

Article

“More Feedback, Please”: Student Perceptions of Active Learning Strategies for Formative Assessment to Enhance Sustainable Learning in Higher Education

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Abstract

This study examines a persistent puzzle in active learning research in education: why do pedagogically sound interventions not always translate into perceived student value? We analyzed Information and Communications (ICT) Engineering students’ perceptions of three structurally distinct activities (weekly quizzes, individual concept maps, and a finance escape room) within a compulsory business course. Using bipolar laddering, 133 positive and 72 negative perception elements were mapped onto four dimensions of the Sustainable Learning in Education (SLE) framework: renewal and relearning, transferability, independent and collaborative learning, and active learning. Self-regulated learning (SRL) functioned as the mechanism linking environmental dimensions to student agency and engagement. Students perceived all three activities as useful for examination preparation, but through different cognitive pathways. Quizzes supported distributed retrieval practice and were valued for re-attempts, though their usefulness declined with weak exam alignment or limited access. Concept maps enabled synthesis and relational understanding, yet received the lowest student endorsement, largely because in some instances student work was not returned post-submission. The escape room achieved the strongest and most consistent endorsement for exam preparation, with perceived limitations related only to activity duration and syllabus coverage. Activity alignment with SLE dimensions was uneven: quizzes aligned principally with renewal, concept maps with transferability, and all activities with independent and collaborative learning in distinct ways. Active learning was present throughout, but not uniform. The central finding was that perceived usefulness depended less on activity type than on feedback distribution and continuity. When feedback loops broke, perceived value declined. Together, the activities, therefore, form a complementary course-level feedback system. Through this case study, we identified five design recommendations to be implemented in the next edition of the course, positioning feedback as a system-level variable.

Keywords: active learning; formative assessment; quiz; concept map; escape room; bipolar laddering (BLA)



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1. Introduction

Higher education is being asked to do more than transmit content. Quality education, the fourth of the United Nations’ Sustainable Development Goals, calls for learners who

can keep learning throughout their lives across changing circumstances and unfamiliar problems. This ambition has pushed universities away from lecture-and-recall teaching towards active learning (AL), in which students take a deliberate, participatory role in building their own understanding. AL is now widely treated as a practical route to that long-term goal, and as a core component of what has come to be called sustainable learning in education (SLE).

As pointed out by Ben-Eliyahu [1], SLE is distinct from teaching for sustainability or sustainable learning, both focusing on the conservation, restoration and reuse of essential resources like clean water. In contrast, SLE is about equipping learners with strategies and skills that enable them to restore, reconstruct, repurpose, question, remain open-minded, and navigate complex and demanding situations that call for ongoing learning and unlearning. SLE is characterized by four key dimensions: (1) renewal and relearning; (2) independent and collaborative learning; (3) active learning; and (4) transferability. These four dimensions are held together by self-regulated learning (SRL) as a common underlying mechanism: the cycle of setting goals, monitoring progress, and adjusting. Within that cycle, feedback is what allows a learner to detect a gap and act on it. In this paper SLE supplies the analytical categories and SRL supplies the mechanism that explains how those categories are enacted.

In a complementary vein, formative assessment (FA) constitutes a highly relevant component in the educational context, as highlighted by various academic contributions [2,3]. It is significant for course design, given its potential impact on areas such as engagement [4], motivation [5], and learning improvements [6], as evidenced by systematic reviews (e.g., [7]).

In the present study, the course redesign was undertaken with a dual objective: (1) to provide students with learning strategies that can be applied to the study of diverse topics in the future, i.e., SRL; and (2) to incorporate new learning practices, aimed at increasing dynamism, fostering engagement, addressing content-level inconsistencies, and consolidating subject knowledge, in a business-related course that some students perceive as being distant from the core of their engineering studies. To achieve this dual aim, three AL strategies were integrated into the course (a second iteration of online quizzes, individually constructed concept maps, and an accounting escape room), in addition to those already implemented in previous academic years as per Figure 1 below.

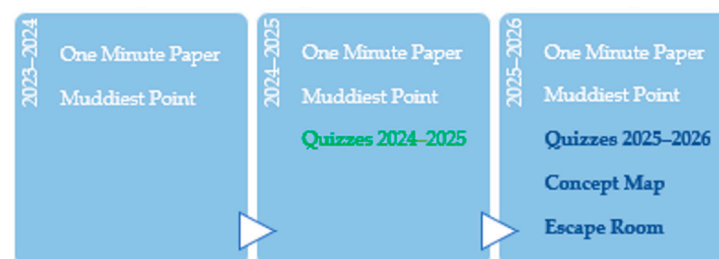


Figure 1. Evolution of active learning activities across academic years. The 2025–2026 quiz design was revised based on student feedback collected on the 2024–2025 quizzes. Concept maps and the escape room were introduced for the first time in the 2025–2026 academic course.

The aim of this research is to examine how students perceive these three AL strategies, both in terms of their usefulness for preparing the summative assessment and in terms of supporting the SLE framework. The study addresses two research questions:

RQ1: How do students perceive the usefulness of each active learning strategy for preparing the summative assessment and which conditions do they identify as enabling or limiting that usefulness?

RQ2: How did students report perceptions of each strategy map onto the four dimensions of SLE? What does the resulting pattern show about the conditions under which these strategies are perceived to sustain learning?

This paper makes two contributions: (1) conceptually, it applies Ben-Eliyahu's SLE framework to an engineering education context; and (2) empirically, the study reports that feedback-related elements recurred across all three activities despite their very different formats. In each activity, the reported limit on perceived usefulness fell at the point where feedback ceased to be available, in timing, in depth, or in access. We therefore propose that the SLE framework requires a supply-side complement specifying what a learning environment must be available for each dimension to be enacted. Reading the three activities as interconnected nodes in a course-level feedback system rather than as independent interventions, we identify feedback distribution (who supplies it, in what form, at what point in the task cycle, and for how long it persists) as a candidate cross-cutting design variable for sustainable learning experiences. Note that this second contribution is interpretative: our students were not asked about relationships between the activities; the reading is further developed in Section 5.4. The remainder of the paper is organized as follows: Section 2 develops the theoretical framework; Section 3 describes the context, activities and methodology; Section 4 reports the perceived positives and negatives of each AL activity; Section 5 interprets these findings through the SLE framework and answers the two research questions; and finally, Section 6 concludes and offers practical recommendations for course design.

