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Assessment Redesign for Deep Approach to Learning in Engineering Education: The Impact of Graded Hand-ins, Oral Examination, and Early-Released Exam Cases

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ABSTRACT

Student motivation and deep approach to learning are strongly influenced by assessment design. This study investigates the impact of redesigning assessment in a Food Technology course for undergraduate engineering students at DTU. Following two years of low pass rates under a 100% written exam, the course was restructured to include six graded hand-ins (30%) and an oral examination (70%) based on early release of examination cases.

The study draws on course and examination evaluations from 2021–2024 on small cohorts, supplemented by a focus group interview (six students) and a Likert scale survey conducted in 2023. The aim was to investigate whether graded hand-ins, oral assessment, and transparent assessment could enhance student motivation, engagement, and long-term learning.

Quantitatively, the redesign coincided with a marked increase in pass rates and average grades, from a maximum of 2.8 (before) to a minimum of 7.9 (after). Qualitatively, students reported improved motivation, clearer expectations, and deeper understanding. Students perceived the oral examination as better aligned with learning objectives and more effective at promoting deep learning than the previous written exam. Early release of exam cases further encouraged preparation and reduced stress.

The exploratory findings suggest that combining graded formative tasks, oral assessment, and transparent assessment design can strengthen motivation, support deeper learning, and improve learning outcomes in engineering education.

KEYWORDS

Assessment Redesign, Self-Determination Theory, Deep Learning, Formative Assessment, Oral Examination, Student Motivation

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Introduction

Student motivation is widely recognised as a critical factor influencing learning quality, progression, and retention in engineering higher education. European engineering education research increasingly conceptualises motivation not as a fixed student attribute, but as something contextually shaped by teaching and assessment practices (Baillie & Fitzgerald, 2010; Baeten et al., 2013). While Self-Determination Theory (SDT) provides a useful conceptual lens by distinguishing between autonomous and controlled forms of motivation and emphasising the role of perceived autonomy and competence (Deci & Ryan, 2000), recent engineering education studies have highlighted assessment design as one of the strongest structural determinants of these motivational conditions (Streveler et al., 2008; Pellegrino et al., 2015).

According to Ryan and Deci (2000), motivation is the process of being moved to do something. SDT highlights teaching methods (competence), classroom environment (autonomy), and cultural context (relatedness) as key drivers of student motivation (Deci & Ryan, 1985; 2000; Ryan & Deci, 2000; 2017). Consequently, approaches that provide clarity (competence – clear goals and structured learning), allow meaningful student choice (autonomy – flexible engagement with material), and create a caring environment (relatedness – supportive teacher–student interaction) can enhance student motivation and engagement with the subject matter. In engineering education, clear objectives and structured tasks have been shown to mitigate perceptions of high workload and reduce student stress (Kember & Leung, 2006).

Several studies have found that students who adopt a deep approach to learning (often referred to as deep learning) are more engaged and integrate, retain, and transform knowledge more effectively than students who use surface approaches. As a result, deep learners tend to achieve better learning outcomes and apply knowledge more effectively in practice (Ramsden, 2003; Laird et al., 2008). According to Warburton (2003), the three most significant factors influencing deep learning among engineering students are the learning environment, course content, and individual student factors. While teachers cannot directly influence the latter in a teaching context, they can focus on the learning environment and course content. Fawzia and Karim (2024) also emphasise these aspects. The learning environment encompasses multiple dimensions, including student–teacher relationships, student satisfaction, and staff commitment. In contrast, course content includes students' interest in the subject, access to teaching resources and tools, assessment effectiveness, and relevance to engineering practice. Biggs and Tang (2011) already argued that assessment types aligned with clearly defined learning outcomes and well-designed learning activities can promote meaningful and deep learning.

Fawzia and Karim (2024) surveyed 600 Civil and Mechanical Engineering students, receiving 235 responses, and found that deep learning was strongly associated with the learning environment and course design and content. They also showed that using both formative assessments, which give students opportunities to improve their performance during the course (Bamford et al., 2012), and summative assessments, which evaluate students' performance at the end of the semester, enhanced student learning and made the learning process more efficient.

In our study, we aimed to motivate students to engage more actively with the course and thereby achieve deeper learning of the topics taught. To support this, we replaced voluntary exercises with graded written assignments worth up to 30% of the final grade, shifting this element toward formative assessment. In addition, we changed the summative assessment from a 100% written examination to an oral presentation on pre-assigned topics, accounting for the remaining 70% of the final grade. These changes were intended to promote deeper learning among students.

The concept of deep learning, first introduced by Marton and Säljö (1976), describes an approach to learning that educators generally prefer, as it enables students to understand the underlying meaning of a topic rather than merely memorising surface-level details. Deep learning is primarily associated with intrinsic motivation. It is often characterised by interest in the task, a desire to understand the presented material, and an effort to relate new concepts to prior knowledge. In contrast, surface approaches, which focus on memorising facts and procedures without connecting them to real-life contexts, are typically associated with extrinsic or instrumental motivation.

Traditional written examinations with a single correct answer prioritise standardisation and reliability, but they also tend to direct student effort towards performance-oriented and surface learning strategies (Biggs & Tang, 2011; Baeten et al., 2013). Conversely, assessment systems that combine compulsory coursework with structured feedback and examinations that allow students to articulate their reasoning—such as oral examinations—are associated with higher engagement and deeper learning approaches, particularly within European and Nordic engineering education contexts (Kolmos et al., 2004; Gynnild, 2011). From this perspective, assessment choices function not merely as measurement instruments, but as pedagogical

interventions that influence both motivation and learning behaviour over time. However, in European countries, the literature has primarily focused on social and environmental influences and has therefore given limited attention to students' study habits, which our study addresses. Specifically, the study aims to demonstrate to students that early engagement with the course through graded assignments can facilitate understanding of more complex topics introduced later in the semester. Furthermore, providing students with oral examination cases before the midpoint of the course was intended to encourage continuous engagement with the curriculum, rather than concentrating effort solely in the period immediately preceding the examination.

Traditional written engineering examinations, typically based on problems with a single correct answer, emphasise objectivity, reliability, and procedural accuracy. Empirical research indicates that such examinations primarily assess lower-order cognitive skills, such as recall, comprehension, and routine application, while offering limited insight into students' reasoning processes or higher-order understanding. Oral examinations, by contrast, prompt students to articulate explanations, assumptions, and judgements through interactive dialogue. This interaction offers stronger construct validity for assessing higher-order cognitive skills and professional reasoning, although it also presents greater challenges related to reliability and examiner bias (Pellegrino et al., 2015; Fenton, 2025).

