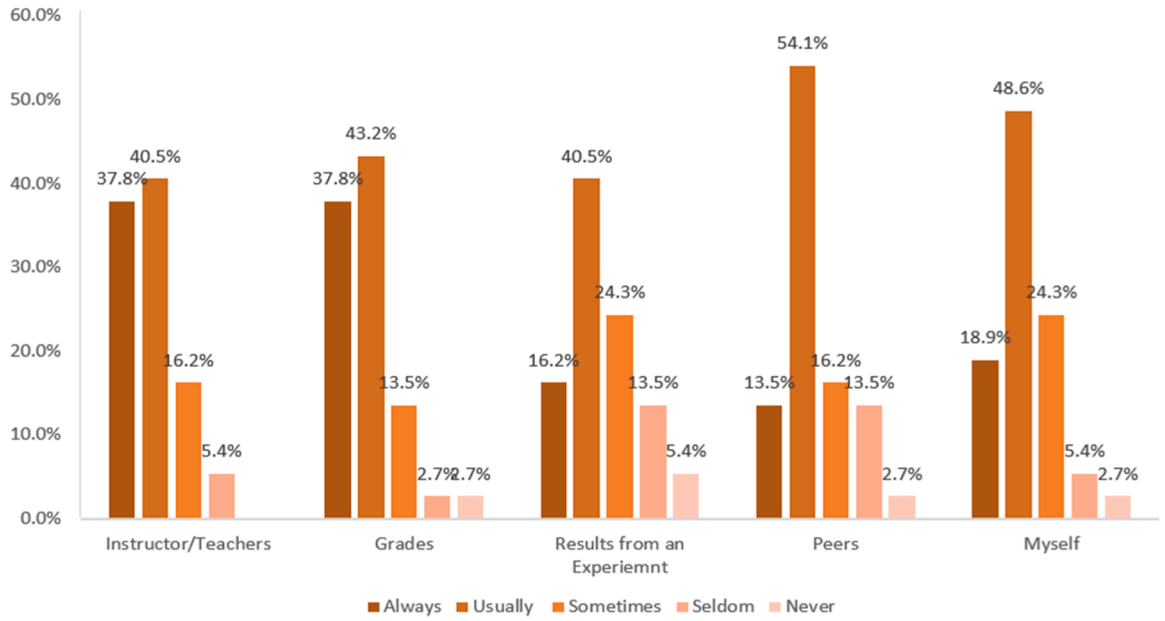

Fig. 3. The extent to which students receive feedback that they find readable, understandable and usable.

agreed that these elements were quite or very useful to them personally. The students with positive feelings (rate 5) perceived that a tick or rating against criteria (85 points) and numeric mark (75 points) were their preferred feedback forms. In contrast, a relatively small number of students found a stated grade to be useful feedback. Noteworthy is that most students perceived all three feedback elements as applicable to them personally. However, there were still a few students who did not find them very useful (rate 2).

3.5. Dimension 4: open-ended questions

To gain an in-depth understanding of how students feel about the feedback they have received so far, the survey also included three open-ended questions for students to give unqualified answers based on their own experiences. The student's responses to each question are summarised below.

What type of feedback do you personally prefer?

For this question, most students mentioned that they preferred receiving individual feedback. Some students also stated that feedback should be able to give clear advice on further improvements, point out what is correct, indicate mistakes and whether they have met the assignment criteria. As indicated from the responses, handwritten or typed feedback would allow them to see where they need to improve and could give them a record to return later for similar problems.

Looking back at your experience with feedback, are there any positive aspects you would like to highlight?

In response to the UG student's experiences, they found that the most helpful feedback they received was mainly from lab reports. The feedback on lab reports received by the students was relevant, constructive and with suggestions for improvement in their future studies. Moreover, the students agreed that when they received positive feedback, it motivated them to learn better. Some students also felt that getting feedback from teaching assistants was very helpful.

Looking back at your experience with feedback, are there any areas for improvement you would like to highlight?

In the students' view, the feedback they received needed to improve the timeliness of releasing and receiving feedback and to standardise the modes and contents of feedback. Students also preferred receiving specific feedback on their own work rather than generalised or group comments.

4. Discussion

This study explores UG students' perceptions, understandings and preferences regarding feedback. It paves the way for future in-depth and extensive research on engineering students' perceptions of feedback across other departments in Sheffield and UK universities. Whilst feedback ratings are mentioned in the annual NSS data, it does not differentiate between the outcomes of engineering students and those studying other subjects. In engineering courses, there is a substantial emphasis on practical work and project design, which necessitates a distinct level of quality and timeliness in feedback compared to other disciplines. Therefore, this investigation was conducted in CBE as a valuable preparatory step to obtain a more comprehensive picture of UG students' perceptions of feedback at different study levels and subjects. The survey responses show that the UG students who participated in this research were relatively satisfied with the departmental feedback received. Still, there remain several issues that require more attention.