2. Literature Review

To contextualize this study, we briefly comment on a few landmark SLE studies and then review relevant research related to the AL strategies used in this research.

2.1. Sustainable Learning in Education (SLE)

SLE is an emerging educational philosophy focusing on curricula and teaching methods that give individuals the knowledge and ability to keep learning under different circumstances, through life transitions and in different domains [1]. It applies the logic we use for natural resources (i.e., renew them, reuse them, do not let them run out) to a learner's capacity to keep learning. Ben-Eliyahu, therefore, identifies four aspects that sustain learning: (1) renewing and relearning (assessing what one knows and learning it again when it is missing or out of date); (2) independent and collaborative learning (working alone, but also drawing on others when needed); (3) active learning (seeking knowledge intentionally and adjusting along the way); and (4) transferability (carrying a strategy learned in one setting into a new one). These four are not a checklist of separate skills. They are held together by SRL as a common mechanism: the cycle of setting goals, monitoring progress, and adjusting [8,9]. Central to this cycle are two mechanisms: a feedback loop, which acts on the task at hand by identifying and correcting errors now, and a feedforward loop, which carries lessons into future encounters [1]. The first loop mostly serves relearning in the moment; the second mostly serves transfer to the future. Both, however, depend on the learner receiving clear information about the gap between current and intended understanding, information that may be generated by the learner through self-assessment, or supplied from outside by a teacher, peer, or system. Ben-Eliyahu [1] treats the ability to take in and act on others' assessment as a lifelong learning skill.

If SRL is the mechanism that binds the four SLE dimensions, feedback is the mechanism that drives SRL. Sadler's formulation [10] remains the reference point. For a learner to close a gap, three things must be simultaneously available: a concept of the standard being aimed at, a comparison of current performance against that standard, and the oppor-

tunity to act. Information alone is insufficient; without a referent the comparison cannot be made; and without an opportunity to act the comparison changes nothing. Hattie & Timperley [11] extended this by distinguishing the levels at which feedback can operate and observed that its effect depends on which level is addressed rather than on its presence or absence. Wisniewski et al. [12] reached a compatible conclusion from meta-analytic evidence: feedback is not uniformly beneficial, and its effect varies substantially with its form.

A parallel line of work reframed feedback from a transmission event into a designed process. Nicol & Macfarlane-Dick [13] argued that the function of feedback in higher education is to develop the learner's capacity to regulate their own learning, which relocates the design question from what information is delivered to what the student is subsequently able to do with it. Boud & Molloy [14] pushed this further, treating feedback as incomplete until the learner acted. Boud & Soler [15] connected it to sustainability, arguing that assessment should equip students for learning beyond the immediate task. Nicol [16] added the internal dimension, showing that learners generate feedback for themselves by comparing their work against available referents, and that the quality of that internal feedback depends on the quality of the referents supplied.

Two considerations of relevance for the present study are outlined below. First, the design question for any AL activity is not only whether it generates feedback but where in the task cycle that information arrives, from whom, and for how long it remains accessible. Second, because internal and external feedback are complementary rather than substitutes (a point on which Nicol [16], Ben-Eliyahu [1], and Zhou et al. [17] converge), activities that produce a self-generated artifact without also supplying an external referent leave the comparison step of the cycle incomplete. SLE needs a balance between the feedback learners generate for themselves and the feedback they receive from a teacher. Both considerations are relevant to the pattern reported in Section 4.

2.2. *The Three AL Strategies in Prior Research*

The concept of AL has captured the attention of higher education scholarship for over three decades, originating in the widely cited monograph of Bonwell & Eison [18] which challenged the prevailing lecture-based model by repositioning students as active participants in their own learning. This shift from content-centered transmission to student-centered instruction was further grounded by Michael's review [19] which synthesized evidence from a number of disciplines. The evidence base for AL effectiveness is, in fact, substantial: from Prince's seminal work [20] about the effectiveness of AL in engineering, through Freeman et al. landmark meta-analysis of STEM studies [21], all the way to Allsop et al. [22] who confirmed that AL also promotes communication and interactivity, fosters a stronger sense of community and connectedness, enhances student satisfaction, and provides greater flexibility. Notwithstanding the weight of evidence in favor of AL, student resistance remains a documented concern [23,24]. However, Andrews et al. [25], in a STEM study comparing instructor and student survey data alongside classroom observations, found that instructors tended to overestimate student resistance due to their own anxieties about students' end-of-semester course evaluations. Diverse scholars have conducted literature reviews on AL strategies implemented when teaching STEM topics (e.g., [26,27]), such as: challenge-based learning, concept maps, debates, escape rooms, one-minute papers, problem-based learning, quizzes, etc.

Post-lecture quizzes are an AL strategy but also function as a specific mode of FA: they prompt retrieval of recently presented material, provide students with feedback on its understanding, and when conducted in digital environments, supply instructors with diagnostic data on learning gaps. Indeed, the shift to online and hybrid learning

environments, accelerated by the COVID-19 pandemic, has increased the relevance of digitally delivered formative quizzes. Interestingly, Ross et al. [28] studied adaptive quizzes in an online first-year accounting subject where qualitative data indicated positive student perceptions regarding motivation and engagement, even though statistically significant improvements in their scores were not consistently observed. However, in a systematic review of causal evidence, Morris et al. [2] concluded that regular low-stake quizzing is among the most powerful FA approaches, albeit they noted that the overall evidence base in higher education remains limited. Although frequent low-stake quizzes are often associated with improved retention, emerging evidence suggests their effectiveness is highly dependent on design, context and learner perception. Poorly calibrated post-lecture quizzes may increase anxiety [29], strengthen recall but not deep understanding [30], or even foster metacognitive illusion [31]. The provision of feedback following quiz attempts is often identified as a key moderator of the testing effect. Both [32] and [2] found that the testing effect is amplified when learners receive corrective feedback. Feedback serves multiple functions: it corrects erroneous responses, reinforces correct ones, and informs learners about the gap between current and desired performance.