Assessment stakes further shape student learning behaviour. Research on assessment and feedback consistently shows that graded, compulsory assignments increase participation and effort. However, it may also shift students' focus towards performance and compliance, often at the expense of exploratory or reflective learning. Voluntary, ungraded submissions, in contrast, are more strongly associated with formative learning, self-regulation, and conceptual development, although participation rates tend to be lower. Together, these findings underscore how both assessment format and grading policy critically influence what engineering students learn and how they learn it (Kolmos et al., 2004; Kolmos, 2009; Baeten et al., 2013; Fenton, 2025).

Setting

The Technical University of Denmark (DTU) is internationally recognised for its world-class engineering education, with a strong emphasis on cross-disciplinary learning and hands-on experience (DTU, 2026a). DTU offers 3.5-year Bachelor of Engineering (BEng) programmes designed to provide students with a solid foundation in mathematics, physics, and chemistry. These programmes include project-based assignments that encourage students to apply theoretical knowledge to real-world problems, structured around the CDIO framework (Conceive–Design–Implement–Operate) (Crawley et al., 2014). The CDIO approach emphasises hands-on, project-based learning and integrates technical knowledge with practical skills, innovation, and sustainability. As a result, graduates develop a comprehensive understanding of the full lifecycle of engineering projects, preparing them to address real-world engineering challenges.

The BEng programme in Food Safety and Quality was established after the merger of DTU and the Public Research Sector for Food in 2007. The programme was first offered in 2011, and its initial comprehensive review of structure and content was conducted in 2019. The then Head of Study led this review, which evaluated the entire curriculum and graduates' career paths. This included whether students continued with a master's degree (which and where) or entered the labour market (which sector). In addition, the team collected feedback from industry stakeholders to assess whether graduates possessed the necessary competencies or whether gaps existed in their knowledge base. Based on this comprehensive evaluation, a vision paper identified the need for a dedicated course in food technology. This course aimed to give students a deeper understanding of food processing technologies, which had previously been offered through a limited number of lectures embedded in other courses covering basic aspects of food technology (DTU 2019, Internal study line accreditation document).

DTU's course structure balances theoretical and practical learning, with each course designed to address clearly specified learning objectives. Courses include detailed descriptions of expected learning outcomes, ensuring transparency regarding what students are expected to achieve upon completion (DTU, 2026b). The newly developed food technology course, corresponding to 5 ECTS credits, was designed for third-semester students enrolled in the BEng programme in Food Safety and Quality (DTU, 2026c). The course was first introduced in 2021, drawing on experience from a similar course offered to second-semester Bachelor of Science students and an existing master's-level course in food technology.

The course (23952) aims to provide students with a solid theoretical foundation in food processing technology, with a particular focus on fundamental calculation tools within process and product technology. In addition, students are introduced to key production-related challenges in the food industry, such as identifying limiting factors in process lines, optimising process times, and estimating the time required to achieve desired changes

in food products. Upon completion of the course, students are expected to perform calculations required to evaluate unit operations (e.g. heating and cooling), estimate energy consumption, size equipment, and plan a complete production process for a given food product. This is all reflected in the course learning objectives in Table 1.

Table 1. Course 23952 learning objectives (LO). LO9 was included from 2023 onward.

No.	Learning objectives (LO)
LO1	Identify and Describe Unit Operations
LO2	Analyse and Calculate Basic Mass and Energy Transport Mechanisms
LO3	Describe the Physical Meaning of Process Variables and Parameters and Analyse Their Impact on Process Time
LO4	Calculate Times for Heating, Cooling, and Freezing Under Simple Assumptions
LO5	Analyse Simple Process Lines to Identify the Limiting Process
LO6	Apply Basic Formulas for Food Processes to Estimate the Total Process Time for a Given Product
LO7	Analyse Processes Using Gantt Charts to Optimise the Overall Process Time
LO8	Create a Process Plan and Visualize it in a Gantt Chart
LO9	Use Spreadsheets for Simple Food Technological Calculations

The course follows DTU's 13-week teaching structure, with topics distributed across thirteen four-hour modules. Figure 1 provides an overview of module topics, with green shading indicating changes implemented from 2023 onwards. In 2021 and 2022, a relatively simple case study (Case A) was used throughout the lectures, while a more complex case study (Case B) was used in the exercise sessions at the end of each module (Figure 1). Case B was introduced in class, and students were encouraged to complete the casework at home to prepare for the next module, with the opportunity to receive feedback during subsequent sessions where teachers presented solution approaches. The assessment consisted of a four-hour written examination based on calculation exercises covering the entire curriculum, with all aids permitted.

After running the course for two years, it became evident that many students did not develop the skills required to pass the examination. Evaluation of the exam, with both the censor and colleagues teaching similar courses, revealed that the exam length and its constructive alignment with the learning objectives were well balanced. Consequently, the course structure needed revision to motivate students to engage more actively throughout the semester and improve learning outcomes.

From 2023, the summative assessment was therefore changed to a combination of six minor compulsory hand-ins submitted in Excel spreadsheets (formative assessment, accounting for 5% each, thus 30% of the final grade) and an oral examination (summative assessment, 70%). The decision to introduce the hand-ins was primarily based on student feedback from both written and oral course evaluations, in which many students acknowledged that they did not complete the recommended exercises during the first four to five weeks of the course. During this early phase, the theoretical content is relatively basic, and students often perceive the exercises as manageable. However, they later realise that insufficient engagement with this fundamental material hinders their ability to understand more complex topics introduced later in the course.

The hand-ins were designed as a case question in Excel, with all expected results marked as coloured cells where the formula should be included. All students received the same question and could answer in groups of up to four people. Students had 14 days to answer the question, which had a working load of approx. 3 hours, and all aids were allowed. After handing in, the Excel sheet was presented in plenum, where students were allowed to correct their own Excel sheet and discuss the solutions, enabling formative assessment.

The introduction of Excel-based hand-ins also aligns with feedback from the programme's industrial advisory board, which emphasised that graduates should have stronger spreadsheet competencies than those demonstrated by students completing the BEng programme in Food Safety and Quality in 2020. Thus, the inclusion of six minor hand-ins submitted in Excel was intended to motivate students to work with spreadsheets and to engage with the exercises. At the same time, the topics were still relatively basic. By doing so, students were expected to acquire the foundational knowledge required to build upon more complex topics introduced later in the course.

The motivation for changing the summative assessment from a written to an oral examination was to emphasise the course focus on understanding how theory relates to practice and how process conditions in food processing can be estimated using relatively simple calculations. In a written examination format, students often focus on obtaining correct numerical results rather than reflecting on why they apply specific calculations. By contrast, an oral examination allows examiners to probe students' understanding of their calculations and engage in dialogue around the underlying theory. The revised assessment format therefore aligned more closely with the learning objectives (Table 1) and the course's intended learning outcomes (DTU, 2026c).