The study's findings revealed a higher participation of overseas students in our feedback survey, particularly from Asia. It may be an indication of the willingness of these overseas students to care more about their studies in universities. Similar to the findings of Campbell and Li (2008), Asian students tend to lack knowledge regarding learning support provided in Western universities, which may lead them to expect more from receiving feedback. However, this phenomenon does not fully represent the distribution of student cohorts in the department.

In recent years, there has been a shift towards consumerism in Western higher education (Naidoo et al., 2011; Palfreyman, 2013) has resulted in an increase in the number of overseas students enrolled in UK universities (The Economist, 2022). Overseas students pay higher tuition fees than domestic students, leading them to view themselves as paying customers for access to educational services. According to Higgins et al.'s report (2002), students perceive feedback as part of the "service" they are paying for and expect value for their money. Some studies suggest that this consumerist attitude leads to passive and superficial learning approaches (Webb, 2018; Molesworth et al., 2009; Svensson and Wood, 2007). However, conversely, if students perceive education as a consumer service, they are more likely to engage in activities that lead to better performance. Hence, educators should consider more about how to provide students with qualified feedback from students' perspectives.

The findings from the section on students' knowledge and

Table 2
The students' perception towards different statements.

How strongly do you agree with the following statements	Strongly agree %	Agree %	Neither %	Disagree %	Strongly disagree %
The feedback I receive is clear and easy to read.	16.2	67.6	10.8	5.4	0.0
Feedback relates to the learning outcomes.	24.3	59.5	13.5	2.7	0.0
Feedback relates to the assessment criteria.	37.8	48.6	10.8	2.7	0.0
Tutors don't provide enough feedback.	13.5	27.0	27.0	29.7	2.7
Feedback rarely provides me with useful suggestions for improvement.	51.4	40.5	8.1	0.0	0.0
Feedback given at the end of the module is not useful.	10.8	24.3	27.0	32.4	5.4
Positive comments have boosted my confidence	8.1	40.5	24.3	21.6	5.4
I thought about giving up when I got negative feedback.	43.2	40.5	8.1	8.1	0.0
Important that students have an opportunity to discuss feedback with lecturer face-to-face.	13.5	13.5	35.1	32.4	5.4
Important that feedback is constructive and encouraging.	37.8	45.9	13.5	2.7	0.0
Important that feedback gives detailed direction for future improvement.	18.9	32.4	21.6	21.6	5.4
Lecturers encourage students to discuss feedback face-to-face.	43.2	37.8	16.2	2.7	0.0
Feedback is of varying quality depending on the lecturer providing it.	40.5	40.5	18.9	0.0	0.0
The feedback I receive is always constructive and encouraging.	13.5	27.0	40.5	18.9	0.0
In general, I am satisfied with the quality of feedback I receive.	10.8	40.5	29.7	18.9	0.0

understanding of feedback also indicate that most students clearly understand what "feedback" entails and can judge what feedback resources are helpful to them. Because UG students tend to have an initial understanding of what constitutes feedback before or at the beginning of their university course. As reported by Burke (2009), students have the opportunity to receive guidance before they enter university to help increase their preliminary knowledge regarding feedback, although the quality of the guidance varies.

The results of students' perception of effectiveness and quality of feedback show that a large proportion of students cannot improve their studies of the feedback they receive. While this phenomenon may reflect the fact that it may not be enough for feedback to be merely readable and usable, the quality and effectiveness of feedback may be affected by when it is provided to students, how much time the teachers spend providing it, and how much time students spend reading it. This study was conducted at the end of the autumn semester (later November to early January), when students have submitted their final assignments but may not have received feedback yet, which could also result in a bias in students' perception of feedback. While most students largely agreed with the positive statements regarding the quality of the feedback, several students, however, gave more critical responses, suggesting that they differed in their opinions regarding the quality of feedback given by different tutors/instructors in the department. According to Evans (2013) and Henderson et al.'s (2019) research, effective feedback can help students improve by providing extra guidance, practice, and training. Feedback, for instance, which uses specific notes, applies examples and directly illustrates how to correct or improve, is more likely to be appreciated by students.

As seen in the subsequent questions on student preferences for feedback formats, it is clear that over half of the participants preferred to receive individual feedback, and they are also relatively satisfied with the form of feedback they currently receive. In terms of its functionality, the purpose of feedback is to narrow the gap between actual performance levels and expected learning goals (Lizzio and Wilson, 2008; Ramaprasad, 1983; Sadler, 1989). Therefore, it can be seen that the feedback provided in the chemical engineering course currently meets the learning and development needs of UG students. However, if we want to develop a personalised feedback mode further, it may increase the workload of the teaching staff.