Concept maps (CMs) are an AL strategy rooted in the theory of meaningful learning [33], which posits that new knowledge is most effectively acquired when it is deliberately integrated into learners' existing cognitive structures. Novak and Gowin [34] operationalized this theory by developing CM as a pedagogical method that externalizes a learner's mental schema, making conceptual understanding amenable to instruction and assessment. As Clayton [35] noted in nursing education, CM functions as an active learning-teaching strategy that promotes meaningful learning, compelling students to process course material at a deeper cognitive level. Indeed, a robust body of evidence supports the effectiveness of CMs across educational settings. In a landmark meta-analysis, Ref. [36] found that CMs were consistently associated with increased knowledge retention across various domains. Schroeder [37] updated this work and reported a moderate overall effect, noting though that constructing CMs yielded greater benefits than studying pre-made CMs. More recently, Wang et al. [38] analyzed the use of CMs in STEM disciplines, and similarly, identified a moderate overall effect on students' achievement. Within the business management discipline, a quasi-experimental study comparing concept mapping with traditional methods of teaching cost accounting found that the CM group performed better on post-test scores than the control group [39]. Another CM-related theme, the relationship between concept mapping and critical thinking, has attracted considerable attention, though findings across various studies remain mixed. For example, in their systematic review of the effects of concept mapping on critical thinking using standardized tests, Jeong et al. [40] found inconsistencies, which they attributed to methodological gaps in specifying, practicing and evaluating critical thinking skills. This echoes another study where researchers found that randomized studies showed higher effect sizes than non-randomized ones for the impact of CMs on critical thinking ability [41]. Beyond questions of efficacy, however, research on student perceptions indicates that, while CMs are generally viewed positively, challenges are also well-documented. Bes-Piá et al. [42], for example, reported that engineering students perceived high workload alongside acknowledged learning benefits. Cañas et al. [43], on the other hand, examined the differences in the use of CM for learning and for assessment and pointed out how important it was to keep in mind that CM is a tool rather than a methodology. It is, therefore, the educational approach in which the CM is embedded that largely determines whether this AL activity will result in meaningful learning.

Over the past decade, educational escape rooms (ERs) have emerged as an innovative form of active and collaborative learning in higher education, adapted from commercial

ERs where teams solve interlinked puzzles under time pressure. Clarke et al. [44] offered EscapED framework providing one of the earliest design models for higher education implementation. Later frameworks, such as Room2Educ8 [45], have refined ER design using design thinking principles. Theoretical grounding is most commonly drawn from Self-Determination Theory [46] which explains ER's motivational benefits through autonomy (a sense of volition and choice), competence (the experience of mastery and effectiveness) and relatedness (feeling connected to others). The most consistently reported outcome in ER research is increased student engagement and motivation, as shown in a recent systematic review [47]. Sánchez-Martin et al. [48] examined ER experiences with engineering and education students at a Spanish university and reported that the activities were positively received regardless of the discipline or gender. However, the study also cautioned that the methodology remains in its early stages and requires more robust empirical evaluation. In accounting, Cainas & Kralik [49] provided one of the first peer-reviewed accounting ER implementations, showing how time-pressured, narrative-driven decision tasks can support applied understanding of managerial accounting concepts. The ER design, indeed, presents a significant challenge for educators. The need to align game goals and game mechanics with the actual learning objectives has been emphasized as a critical ER design element [50]. The growing body of discipline-specific ER adaptations, such as Ouariachi & Elving's application of ER to climate change education [51], shows that tailoring game design to the demands of a given field is an emerging priority in ER research. Time constraints, while essential to the ER format, are a frequently cited source of student frustration, as reported by several studies (e.g., [48,52]).

3. Materials and Methods

The present study investigated the student experience with post-lecture quizzes, CMs and a finance ER during the first term of the academic year 2025–2026 among the second-year ICT Engineering students at La Salle-URL (La Salle-Universidad Ramon Llull). Financial Economics is a compulsory management course for all seven ICT undergraduate engineering programs (Audiovisual Engineering, Computer Engineering, Electronic Engineering, Engineering in ICT Management, Multimedia Engineering, Telecommunications Systems Engineering, and Telematics Engineering). This cross-disciplinary course leverages technology-enhanced FA via the Moodle Learning Management System (LMS) for distributing materials, hosting activities and providing feedback. The first quiz iteration was conducted during the first academic term of 2024–2025, with the then-current cohort of the second-year ICT Engineering students [53]. Building on engineering education research that emphasizes the importance of frequent, low-stake formative tasks with clear learning outcomes, as well as student suggestions for activity improvement, a revised quiz design was implemented in 2025–2026. Each week, students completed an individual post-lecture Moodle quiz, containing 15–20 multiple-choice questions on key financial concepts and problem-solving exercises. Quizzes provided immediate automated feedback, including the correct responses and item-level explanations. Scores were used for feedback purposes, but only timely submission counted toward 10% of the final course mark, thereby prioritizing formative learning over performance pressure. Four weeks before the final exam, all quizzes were reopened with unlimited attempts and reshuffled questions as a self-study resource. In addition, twice per semester, students individually created CMs synthesizing the material covered up to that point in the course and uploaded them to the Moodle LMS for reference. Before the first CM exercise, students attended a 20 min in-class session that introduced concept-mapping theory, presented worked examples of high-quality maps, and addressed student questions, making expectations and success criteria explicit. At the end of the concept mapping class, selected students shared their

CMs via SmartBoard for the instructor and their peers to provide feedback and help correct individual CMs. Finally, one week before the final exam, students joined an accounting ER conducted in class as a group activity, framed around an engineering club running a parts kiosk that had to keep accurate books across four fiscal quarters to secure venture capital funding. Each quarter, teams received a transaction packet, recorded journal entries in a daybook, and produced a balance sheet (BS). Each quarter built on the previous with progressively complex accounting content. Team progression was gated: the next packet got released only after the instructor verified BS accuracy; erroneous BSs had to be fixed and resubmitted. Throughout the activity, students were encouraged to ask questions and get instructor's feedback on work-in-progress. Team ranking reflected the number of correctly completed quarters, integrating teamwork, time pressure, and cumulative application of course material. The ER did not count toward the course mark but served as optional practice for the exam's most demanding section, worth 4.5 points out of the exam's 10-point total. Students entered the ER having already completed three graded assignments earlier in the semester covering transaction recording, the income statement, and the balance sheet, which established the technical standards expected during the activity.