In 2023, the oral examination was based on ten case questions. Following student feedback regarding workload, this number was reduced to seven case questions in 2024, while still covering the full curriculum. Students were assigned case questions by individual lottery draw. For each case, students should prepare a 5-minute presentation. In 2024, students had two minutes to recap the selected case followed by an 18-minute oral examination (including the presentation) focused on the chosen case and one of the six hand-in assignments. Although this examination format did not assess the entire curriculum for each student, preparation for all case questions ensured that students engaged with the full course content. The case questions were presented to students in teaching week five (Figure 1) to encourage active participation in subsequent modules and to clarify the overall focus of the course.

The assessment design used in this study—combining graded hand-ins with a summative oral examination—is fully consistent with DTU and Nordic examination regulations, which permit mixed assessment formats provided they align with course learning objectives and uphold academic standards (DTU, 2026d). All changes were implemented simultaneously, which may affect students' evaluation of the course.

Aim and objective of the study

Based on observed challenges related to student engagement, preparation, and learning outcomes in the food technology course, the teaching team identified a need to redesign the course structure to support active learning better and sustained student engagement. In particular, assessment was seen as a key lever for influencing students' study behaviour and motivation throughout the semester.

Teachers were motivated to implement course changes and to investigate whether a shift towards active learning, exemplified by graded hand-in exercises during the course, could increase student motivation and engagement in learning food technology. This led to the following overall research question (RQ):

Overall RQ: *Does active participation increase student motivation and support long-term learning in food technology?*

This study therefore explores whether redesigning the course structure, by simultaneously incorporating graded hand-ins and oral assessment, improves student motivation for learning food technology. To clarify the specific challenges addressed, the study is divided into three research questions, each focusing on a distinct aspect of the course design:

RQ1: *Will graded hand-ins increase student motivation to prepare for exercises?*

RQ2: *Will changing the summative assessment from a written to an oral examination increase student motivation for conceptual understanding?*

RQ3**:** *Will early disclosure of oral assessment questions (eight weeks prior to the exam) motivate continuous preparation, in contrast to a traditional written examination?*

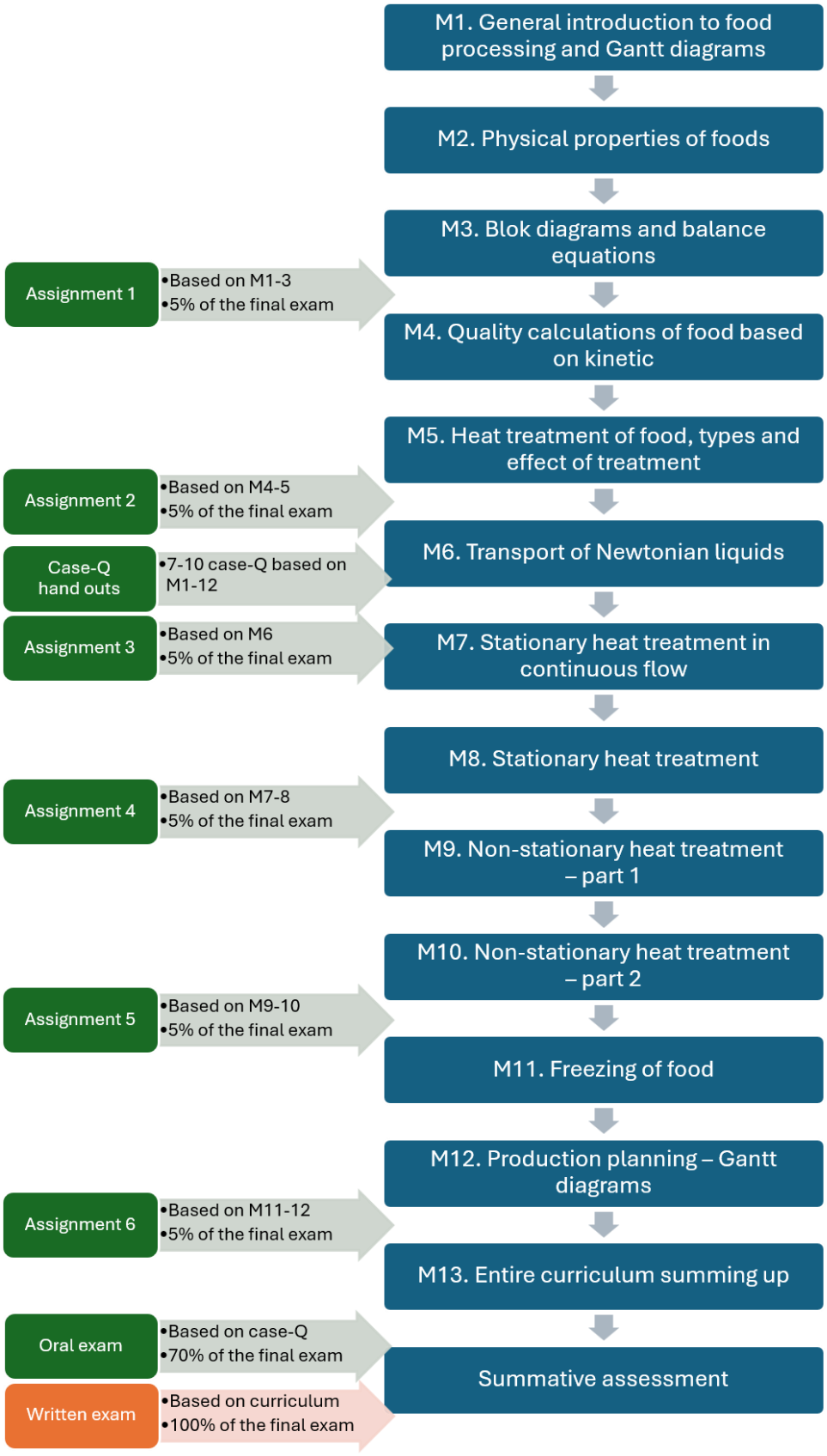


Figure 1. Course modules (M) in blue (13) taught in the Food Technology course with assessment format; orange colours include assessment 2021-2022, whereas green boxes are the changes from 2023, with graded hand-in assignments and an oral exam based on case questions (Q).

Method

Data were collected using individual student DTU course and examination evaluations (CEQ) from 2021 to 2024, as well as a focus group interview conducted in 2023, which included open-ended focus group questions and Likert scale questions.