Finally, as shown in the open-ended questions, most students perceive that the feedback provided at the current stage is helpful for their learning. The responses suggest that students tend to show a positive attitude towards the feedback they receive. The key aspects include specific suggestions and customising to their own work, which encourages them for better improvements in future learning. However, several issues were still identified: the timing for feedback, whether there is a standard format of feedback, avoiding generalised feedback for different students and so forth. The university and the department should encourage and support students to follow up after receiving feedback. In addition, due to the revolution of AI technology, such as ChatGPT in the education sector in recent years, an increasing number of such technologies are applied to provide students with fast and more personalised feedback (Chan and Tsi, 2023; Sandu and Gide, 2019). Thus, enabling teaching staff to improve the effectiveness of feedback and allowing students to receive timely feedback will remain a top priority for universities to improve future education quality (Murtagh, 2014; Peterson and Irving, 2008; Mathisen, 2012).

In summary, based on the various definitions of feedback reviewed by the authors and the results of this study, feedback conveys the current and expected performance of learners, identifying areas for improvement, and suggesting possible steps to address them. Learners should engage with and respond to feedback for it to be effective. In today's

Table 3
The student's perception of the effectiveness of different feedback types.

How helpful do you find the following types of feedback?	Very important %	Quite important %	Somewhat important %	Not very important %	Not important at all %
Suggestions for improvement	67.6	24.3	8.1	0.0	0.0
Specific notes	51.4	37.8	10.8	0.0	0.0
Identifying mistakes	62.2	21.6	13.5	2.7	0.0
Use of examples	59.5	37.8	0.0	2.7	0.0
Pointing out what was correct	37.8	29.7	27.0	5.4	0.0
Alignment to task criteria	35.1	51.4	13.5	0.0	0.0
General/Overall comments about your work	37.8	32.4	21.6	8.1	0.0

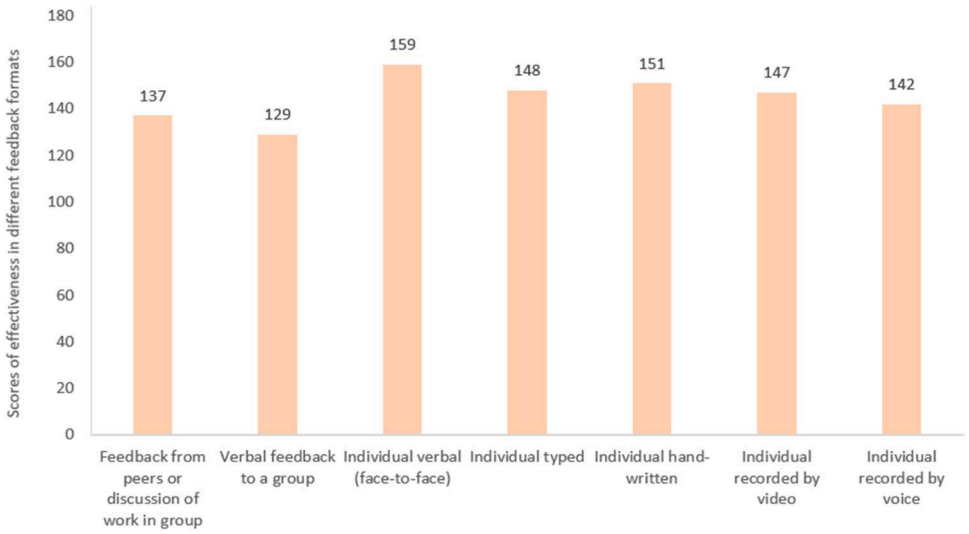

Fig. 4. The effectiveness of different feedback formats.