Two surveys were administered in separate sessions to limit student survey fatigue. The instrument covering quizzes and CMs was completed during the final lecture session before the Christmas break, whereas the ER and its associated survey took place in the following session, one week before the final examination. The difference in respondent numbers between the two instruments (33 and 21) is a consequence of differing attendance at the two sessions. Because no identifier linked the two instruments, it cannot be determined whether the 21 ER respondents were among the 33 who responded on quizzes and CMs. However, all respondents belonged to the same population, had followed the same course with the same three instructors, and had experienced all three activities before responding. The two samples are therefore not independent populations, but neither can they be treated as a single panel. Consequently, every cross-activity observation reported in Sections 4 and 5 describes the aggregate distribution of perceptions across the cohort rather than a within-subject comparison, and no claim is made that any individual student evaluated all three activities. Where mention counts are compared across activities, they are normalized by the number of respondents to the relevant instrument, since raw totals drawn from samples of 33 and 21 are not directly comparable.

Both instruments were administered anonymously to the same enrolled cohort of 174 students, corresponding to response rates of 19.0% and 12.1% respectively.

The analysis has been conducted using the bipolar laddering (BLA) methodology [53,54]. BLA is a qualitative approach that combines open-ended questioning with laddering interview-like techniques once the whole academic experience is completed. Without prior prompting, students first identify positive and negative aspects of their learning experiences, rate their importance on a 10-point scale, and justify their ratings through follow-up "Why?" questions. They then propose potential improvements. This method minimizes bias by eliciting responses grounded in students' own experiences and is well-suited for digital learning contexts. Large samples are not specifically required for the BLA technique as the aim is to capture the range and hierarchy of perceptions, instead of achieving statistical representativeness [55,56]. In the present study, each of the three authors independently coded the results of the BLA analysis to ensure analytical rigor and reduce individual bias. Following this initial coding phase, the authors met to compare and reconcile their coding, resolving discrepancies through discussion and consensus. A subsequent round of collaborative review was conducted to agree on the final interpretation of the findings. This iterative process constitutes investigator triangulation [57], enhancing the credibility, reliability and robustness of the study's conclusions. The data points in

this paper were coded following the procedure outlined by [54]. Positive feedback from students was tagged as Positive (P) Elements (E) and further classified as either Common (C) when raised spontaneously by more than one student or Unique (U) when raised by only one student. The same coding scheme was applied to negative feedback, with N (Negative) replacing P (Positive). Therefore, for each AL experience, the researchers identified Positive Common Elements (PCE), Positive Unique Elements (PUE), Negative Common Elements (NCE) and Negative Unique Elements (NUE), all expressed as statements. Both positive and negative elements were then ranked by number of “Mentions”, defined as how many times each element was cited by students when describing their perception of the experience. This is indicated in the “Mentions n” column in the tables below, while “Mentions %” indicates percentages calculated against the total number of mentions. Since each respondent could list up to three positive and three negative aspects, the “Mentions” percentages do not sum to 100% respondents. The BLA methodology is of qualitative nature, so “Average” and “Variance” are used here as interpretative proxies rather than as strict statistical measures. Importance was recorded on a single bipolar 1–10 scale in which position on the scale conveys both the direction and the strength of the element’s perceived effect on the respondent’s learning. Positive elements are rated between 5 and 10, where 10 denotes the strongest perceived contribution to learning and 5 denotes a contribution close to negligible. Negative elements are rated between 1 and 5, where 1 denotes the strongest perceived obstacle to learning and 5 denotes an impediment close to negligible. The two halves of the scale must therefore be read in opposite directions: in the positive tables a higher average shows a more strongly valued element, while in the negative tables a lower average indicates a more damaging one. To avoid ambiguity, we refer throughout to the intensity of an element, defined as the distance of its average from the scale midpoint of 5 in the relevant direction; an element averaging 9.0 and one averaging 1.0 are both high intensities, in opposite directions. “Variance” indicates whether respondents converged on a similar rating (low variance) or diverged (high variance) and is used to describe the degree of consensus around a perception, not to support formal inference.

It is important to clarify what this study captured and what it did not. The reported evidence is about how students experienced the AL activities: among other things, how the feedback felt, where it helped, and where it was missing, and not about whether their grades in the subject improved. The activities were not linked to subject outcomes, and no such claim is made; the study operates entirely at the formative level.

4. Findings

The BLA survey was carried out anonymously at the close of the first academic term of 2025–2026. Participants had prior experience of AL, which is the methodology commonly implemented across La Salle-URL ICT Engineering programs. Before taking the survey, students had completed their coursework in the business-oriented subject “Financial Economics”. The course had 174 enrolled students, divided into five groups and taught by three instructors. Of this cohort, 33 (17 males; 14 females; two withheld) responded to the survey about quizzes and CMs while 21 (12 males; eight females; one withheld) answered the ER survey. Across the two instruments, respondents shared 133 positive and 72 negative aspects of the three AL strategies. Each respondent could name up to three positive and three negative aspects of a given activity. Table 1 summarizes the dataset on this basis.

Table 1. Structure of the response dataset across the three active learning activities.