The CEQ is a well-established evaluation tool at DTU. The questions are used across all DTU courses and are therefore generic, addressing students' experiences of both course activities (C) and examinations (E) (Table 2). As the same questions are applied each teaching year, it is possible to track the effects of implemented course changes over time. In addition, individual, anonymous course evaluations using a Likert scale (1–5) allow monitoring of course development and teaching performance over a longer period; both are included in the DTU evaluation system. Each course responsible for a Food course must reflect on the evaluation results, address challenges identified by students, and propose initiatives to address these issues. The National Food Institute study board reviews these reflections and serves as a peer-feedback mechanism to ensure appropriate action when necessary.

Between 2021 and 2024, more than 50% of enrolled students in the food technology course responded to the evaluations, providing representative CEQ data. For transparency, we report the number of respondents alongside each result and provide the raw CEQ data in Supplementary file_CEQ.

To support the generic DTU course evaluations (CEQ), we conducted a focus group interview in 2023 to follow up on the course changes introduced that year. Focus group interviews are well suited for exploring issues of shared importance and were used here to document students' experiences and perceived learning developments following changes to the course structure. The focus group interview aimed to understand how the changes affected students' motivation and learning. In particular, we explored whether the graded hand-ins motivated students to engage more actively with course content and whether this form of formative assessment supported conceptual understanding. Additionally, we examined whether the transition from a written to an oral examination influenced student motivation. However, a limitation of this setup is that we did not study the combination of graded formative tasks with a summative written assessment or the changes individually.

The focus group consisted of six students who had all failed the written examination in 2022 but passed the oral examination in 2023, ensuring comparable course experiences. The gender and ethical distribution reflected that of the course cohort, with four female and two male students from the BEng programme in Food Safety and Quality. All participants were fifth-semester students. Students were recruited voluntarily after an invitation from the course coordinator to discuss the outcomes of the two evaluation formats. Participants were informed that the interview aimed to gain insights into the effects of the course changes and to share findings with colleagues for further course development. The interview was scheduled in a neutral meeting room on the DTU campus at a time when all participants were available.

The session began with an introduction outlining the study's purpose, assuring confidentiality, and explaining the interview structure. In the first part of the focus group interview, questions progressed from general experiences (F1, Table 3) to more specific aspects of the course changes (F2–F5, Table 3). For each question, students were first given five minutes to note individual reflections on post-it notes, followed by pairwise discussions and a concluding plenary discussion. Key points were summarised at the end of the interview to ensure shared understanding and agreement. The moderators encouraged participants to elaborate on their experiences, compare perspectives, and discuss points of agreement and disagreement. The moderators emphasised a supportive, open atmosphere and encouraged participants to ask for clarification as needed. Representative student statements are presented in the Results section, and complete notes from the focus group questions are provided in Supplementary file_F.

In the second part of the focus group interview, students completed twelve Likert scale questions (L) individually using a paper questionnaire (Table 4). The Likert scale survey (scales 1–10) complemented the qualitative data from the focus group discussion by capturing individual student perceptions and summarising key reflections from the interview session.

In general, this study includes a maximum of 19 students answering the CEQ and a focus group with only six students. Thus, no inferential statistical analysis was applied. Results for the CEQ Likert scale (scales 1-5) are therefore presented as percentages of total responses per year. We present results from the focus group's Likert scaled questions as averages and ranges (scales 1–10). All data are supplemented by selected student statements to contextualise the findings. All responses to the Likert scale questions are included in Supplementary file_L.

All students who participated in both written and oral course evaluations were informed that their responses could be used for publication, and all participants provided informed consent.

Table 2. Course (C) and examination (E) evaluation questions (CEQ) included for data collection, and the research questions (RQ) addressed. All responses were measured using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

No.	Course or Exam evaluation question	RQ addressed
C1	I have learned a lot in this course.	Overall RQ
C2	The teaching activities in the course align well with the course's learning objectives.	Overall RQ
C3	The teaching activities motivate me to work with the material.	RQ1
C4	I have had the opportunity to receive feedback on my academic performance during the course.	RQ1
C5	In general, it has been clear to me what is expected of me in exercises, project work, and similar activities.	RQ1
C6	5 ECTS points are equivalent to 9 working hours per week during the 13 weeks (45 working hours per week during the three weeks). I believe that the time I have spent on the course is.	Overall RQ
E1	I think the exam aligned with the course teaching (format, activities, content, and difficulty level).	RQ2
E2	I think the form and content of the exam fit the course learning objectives.	RQ2

Table 3. Focus group questions (F) and the corresponding research questions (RQ) addressed.

No.	Focus group question	RQ addressed
F1	What experiences do you take away from the two ways of course activities?	Overall RQ
F2	What was decisive for you passing the second time and not the first time?	Overall RQ and RQ1
F3	How did the graded hand-in assignment affect your motivation to work with the curriculum?	RQ1
F4	We talk about deep learning – i.e., that students can remember and use what they have learned AFTER the course is over. How has the new teaching method affected your long-term learning?	RQ1
F5	What is the difference between preparing for an oral exam versus a written exam?	RQ2

Table 4. Likert scale (L) questions used in the focus group and the corresponding research questions (RQ) addressed. All responses were measured using a Likert scale ranging from 1 (strongly disagree) to 10 (strongly agree).

No.	Likert scale question	RQ addressed
L1	Exam requirements increase motivation to complete assignments.	RQ1
L2	Hand-in requirements caused unnecessary stress.	RQ1
L3	Lecture participation is motivated by assignment submissions.	RQ1
L4	Feedback after each submission increased my understanding.	RQ1
L5	A 4-hour written exam motivated my learning.	RQ2
L6	A 4-hour written exam caused unnecessary stress.	RQ2
L7	Preparation for a written exam promotes deep learning.	RQ2
L8	Preparation for an oral exam promotes deep learning.	RQ2
L9	Oral exam ensures I cover the curriculum.	RQ2
L10	Written exam ensures I cover the curriculum.	RQ2
L11	Mid-course release of exam questions motivated my learning.	RQ3
L12	Mid-course release of exam questions caused unnecessary stress.	RQ3

Results and discussions

The food technology course aims to develop students' competencies and conceptual understanding within food process engineering. Over the four years (2021–2024), key changes were implemented in both course structure and assessment design. The traditional model—comprising voluntary exercises and a 100% four-hour written summative examination (2021–2022)—was replaced by a revised format including six graded hand-in assignments (each contributing 5%) and a final 20-minute oral examination (70%), supported by a pre-prepared presentation and early access to exam case questions (2023–2024). The oral examination was based on case preparation (10 cases in 2023 and 7 in 2024). It was designed to enable students to demonstrate conceptual understanding of the underlying physical and mathematical principles in food technology—an aspect less accessible in the previous written format. Results are therefore presented by comparing outcomes before (2021–2022) and after (2023–2024) implementing these changes. The number of students enrolled varied across the four years, and consequently so did the number of students passing the course (Table 5). The instruments outlined in Table 5 form the basis for the results presented and are used to address the research questions stated in the Aim section. In addition to the six structured course evaluation questions (C1–C6, Table 2), students were invited to provide general comments (Supplementary file_CEQ). Across all years, these comments indicate that students perceived the course as relevant and engaging, with particular appreciation for its structured design and the balance between lectures, assignments, and case-based learning activities.