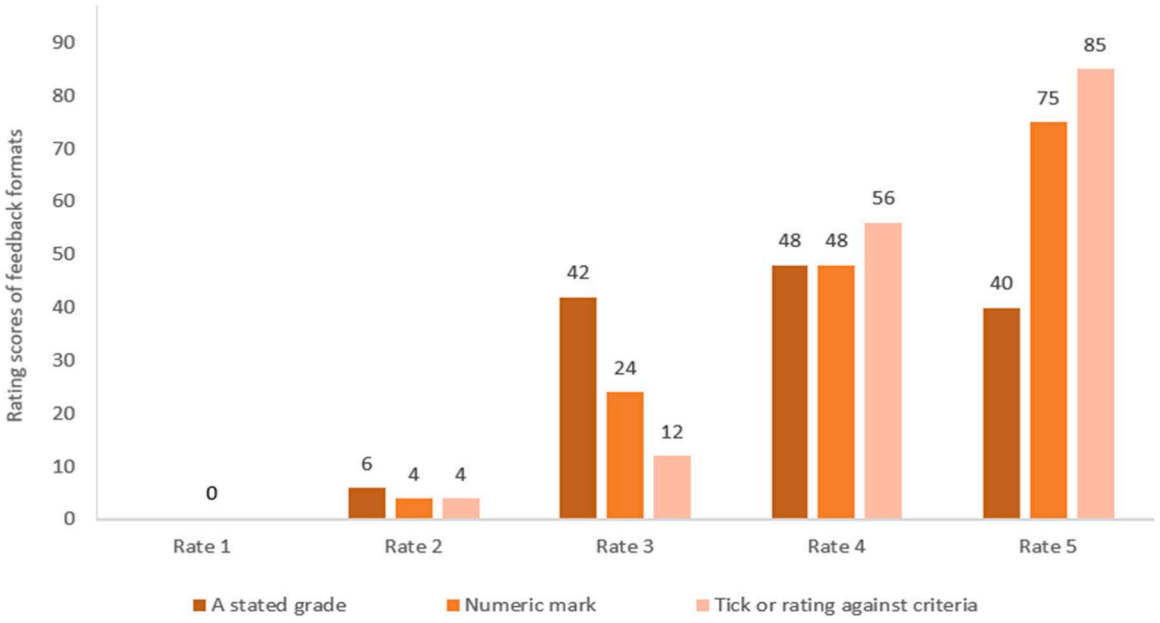

Fig. 5. The usefulness of different feedback elements.

higher education, feedback is not just a one-sided communication from the instructor to the learner. Instead, it is more dynamic and requires learners to actively engage with the feedback, seeking clarification and discussing ways to implement improvements. Thus, giving and receiving feedback is becoming a skill for both educators and learners need to develop. Educators should be trained to give constructive, clear, and targeted feedback, while learners should be guided on how to receive, interpret, and use the feedback they receive.

5. Conclusions

This study sought to add valuable insights into the form and effectiveness of feedback for Chemical Engineering UG programmes. The findings from the initial, limited-scale survey lay a strong foundation for more extensive research on feedback across a wider range of institutions. The insights gained have highlighted key areas and variables for further improving the content and quality of feedback. Building on this groundwork, our future studies will expand the participant sample size and incorporate a diverse range of organisations, enhancing the generalisability and applicability of the results. Our research progression from a focused to a more comprehensive investigation allows for progressive clarification and definition of feedback. At the present stage, we have clarified that effective feedback is dynamic and integral to the learning process. For students, it is a two-way dialogue with instructors that not only identifies areas for improvement but also highlights strengths, thereby increasing learner understanding and motivation. Furthermore, targeted feedback, given at the right time, promotes learning and skill development and encourages learners to see challenges as opportunities for improvement, also enhancing the learning experience.

Our investigation not only explored students' perceptions of feedback but also brought to our attention that overseas students place a particular emphasis on receiving effective feedback. Because their previous educational environment and patterns may differ from those of UK universities, they are more likely to treat feedback as a channel through which they can acquire personalised and timely evaluation for their

learning effectiveness. Along with today's increasing internationalisation of UK universities, feedback can be an important tool to facilitate students' transition from different educational and cultural backgrounds (Pokorny and Pickford, 2010), not only for overseas students but also for most various learners.

This study gained specific insights from selected groups of students studying Chemical Engineering programmes. The findings shed light on issues that must be confronted in Higher Education about how to provide personalised feedback to students to help them achieve better individual development. Such a perspective is not only a concern for UK students but is also valued globally at all levels of education, where feedback is a necessary component of personal self-evaluation and reflection for learners. Educators giving feedback and students receiving feedback is a gateway to identifying biases and deficiencies in teaching and learning and teaching.

Furthermore, with the recent emergence of AI technology, AI-assisted education is bound to become one of the key concerns of global education. Exploring how to apply AI tools to promote personalised learning, self-evaluation, data-driven decision-making, gamification, and predictive analytics for student success will create new opportunities for future education research. Introducing AI tools will not only help teachers improve their teaching skills and strategies but also give them a digital perspective on the learning needs of Generation Z students. For students, on the other hand, being able to learn and apply AI tools correctly can facilitate their essential skills of working in Industry 4.0 and individual development of lifelong learning skills. Hence, our forthcoming research will conduct feedback studies on broader engineering student groups, exploring the potential of AI in Engineering Education and applying it to provide students with immediate and personalised feedback.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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