	Quizzes	CMs	ER
Respondents	33	33	21
Positive mentions (<i>n</i>)	52	39	42
Positive mentions per respondent	1.58	1.18	2.00
Negative mentions (<i>n</i>)	24	23	25
Negative mentions per respondent	0.73	0.70	1.19
Distinct positive elements	10	11	8
Distinct negative elements	9	9	11
Unique elements as share of negative mentions	0.04	0.09	0.2
Weighted mean intensity, positive elements	7.52	7.64	8.88
Weighted mean intensity, negative elements	2.92	3.09	2.76

Three structural features condition how to read the results. First, volume differs more than balance. The ER drew twice as many positive mentions per respondent as CMs (2.00 vs. 1.18) and 1.7 times as many negative ones (1.19 vs. 0.70), making it the most important activity in both directions. The positive-to-negative ratio barely separates activities (2.17, 1.70, 1.68). CMs and ER are indistinguishable in this measure despite very different intensity profiles. Second, intensity and volume diverge. The ER combines the highest positive intensity (8.88) with the most severe negatives (2.76), while quizzes and CMs cluster closely on both measures (7.52–7.64 positive; 2.92–3.09 negative). Raw mention counts alone miss this extremity. Third, negative feedback differs structurally. Quiz complaints concentrate heavily (nine elements, one unique, 4% of negatives). ER complaints disperse across eleven elements, five unique, accounting for 20% of negatives, with one element absorbing 32% of the total. A dispersed profile of single mentions carries different interpretative weight than a concentrated one, even at comparable severity.

For quizzes, positive mentions (Table 2) cluster on two related statements: reviewing theory (PCE-1) and reinforcing classroom content (PCE-2). These attracted the most citations (e.g., “quizzes help me go back over the theory and really absorb it”; “they give me a chance to apply and solidify what was covered in class”) but rated lowest (7.27 and 6.91). The highest-rated elements (two attempts PCE-6; real-world examples PCE-7; exam preparation PCE-3; and supplementary content PUE-1) each drew only one to six mentions (e.g., “you practice what you learned in class in an easy way”). Students cited generic quiz functions most; they rated specific design choices highest. Exception: staying up to date weekly (PCE-4) showed tight consensus. The two-attempt provision (PCE-6) showed high variance—rated very highly by some respondents, considerably lower by others.

Quiz complaints (Table 3) mostly request more activity rather than rejecting it. Insufficient practice (NCE-1) accounts for 21% of negative mentions at intensity 2.40. The second most frequent complaint (quizzes not matching exam difficulty NCE-2), carries greater design implications. Frequency and severity diverge: the most severe complaint in the entire dataset is that quizzes do not help students learn effectively (NCE-8), cited only twice but at extreme intensity by two respondents in near agreement. A small minority rejected quizzes outright with more conviction than the majority brought to any complaint. Remaining negatives cluster narrowly between 3.00 and 3.50.

Table 2. Students' perceptions of quiz elements that enhance their learning.

Statement	Element	Mentions <i>n</i>	Mentions %	Average	Var
Quizzes help me review and consolidate theoretical concepts	PCE-1	11	21%	7.27	2.20
Quizzes help me practice and reinforce what was taught in class	PCE-2	11	21%	6.91	2.26
Quizzes help me prepare for exams and assignments	PCE-3	6	12%	8.00	1.67
Quizzes help me stay up to date with course content weekly	PCE-4	6	12%	7.33	0.56
Quizzes are quick, easy, and convenient to complete	PCE-5	5	10%	7.60	2.64
Having two quiz attempts helps me learn and improve my grade	PCE-6	4	8%	8.50	2.75
Quizzes expose me to interesting real-world examples	PCE-7	4	8%	8.25	1.19
Quizzes provide corrected questions useful for studying	PCE-8	2	4%	7.50	0.25
Quizzes expand my knowledge of finance beyond class	PCE-9	2	4%	7.50	0.25
Quizzes add good supplementary content on Moodle LMS	PUE-1	1	2%	8.00	0.00

Note: Elements (E) are identified as Positive (P), Common (C) or Unique (U).

Table 3. Students' perceptions of quiz elements that hinder their learning.

Statement	Element	Mentions <i>n</i>	Mentions %	Average	Var
There are not enough practice exercises or quizzes available	NCE-1	5	21%	2.40	1.84
Quizzes are not similar enough to exam-level questions	NCE-2	4	17%	3.00	2.50
Quizzes are too easily completed using AI or external help	NCE-3	3	13%	3.33	1.56
Quiz deadlines are too short, or quizzes become unavailable for review	NCE-4	3	13%	3.00	0.67
Quiz corrections are too short and lack sufficient explanations	NCE-5	2	8%	3.50	0.25
Quiz questions are tricky, unclear, or lack answer flexibility	NCE-6	2	8%	3.50	2.25
There are too many questions in the quizzes	NCE-7	2	8%	3.50	0.25
Quizzes do not help me learn or practice effectively	NCE-8	2	8%	1.50	0.25
There are too few attempts allowed on quizzes	NUE-1	1	3%	3.00	0.00

Note: Elements (E) are identified as Negative (N), Common (C) or Unique (U).

Three design features appear in both positive and negative feedback. The two attempt provision rates are highest positively (PCE-6) but also appear as complaints about too few attempts (NUE-1). Corrected questions are valued as study material (PCE-8) while their brevity is criticized (NCE-5). Most strikingly, quizzes receive credit for exam preparation (PCE-3), yet they are criticized for not matching exam difficulty enough (NCE-2). These are not contradictions but evidence that the same three features (attempts, corrections, and exam calibration) were focal points for both strongest approval and most specific dissatisfaction.

As for CMs (Table 4), positive mentions concentrate on synthesis and clarification: summarizing course content (PCE-1) and clarifying and understanding concepts (PCE-2) together account for 41% of positive comments. Respondents described the activity in structural terms (e.g., “concept maps help me synthesize and summarize course content”; “concept maps help me see connections and relationships between topics.”) Two features distinguish this table from the other two positive tables. The first is dispersion: PCE-2 carries a variance of 3.06, the highest of any positive element in the dataset. Students agreed that CMs clarify concepts more readily than they agreed on how much they do so. The second is the concentration of maximum ratings among single-respondent elements. Three of the four unique positive elements (active recall PUE-2; speed and ease of completion PUE-3; and universal participation PUE-4) were rated 10.00, the ceiling of the scale. CMs

produced both the most contested common element and the largest number of maximum individual endorsements in the study. Among common elements, the highest-rated is seeing connections between topics (PCE-5), which is the least frequently mentioned of the common positives at four mentions. The lowest-rated positive element in the entire dataset is also here: identifying gaps in understanding (PCE-6), cited by two respondents who rated it identically. Students recognized the diagnostic function of the activity but registered it as marginal in a way they did not register any other benefit.