Table 5. Number of students taking the examination and the percentage passing for the years 2021–2024. Instruments and course activities with associated assessment are included. Q = question; C1–C6 and E1–E2 refer to the CEQ listed in Table 2; F1–F5 refer to focus group questions listed in Table 3; and L1–L12 refer to Likert scale questions listed in Table 4.

Year	Students taking the exam, #	Students passing the exam, (%)	Hand-ins as part of the assessment	Summative assessment format	Instruments
2021	24	70	No	4h written (100%)	Course (C1-6) and exam (E1-2) evaluation
2022	27	22	No	4h written (100%)	Course (C1-6) and exam (E1-2) evaluation
2023	35	100	Yes, (6 x 5%)	Oral, 10 case Q (70%)	Course (C1-6) and exam (E1-2) evaluation. Focus (F1-5) group incl. Likert scale Q (L1-12)
2024	14	100	Yes, (6 x 5%)	Oral, 7 case Q (70%)	Course (C1-6) and exam (E1-2) evaluation

Outcome related to RQ1: Effect of graded hand-ins on student motivation

To examine the effect of graded hand-ins on student motivation, we analysed data from course evaluations, focus group interviews, and Likert responses. We placed particular emphasis on students' perceived motivation, clarity of expectations, and engagement with course activities.

Towards the end of the course (prior to the examination), students completed an anonymous online CEQ evaluation (C1–C6, Table 2). Responses to the motivation-related item (C3: *"The teaching activities motivate me to work with the material"*) are presented in Figure 2. Overall, students reported high levels of motivation, with the majority either agreeing or strongly agreeing across all years. Notably, in 2024, approximately 70% of students selected *strongly agree*, with no responses below *neutral*. In addition, student responses to question C5 (*"It has been clear to me what is expected of me in exercises, project work, and similar activities"*), shown in Figure 3, showed that approximately 75% of students agreed or strongly agreed across the years, increasing to 100% in 2024. This improvement may be linked to course refinements in 2024, including reduced case complexity during lectures, which enabled students to engage more deeply with a single case. Across the earlier years (2021–2023), approximately 70% of students also responded positively (agree or strongly agree), which is considered satisfactory within general course evaluations.

It should be noted that the 2023 cohort included a relatively high proportion of repeat students (17 out of 35 participants), which may have influenced evaluation responses. In earlier years (2021–2022), students highlighted challenges such as limited access to solution materials and an overwhelming workload associated with voluntary exercises (Supplementary file_CEQ). Nevertheless, students consistently viewed the combination of lectures and exercises positively across all years.

Findings from the focus group further support the quantitative results. Responses to the Likert scale questions (Table 6) indicate that examination requirements (L1) strongly motivated students to engage with hand-ins and course exercises. This aligns with previous findings that assessment design influences student learning behaviour (Kolmos et al., 2004; Kolmos, 2009; Baeten et al., 2013). Students also reported that feedback on hand-ins increased their understanding (L4, Table 6), and that the hand-ins were not associated with increased unnecessary stress (L2, Table 6).

During the focus group interview, students were asked what had been decisive for passing the course on their second attempt (F2, Table 3). They highlighted the value of structured tasks and pacing, noting that "*it was good to have something to work on at your own pace*" and that "*the cases made it more visual and improved understanding*". Furthermore, the students also reflected that having previously failed the course motivated them to study more rigorously and attend lectures for additional reinforcement. One student specifically stated that the hand-ins helped them understand the concepts during the second attempt (Supplementary file_F).

When asked directly how the graded hand-ins affected their motivation to engage with the curriculum, students discussed the differences between voluntary and compulsory assignments. They concluded that receiving feedback made a significant difference. Students also recognised the requirement to submit assignments as

Excel spreadsheets as beneficial, as it supported both conceptual understanding and the development of practical skills. Students further reflected on how the teaching methods influenced their long-term learning and conceptual understanding (F4, Table 3). They agreed that spending time on hand-ins—whether voluntary or compulsory—was worthwhile, as it led to a deeper understanding of the material. Students who completed the CEQ in 2023 and 2024 also expressed appreciation for including hand-ins as part of the final grade (Supplementary file_CEQ).

Consistent with previous research, we observed that graded hand-ins function as structured formative elements with summative consequences, increasing participation and sustained effort while providing feedback that supports students' sense of competence (Gibbs & Simpson, 2004; Nicol & Macfarlane-Dick, 2006). Unlike voluntary exercises, which often suffer from uneven participation, compulsory hand-ins appear to create more equitable learning opportunities across the student cohort, thereby improving both motivation and learning outcomes.

Overall, graded hand-ins increased student engagement and motivated earlier, more consistent interaction with the course material, leading students to complete exercises they had previously postponed or omitted when assignments were voluntary. As a result, students developed the intended cumulative competences, which to some extent reduced exam-related cognitive overload. They reported clearer expectations and greater accountability, supporting the argument that assessment structure—not workload alone—drives engagement. These findings support the growing emphasis on assessment-*as*-learning, rather than assessment-*of*-learning, within engineering education.

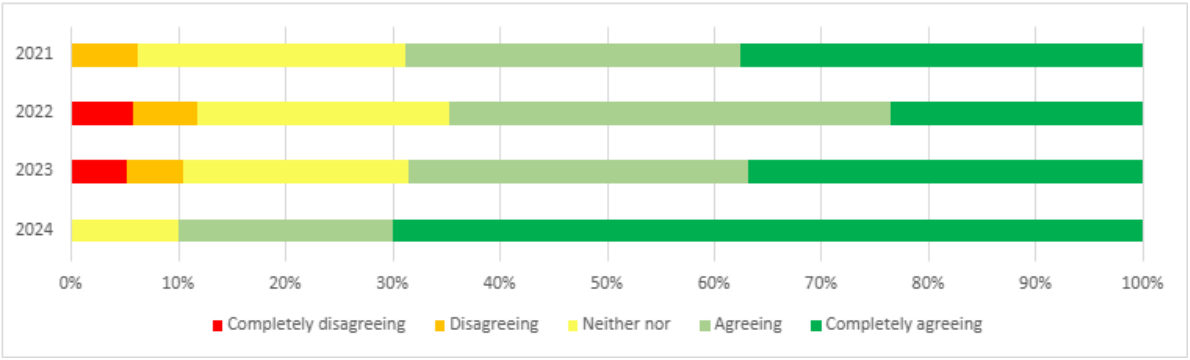


Figure 2. Evaluation question C3: *"The teaching activities motivate me to work with the material."* Results are based on responses from 16, 17, 19, and 10 students in 2021, 2022, 2023, and 2024, respectively.