Table 4. Students' perceptions of concept map elements that enhance their learning.

Statement	Element	Mentions <i>n</i>	Mentions %	Average	Var
Concept maps help me synthesize and summarize course content	PCE-1	9	23%	7.44	1.80
Concept maps help me clarify and understand concepts better	PCE-2	7	18%	7.71	3.06
Concept maps help me study and prepare for exams	PCE-3	6	15%	7.67	1.56
Concept maps help me review and reinforce what was covered in class	PCE-4	5	13%	6.80	0.56
Concept maps help me see connections and relationships between topics	PCE-5	4	10%	8.00	1.50
Concept maps help me identify gaps in my understanding	PCE-6	2	5%	6.00	0.00
Concept maps provide useful visual learning	PCE-7	2	5%	7.50	0.25
Concept maps help me retain and memorize content	PUE-1	1	3%	8.00	0.00
Concept maps promote active recall	PUE-2	1	3%	10.00	0.00
Concept maps are quick and easy to complete	PUE-3	1	3%	10.00	0.00
Concept maps ensure everyone participates	PUE-4	1	3%	10.00	0.00

Note: Elements (E) are identified as Positive (P), Common (C) or Unique (U).

The frequency–severity divergence is sharpest for CMs (Table 5). The most frequent complaint is that maps were neither returned nor accompanied by a model answer (NCE-1), yet its intensity is mid-range, and less severe than several elements cited less often. The two most severe complaints are that maps were handwritten rather than digital (NCE-6) and that the activity was not perceived as an effective learning method (NCE-7), each cited twice. Insufficient time (NCE-2) and too few maps (NCE-3) fall in between. At the other end, the individual rather than group format (NCE-4) is interesting because it is contradicted within the dataset by PUE-4, which values the individual format at 10.00 for ensuring that everyone participates. The individual configuration of the activity produced simultaneously the highest-rated positive element in the CM table and one of its mildest negatives, indicating divided rather than adverse reception.

Together, Tables 4 and 5 show the least polarized profile of the three activities. CMs generated the weakest positive-to-negative ratio (1.70), the least severe set of negatives (3.09), and the most dispersed positive ratings. The activity was neither strongly endorsed nor strongly rejected.

The ER produced the most consensual positive profile in the study (Table 6). All six common positive elements are rated between 8.40 and 9.33, and all six carry variances between 0.25 and 1.20—the lowest range of any table in the dataset. Where the quiz and CM tables show respondents dispersed across the positive half-scale, escape-room respondents converged near its upper end. Within this compressed range, the ordering is informative. The most frequently cited element is that the activity is “fun and engaging” (PCE-1). The most highly rated element, however, is that it helps students review and consolidate course content before the exam (PCE-2). The instrumental claim outranks the effective one on intensity while trailing it by a single mention on frequency, and it does so with the tighter

consensus of the two. Some responses are: “I liked the dynamics”; “the structure naturally encourages teamwork”; “each phase introduces more aspects to take into consideration”; and “it’s useful for reviewing important topics that will be covered in the exam and learning things that we might not be able to learn on our own before the exam.” The instructor’s availability to resolve doubts during the activity (PCE-4) is the only element anywhere in the dataset that refers to instructor’s presence within the task itself.

Table 5. Students’ perceptions of concept map elements that hinder their learning.

Statement	Element	Mentions <i>n</i>	Mentions %	Average	Var
Concept maps are not returned or accompanied by a model answer.	NCE-1	6	26%	3.00	1.33
Not enough time is given to complete the concept maps	NCE-2	4	17%	2.75	1.19
Too few concept maps	NCE-3	3	13%	2.67	0.22
Concept maps are individual class activity, not group	NCE-4	2	9%	4.50	0.25
We cannot keep or take home the concept maps we create	NCE-5	2	9%	4.00	0.00
Concept maps are handwritten, not created in digital format	NCE-6	2	9%	2.00	1.00
The activity is not perceived as an effective learning method	NCE-7	2	9%	2.00	1.00
The format is unfamiliar and difficult	NUE-1	1	4%	5.00	0.00
The timing of the activity within the class session is poor	NUE-2	1	4%	4.00	0.00

Note: Elements (E) are identified as Negative (N), Common (C) or Unique (U).

Table 6. Student perceptions of escape room elements that enhance their learning.

Statement	Element	Mentions <i>n</i>	Mentions %	Average	Var
The activity is fun and engaging	PCE-1	10	24%	9.00	1.20
The activity helps me review and consolidate course content before the exam	PCE-2	9	21%	9.33	0.67
Working in groups enables cooperative learning and shared problem-solving	PCE-3	8	19%	8.75	1.19
Instructors are available to resolve doubts and provide guidance	PCE-4	6	14%	8.67	0.89
The activity allows me to practice and apply my knowledge	PCE-5	5	12%	8.40	1.04
The staged/progressive structure helps me learn step-by-step	PCE-6	2	5%	8.50	0.25
The activity helped me learn new things I did not know before	PUE-1	1	2%	10.00	0.00
Student participation in the activity is positively valued in assessment	PUE-2	1	2%	8.00	0.00

Note: Elements (E) are identified as Positive (P), Common (C) or Unique (U).

Against this consensual positive profile, the negative ER elements (Table 7) are the most fragmented in the dataset: eleven distinct elements across twenty-five mentions, five of them cited only once. One element nonetheless dominates: the element denoting that the activity was too long and there was insufficient time to finish it (NCE-1) is the largest share held by any single element in the study. The most severe elements are again not the most frequent. Confusion about the activity (NUE-5) is the most extreme rating in the dataset, though it was voiced once. The mildest negatives in the entire dataset are here: forced and oversized groups (NUE-1) and the activity not being useful (NUE-2), both rated at the neutral pole.

Table 7. Student perceptions of escape room elements that hinder their learning.

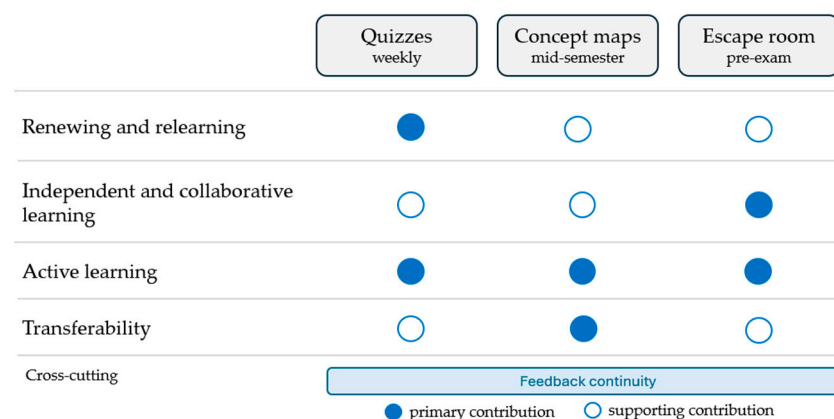
Statement	Element	Mentions <i>n</i>	Mentions %	Average	Var
The activity was too long and there was not enough time to finish it	NCE-1	8	32%	2.88	1.36
The activity was scheduled at an inconvenient time or overlapped with other commitments	NCE-2	3	12%	2.00	1.00
The activity did not cover enough topics from the syllabus	NCE-3	3	12%	1.67	0.22
The activity did not feel like a real escape room	NCE-4	2	8%	3.00	1.00
The competitive format created pressure or was counterproductive	NCE-5	2	8%	3.00	1.00
No correction or feedback was provided after the activity	NCE-6	2	8%	3.00	1.00
The group setup was problematic—groups were forced and too large	NUE-1	1	4%	5.00	0.00
The activity was not useful	NUE-2	1	4%	5.00	0.00
The activity structure was too linear and lacked variety compared to a real escape room	NUE-3	1	4%	4.00	0.00
There was no reward or incentive for participating or winning	NUE-4	1	4%	2.00	0.00
The activity was confusing	NUE-5	1	4%	1.00	0.00

Note: Elements (E) are identified as Negative (N), Common (C) or Unique (U).

Two internal relations in these tables are worth noting for later analysis. NCE-1 reports that the activity was too long compared to the time available, while NCE-3 reports that it covered too little of the syllabus; both concern the ratio of time to content, but they point in opposite directions. And PCE-4, valuing instructor availability during the activity, sits alongside NCE-6, which registers the absence of correction after it: approval of support at one point in the task cycle coexisting with a complaint about its absence at another.

5. Discussion

This study examined how ICT Engineering students perceived three AL activities embedded in a business-oriented semester-long course. We interpret those perceptions through the four dimensions of SLE, treating SRL as the mechanism through which the dimensions are enacted and feedback as the information that drives the cycle (see Figure 2).

**Figure 2.** Four aspects of SLE according to Ben-Eliyahu [1] and its relationship with the three analyzed AL strategies.

Two framing points apply throughout. First, our evidence concerns perceptions, not learning: the activities were not linked to subject outcomes, and no such claim is made. Second, the mapping between activities and SLE dimensions is not one-to-one. Each activity contributes to more than one dimension, while active learning is common for all three.

5.1. Renewing and Relearning

Renewal is most clearly associated with quizzes. Students described them as tools for consolidation and ongoing engagement, aligning with iterative reconstruction [1] and repeatable self-assessment cycles [58]. The highest-valued feature was re-attempts, showing that value lay in the repeatability of retrieval, not retrieval alone. Negative comments cluster is where this cycle breaks: limited access, shallow feedback, and insufficient quantity. The most frequent complaint was wanting more quizzes, suggesting that students valued the mechanism but found its availability constrained. While Boud & Soler [15] frame such activities in terms of preparation for future learning, students emphasized continued access more directly. CMs and ERs also contributed to renewal through review, but at lower intensity.

5.2. Transferability

Transferability is most associated with CMs, though evidence is weaker. Students emphasized synthesis, conceptual clarity, and relationships, which plausibly support transfer. Gap detection aligns with self-generated feedback [16], but was weakly valued. Read alongside the absence of returned maps or model answers, this suggests students lacked a reference standard for comparison [10]. As Nicol [16] notes, internal feedback depends on the quality of that referent. Material constraints reinforce this: maps were not retained, portable, or digital, limiting reuse. This practical condition, rarely addressed in reviews of concept mapping in engineering education [59], directly constrains transfer. Students also framed maps mainly as exam preparation, not future application. This sits alongside evidence that retrieval practice may yield stronger meaningful learning gains than concept mapping [60]. Students did not position the two activities as competing: quizzes were described in terms of consolidation and CMs in terms of organization, which is closer to a division of labor than to a contest.

5.3. Independent and Collaborative Learning

This dimension is distributed: quizzes and CMs were individual, while the ER was collaborative. Students valued both modes conditionally, depending on design. The ER strongly supported collaboration, consistent with prior works [17,52,61], though group configuration and competitive elements shaped its effectiveness. The most valued feature was instructor support during the task, reflecting embedded feedback processes rather than post hoc evaluation [14,62]. This vertical support is not fully captured in SLE's peer-oriented framing and aligns with critiques that design features in ER are more often described than evaluated [63].

5.4. Active Learning and the Distribution of Feedback Across the Course

The fourth SLE dimension does not behave like the other three. All three activities were active by design; all three were experienced as active; and the students were already used to active learning, which is standard across La Salle-URL ICT Engineering programs. The dimension is therefore satisfied uniformly and explains none of the variation between the activities. Differences, instead, align with feedback availability across the task cycle:

- Quizzes: post-task feedback, immediate but limited in depth and access;
- CMs: in some cases, missing external feedback or take-home standard;
- ER: in-task feedback, limited after completion.