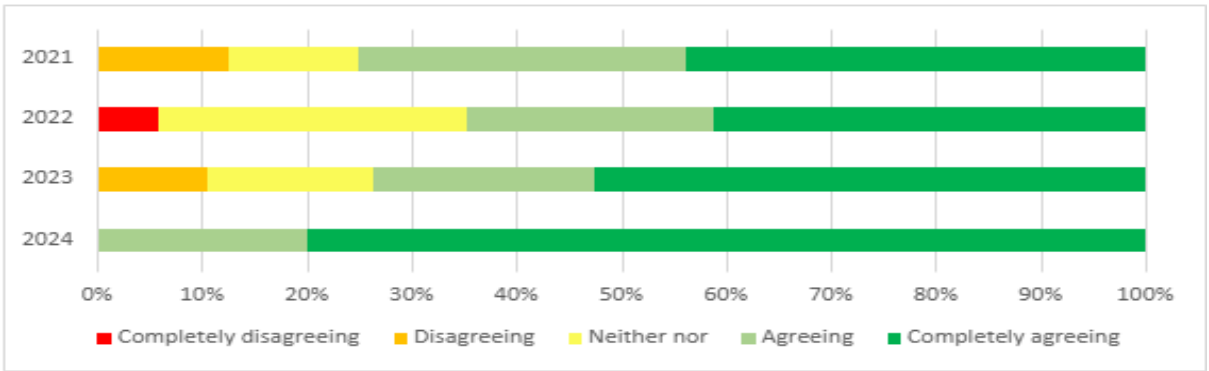


Figure 3. Evaluation question C5: *"In general, it has been clear to me what is expected of me in exercises, project work, and similar activities."* Results are based on 16, 17, 19 and 10 students in 2021, 2022, 2023 and 2024, respectively.

Table **6.** Likert scale answers for Research Question 1. All responses were measured using a Likert scale ranging from 1 (strongly disagree) to 10 (strongly agree).

No.	Likert scale question	Average score	Range
L1	Exam requirements increase motivation to complete assignments	9.3	8-10
L2	Hand-in requirements caused unnecessary stress	1.7	1-3
L3	Lecture participation is motivated by assignment submissions	7.7	5-10
L4	Feedback after each submission increased my understanding	9.0	7-10

Outcome related to RQ2: Effect on student motivation with shift from written to oral assessment

After the examination, students were asked to evaluate the exam format by responding to two questions: (E1) whether the examination was aligned with the teaching format and activities, and (E2) whether it corresponded to the course learning objectives. Figures 4 and 5 clearly demonstrate that students responded positively to the change in assessment format. As shown in Figure 4, the proportion of students who agreed or strongly agreed that the examination was aligned with the teaching increased from 11% in 2021 to 100% in 2024. A similar trend is observed in Figure 5, where alignment to learning objectives (Table 1) increased from 11% agreement in 2021 to 100% complete agreement in 2024.

Students were also invited to provide qualitative comments on the examination. In 2021 and 2022, feedback primarily addressed the complexity and time constraints of the written examination. Several students noted that the examination matched the expectations previously communicated during lectures. For example, in 2021, one student commented that *"while the course aligned reasonably well with the learning objectives, the exam took it a step further and disrupted that alignment"*, while another noted that *"there were far too many and overly lengthy tasks for the allocated time".* In contrast, in 2023 and 2024, student comments indicate a markedly improved perception of the assessment format. For example, one student noted that *"it makes much more sense to have an oral exam in this course, as it is about understanding the process and the use of different equations"* and another that *"the idea behind the exam format is fantastic and forces you to use all areas of the course"*. Students also emphasised improved alignment between teaching and assessment, as shown by comments such as "*everything included in the exam was also covered in the course*". A similar pattern was observed in 2024, with statements such as *"all assignments were clearly related to the material covered"* and *"all relevant aspects were represented in both teaching and examination"*. Students also described the oral format as *"tough but fair"*, indicating a successful transition not only in terms of student satisfaction but also in supporting conceptual understanding (Supplementary file_CEQ). Perceived fairness and interaction with real-life cases seemed to strengthen the student relatedness (SDT) and therefore seemed to aid student motivation.

The findings suggest that carefully designed exam cases, combined with transparency throughout the course, can enhance both student motivation and learning. Oral assessment has previously been associated with deep learning, although concerns regarding assessment reliability have also been raised (Kolmos et al., 2004; Gynnild, 2011; Cantin et al., 2025; Fenton, 2025).

Responses to the Likert scaled question in 2023 further support that motivation to learn is strongly linked to the assessment format (written vs oral; L5, L6, L8, Table 7). The highest scores were associated with perceptions that the oral format ensured better curriculum coverage and promoted deep learning. This is supported by focus group findings (F5 in Supplementary file_F), where students reported preparing more thoroughly and engaging more deeply with the material, partly due to the perceived accountability inherent in an oral examination setting. Some students noted that they felt more compelled to understand the material in depth, as they would otherwise feel unprepared when presenting. These findings align with previous studies showing that oral examinations provide stronger construct validity for assessing higher-order cognitive skills and professional reasoning (Kolmos et al., 2004; Kolmos, 2009; Pellegrino et al., 2015; Fenton, 2025). Additionally, early access to exam questions was reported to reduce stress and support ongoing engagement with the course material, as described further for RQ3.

Overall, students perceived the oral examination as fair, relevant, and well aligned with the learning objectives. Their responses support the view that oral assessment encourages conceptual understanding and deep learning rather than memorisation of equations. Drawing on focus group data, CEQ comments, and Likert scale answers, the shift from written to oral assessment appears to have redirected students' focus from procedural correctness towards explanation, reasoning, and application. The format enabled examiners to probe students' understanding, assumptions, and ability to transfer knowledge to practice. Furthermore, the revised assessment design strengthened the perceived alignment between teaching activities and learning objectives and increased the authenticity of engineering practice within the course.

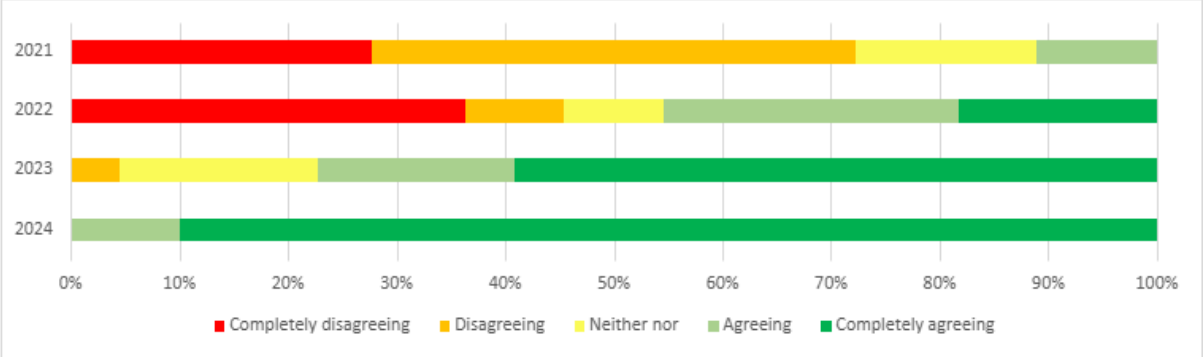


Figure 4. Examination evaluation question E1: *"I think that the examination was in line with the teaching on the course (in terms of format, activities, content, and level of difficulty)."* Results are based on responses from 18, 11, 22, and 10 students in 2021, 2022, 2023, and 2024, respectively.

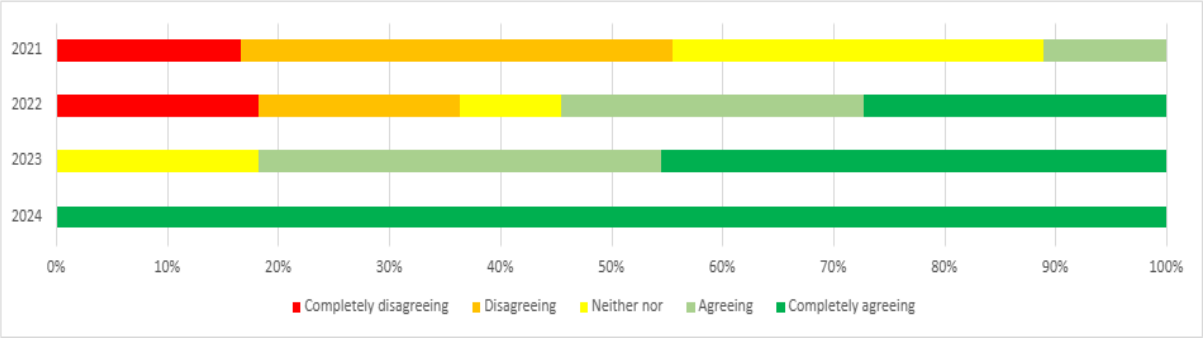


Figure 5. Examination evaluation question E2: *"I think that the form and content of the examination fit the learning objectives of the course."* Results are based on responses from 18, 11, 22, and 10 students in 2021, 2022, 2023, and 2024, respectively.

Table 7. Likert scale questions for Research Question 2 (RQ2). All responses were measured using a Likert scale ranging from 1 (strongly disagree) to 10 (strongly agree).

No.	Likert scale question	Average score	Range
L5	A 4-hour written exam motivated my learning	2.5	1-5
L6	A 4-hour written exam caused unnecessary stress	7.8	7-10
L7	Preparation for a written exam promotes deep learning	3.8	3-5
L8	Preparation for an oral exam promotes deep learning	9.3	8-10
L9	Oral exam ensures I cover the curriculum	9.7	9-10
L10	Written exam ensures I cover the curriculum	5.2	3-8

Outcome related to RQ3: Early disclosure of exam questions increase preparation

From 2023 onwards, the exam format was changed to oral examinations, with exam questions (different cases) handed out eight weeks before the examination. Students were required to prepare and present the cases during the exam. The shift in format acknowledged student requests from 2022 for clearer exam expectations. At the same time, the early release of exam questions was intended to motivate students to attend lectures and engage with the course material. In fact, it appeared to motivate students and reduce exam anxiety associated with the uncertainty typically preceding an examination. This is reflected in the high score (9.5) on Likert scale Question L11 regarding motivation and the low score (1.3) on Question L12 regarding anticipated stress (Table 8). Comments on the written examinations (Supplementary file_CEQ) highlighted the intense time pressure during the exam and improved alignment with the learning objectives in 2022. In CEQ 2023, students commented that the oral examination format and the arrangement of receiving all exam questions well in advance of the examination were highly beneficial. Simultaneously, students commented that there was a lot of time-consuming preparatory work for the exam.

Students commented that the format encouraged thorough engagement with the curriculum and that they felt "forced" to view each topic from a broader perspective and consider the relationships between topics. One student wrote: "*Personally, I feel that I have really learned the material and understand which approach one should use to solve a food technology problem rather than just being able to determine which equations to use. The only downside is that it is quite time-consuming to prepare. But because the questions are handed out so early in the course, I think it's okay.*" Several students commented that the new format shifted the workload from the examination itself to the period preceding it. The new format required skills such as explanation, synthesis, and communication, enabling students to articulate their reasoning clearly and demonstrate an understanding of relationships across topics.

Despite the increased preparation demands, students reported that the early disclosure of exam questions deepened their understanding and supported integrative learning across course topics (Supplementary file_CEQ; Supplementary file_F). During the focus group interview, students expressed strong motivation to prepare the pre-released questions in contrast to written examinations, where all relevant material could be brought into the examination. One student commented: "*It would be embarrassing not to have prepared anything for the oral exam,...*". This illustrates the difference between deep learning and surface approach, defined by Chin and Brown (2000).

Overall, student feedback indicates a progression in the alignment and quality of the examination from 2021 to 2023. In 2023, students emphasised that the oral examination format came with challenges related to high cognitive load, as students were required to master and recall multiple complex scenarios. The format demanded extensive preparation in advance and shifted the focus from calculation-based problem-solving to explanation and synthesis, placing new demands on students' communication skills in achieving the intended learning outcomes. Transparent expectations, supported by the early release of questions, allowed students to plan and take greater ownership of their learning, as well as request supervision on unclear topics. Rather than lowering academic standards, transparency appeared to support integrative learning. In this context, transparency functioned as a motivational feature, probably by enhanced autonomy (SDT), that enabled students to invest their efforts strategically and meaningfully.

Table 8. Likert scale questions for Research Question 3 (RQ3). All responses were measured using a Likert scale ranging from 1 (strongly disagree) to 10 (strongly agree).

No.	Likert scale question	Average score	Range
L11	Mid-course release of exam questions motivated my learning	9.5	8-10
L12	Mid-course release of exam questions caused unnecessary stress	1.3	1-3

Outcome related to the Overall RQ: Does active participation increase student motivation and support long-term learning in food technology?