Together, they form a partial feedback system, but with a consistent gap: no activity supports post-task evaluation of student-generated work against an external standard. This corresponds to the condition under which perceived usefulness declines. Activities function not as isolated interventions but as interconnected parts of a feedback system.

This interpretation is based on inference and does not allow us to determine whether the effects are due to feedback or to other confounding factors such as timing, group format, or grading.

The implication potentially extends the SLE framework. While Ben-Heliyahu [1] defines dimensions as learner capacities, students consistently described them as contingent on environmental provision (e.g., access to quizzes, return of maps, instructor presence). A supply-side complement is therefore needed. Feedback continuity (in timing, depth, and access) is the proposed condition, as it was the only limiting factor common to all three activities.

5.5. Answering the Research Questions

RQ1: How do students perceive the usefulness of each strategy for preparing the summative assessment, and which conditions enable or limit that usefulness?

All three strategies were perceived as useful for examination preparation, but on different grounds and with different limiting conditions. Quizzes were perceived as useful through distributed rehearsal. They were valued for content currency and re-attempts, limited by exam alignment, quantity, and access. CMs were perceived as useful through organization rather than rehearsal. The limiting conditions were the non-return of the artifact, its non-retention and handwritten form, as well as insufficient time and frequency. The ER was perceived as the most useful of the three for examination preparation, and by a clear margin. Reviewing and consolidating content before the exam attracted the largest share of any activity's positive mentions on this basis. The instrumental claim was rated above the effective one, which is worth stating plainly: students did not describe the escape room as enjoyable and therefore valuable, but as valuable and enjoyable. Its limiting conditions were temporal and logistical rather than pedagogical: duration, time pressure, and insufficient syllabus coverage. The escape room carried no weight in the final mark, yet it was the one most strongly and most consensually perceived as useful for summative assessment. Its position one week before the examination, its group format, and the presence of instructors throughout are all plausible contributors, and the design does not permit them to be separated.

RQ2: How did students report perceptions of each strategy map onto the four dimensions of SLE? What does the resulting pattern indicate about the conditions under which these strategies are perceived to sustain learning?

The mapping is not one-to-one, and the pattern is more informative than the mapping. Renewal and relearning were associated principally with the quizzes and were perceived as supported for as long as the quizzes remained accessible. Transferability was perceived as associated with the CMs and the most weakly evidenced of the four. It was perceived as supported at the level of representation-building but not at the level of retention or calibration. Independent and collaborative learning was distributed across all three activities rather than located in one, with the collaborative pole in the ER and the independent pole in the two individual activities. Students valued both poles conditionally: the highest rated element—instructor availability during the task—reflects a vertical form of support not captured in the dimension as defined in the academic literature. Active learning was present uniformly. Across these four SLE aspects, effectiveness was limited where feedback ceased: in timing (ER), depth (quizzes), or access (quizzes and CMs). Thus, variation is better explained by feedback conditions than by activity type, consistent with the system-level interpretation constructed by the researchers from responses that students gave about each activity separately.

5.6. Limitations and Future Research

Several limitations qualify these findings. Its focus on identifying positive and negative aspects of the analyzed AL activities (captured through the BLA tool) meant that data on respondents' academic performance was intentionally omitted. Future research could incorporate objective measures of academic achievement alongside self-reported perceptions. A further limitation concerns the limited sample size, which consists of a subset of second-year ICT Engineering students from seven different degree programs of a single institution. Future research could expand into different programs and other university centers. The BLA technique does not specifically require large samples, since its purpose is to capture the range and hierarchy of perceptions rather than to achieve statistical representativeness. However, future research could employ larger samples, involve participants from other year groups, or replicate the study in other disciplines to help establish whether the findings are specific to engineering or transferable to other fields. Finally, the students were not asked about relationships between the three strategies; the reading advanced in Section 5.5 is interpretative and requires direct testing.

6. Conclusions

This study analyzed ICT Engineering undergraduates' perceptions of three active learning strategies (weekly quizzes, individual concept maps, and an accounting escape room) within a compulsory business course, using the four dimensions of SLE. Through bipolar laddering, 133 positive and 72 negative elements were identified and examined by frequency, intensity, and dispersion. All AL activities were seen as useful for exam preparation, but for different reasons. Quizzes supported distributed practice and re-attempts, though limited by alignment with the exam, workload, and access windows. CMs supported synthesis and relational understanding but received the weakest endorsement, mainly due to lack of return and retention of student-produced artifacts. The ER was most strongly and consistently valued for exam preparation, with limitations related only to duration and syllabus coverage.

Across SLE dimensions, activities did not map one-to-one: quizzes aligned mainly with renewal, CMs with transferability, and all three supported independent and collaborative learning at different poles; AL was uniformly present. The key differentiator was when performance information became available and how long it persisted. Perceived usefulness declined where this information stopped: limited depth/access in quizzes, lack of return/retention in concept maps, and absence of debrief in the escape room. Together, the activities form a complementary course-level feedback cycle.

Five practical recommendations for course design are going to be applied in the next edition of our course:

- Treat access windows as a design parameter; closing formative artifacts limit their learning value. If reopening, ensure it is early and clearly communicated.
- Return self-generated artifacts with a referent; annotated exemplars complete the comparison step more effectively than grading alone.
- Ensure portability of student artifacts; simple digital capture can enable later reuse.
- Combine in-task guidance with post-task closure; short structured debriefs complement real-time support.
- Audit the course as a feedback system by mapping when feedback appears, who provides it, and how long it lasts, identifying uncovered positions (here, post-task correction of self-generated work).

Should the above recommendations be applied in other contexts, they should be read against the study limitations outlined in Section 5.6.

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Abbreviations

The following abbreviations are used in this manuscript:

AL	Active Learning
BLA	Bipolar Laddering
BS	Balance Sheet
CM	Concept Map
ER	Escape Room
ICT	Information and Communication Technology
LMS	Learning Management System
NCE	Negative Common Element
NUE	Negative Unique Element
PCE	Positive Common Element
PUE	Positive Unique Element
SLE	Sustainable Learning in Education
SRL	Self-Regulated Learning

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