The findings in this study show that student motivation is not fixed but is strongly influenced by assessment design and the learning environment. Introducing graded hand-ins created accountability and sustained engagement, while the oral examination shifted the focus from reproducing answers to articulating understanding. This combination supported intrinsic motivation, enabling students to engage with the material and take ownership of their learning. The use of authentic cases further enhanced perceived relevance, a key factor in promoting long-term retention and knowledge transfer. The results therefore indicate that active participation mediates the relationship between assessment design and learning outcomes. When students are required to actively process, apply, and explain knowledge throughout the course, learning becomes both more effective and more durable.

Table 9 shows a marked improvement in student performance following the course redesign implemented in 2023. Most notably, the proportion of students failing (grades below 02) was reduced to zero, while grade point averages increased substantially from 0.6–2.8 in 2021–2022 to 7.9–9.2 in 2023–2024. In parallel, the number of high-performing students (grades 10 and 12) increased significantly, indicating that a greater proportion of students demonstrated higher levels of cognitive achievement. These improvements coincided with the introduction of graded hand-ins and oral examinations, replacing a format based on written summative assessment and voluntary exercises. The findings align with previous research showing that alignment between formative and summative assessment enhances both student achievement and persistence (Kolmos et al., 2004; Warburton, 2003; Biggs & Tang, 2011; Pellegrino et al., 2015; Fawzia & Karim, 2024; Saha, 2024).

Following the redesign, graded hand-ins introduced structured and compulsory engagement, requiring students to engage continuously with the course material. Formative feedback reinforced this by supporting iterative learning and error correction. The oral examination further strengthened the system by assessing reasoning, assumptions, and conceptual coherence, thereby aligning summative assessment with higher-order cognitive skills (Gynnild, 2011; Pellegrino et al., 2015; Cantin et al., 2025).

From a motivational perspective, this alignment supports more internalised goal regulation by rewarding understanding and conceptual coherence rather than reproducing solution procedures (Deci & Ryan, 2000; Streveler et al., 2008). Our results, in which students reported increased motivation to prepare for oral assessments, indicate that improved performance is not due to reduced academic standards but to an assessment system in which formative support and summative evaluation reinforce one another.

Students demonstrated that a clear alignment between learning objectives, learning activities, and assessment is critical for motivation. The embedded spreadsheet-based hand-ins were directly linked to industry-valued learning outcomes. Oral examination questions related clearly to course objectives and previous assignments. This alignment was associated with improved pass rates and higher grade averages (Table 9), as well as increased student satisfaction with both the course and the examination. Several students referred to gaining an understanding of “the bigger picture”, suggesting that knowledge became more integrated rather than fragmented. Our results reinforce the principles of constructive alignment proposed by Biggs and Tang (2011) using concrete evidence from engineering education. Furthermore, our results provide data on constructive alignment that Masuku and coworkers (2021) previously requested.

Our study highlights three implications for engineering education practice. First, assessment design should be recognised as a primary driver of student learning behaviour rather than merely a neutral administrative component. While the need for careful course planning and alignment between teaching activities and assessment may not surprise experienced educators, the findings underline the importance of treating assessment as a central pedagogical tool. Second, an effective strategy for promoting deep learning in technically demanding courses is to combine graded formative tasks and authentic industry-based cases with oral summative assessment. Third, transparency, achieved through early engagement with assessment tasks and authentic assessment formats, can improve learning outcomes without compromising academic standards.

Ultimately, the findings, with their limitations, demonstrate that assessment does not merely measure learning outcomes—it shapes them. In line with Subheesh & Sethy (2020), authentic tasks, continuous engagement, formative feedback, and transparent expectations became powerful drivers of student motivation, deeper understanding, and long-term learning in food technology education.

Table 9: Annual grades with descriptions of the Danish grading scale.

Grade	Year:	2021	2022	2023	2024
12 – Excellent	Outstanding performance with no or only a few minor weaknesses.	1	0	12	4
10 – Very good	Very good performance with a few weaknesses.	1	0	11	2
7 – Good	Good performance with some strengths and some weaknesses.	0	1	7	5
4 – Fair	Acceptable performance, but with several weaknesses.	7	0	4	1
02 – Sufficient	The minimum acceptable performance; meets the basic requirements.	8	5	1	2
00 – Insufficient	Does not meet the minimum requirements.	7	21	0	0
−3 – Unacceptable	Completely unacceptable performance.	0	0	0	0
Number of students		24	27	35	14
Grade point average		2.8	0.6	9.2	7.9

Conclusion

In conclusion, the results from RQ1 on graded hand-ins showed increased student motivation for exercise preparation, suggesting that engineering courses could include regular, compulsory hand-ins that contribute meaningfully to the final grade. Here, graded hand-ins support students' sense of competence (SDT) by encouraging continuous practice, timely feedback, and incremental mastery of foundational concepts.

Regarding RQ2, oral examinations are especially effective in applied, calculation-heavy engineering courses when learning outcomes prioritise understanding over speed and accuracy.

For RQ3, early release of oral assessment questions (less than halfway through the course) creates motivational transparency and enables students to invest meaningfully and strategically. Transparent expectations allow students to plan, distribute effort, and take ownership of their learning, reducing uncertainty-driven surface approaches. Rather than lowering standards, transparency supports intentional, integrative learning.

Overall, when assessment is distributed across the semester, students are more likely to engage in progressive knowledge construction, a prerequisite for deep learning. When oral exams were designed around well-aligned case questions, students shifted their focus from procedural calculation to conceptual explanation, reasoning, and theory–practice integration.

While the results are consistent and supported by both quantitative and qualitative data, the study does not isolate the individual contributions of graded hand-ins, oral examinations and early release of exam questions. Future work could explore whether similar effects can be achieved in larger cohorts through combinations of graded formative tasks and written summative assessment. Furthermore, the balance between workload, pacing, and reflection warrants continued attention to ensure that increased participation does not lead to cognitive overload.

Limitations

The study represents one single institution and one study line. This study is based on data from four consecutive years (2021-2024) with 16, 17, 19 and 10 students answering the common DTU course evaluation questionnaires (CEQ). We have not been able to include possible cohort effects over the years. Furthermore, the study is based on a focus group from 2023, which included only a small cohort (N=6) and may therefore be biased by voluntary selection. In addition, this study considers the consecutive change of three parameters (graded hand-ins, oral examinations, early release of examination cases), so it is not possible to assess individual effects. The findings should therefore be understood as exploratory and context bound.

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Ethical approval

Students participating in the course evaluation questionnaires (CEQ) and focus groups have given their consent for the use of the obtained data in the manuscript. For the CEQ, the students answer anonymously; thus, we do not know the gender and ethnic distribution. For the focus group, however, we know that both gender and ethnic distinction correspond to the general study line. As only six students are in the group, we have chosen to keep their identities anonymous.

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