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Interaction Between Learning Assessment and Student Motivation: A Scoping Review*

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Interaction between assessment and student motivation is a relatively understudied topic in engineering education. Though research and scholarship on both individual constructs are plenty and expansive, literature on the topic is not substantial relative to either of the individual concepts. It is essential to study such interactions as literature on assessments typically focuses on teaching improvement but is scarce from the student perspectives. On the other hand, motivation in engineering education usually focuses on improving content and pedagogies, but not assessment. Thus, this scoping review begins to address the research gap by providing an overview of the state of existing literature on the interaction in the undergraduate context. Grounded in scoping review methodologies, this review found that intentional study on the interaction is limited. Many of the articles scoped show motivation either hinted (no theoretical grounding) or emerged from the findings (no initial plan to include motivation in the study). Besides, most articles employed quantitative methods. These findings warrant a systematic literature review to be conducted on the topic to portray and describe further the research gaps, which can subsequently promote efforts to address the gap in engineering education. Further, the review recommends the engineering education community use diverse motivation theories and research methods to study the topic.

Keywords: assessment; learning assessment; motivation; motivation theory; learner-centered pedagogy; scoping review

1. Introduction

Student motivation has been part of the larger movement toward learner-centered pedagogical approaches, but the movement does not seem to have heavily influenced the design and implementation of learning assessments. Both concepts, individually, have a significant presence in the engineering education literature. For learning assessments, publications on underlying philosophies behind assessment and different assessment methods [1–4], guidelines and tools on how to conduct and improve assessments [1, 5, 6], and guidelines on how to satisfy ABET accreditation requirements [7–9] are abundant. In addition, calls for course alignment further strengthen the value of assessment research [5, 10–12], emphasizing the need to research the construct. Similarly, scholarship on student motivation in engineering education is substantial, mainly because existing literature has been calling for motivation consideration as part of students' individual backgrounds in the process of teaching and learning [13–15]. In engineering education, focuses on motivation research include student self-efficacy on engineering-related tasks [16, 17], and student motivation in pursuing engineering [18, 19]. Brown and colleagues conducted a systematic literature review on the type of motivational theories used in engineering education research, presenting many works related to the motivation construct, which further strengthens the importance of the construct in the field [20]. However, literature on the interaction between these concepts is lacking as compared to that of either of the individual concepts.

Although some studies have researched the influence of assessments on students' motivation and behavior in the general education setting [21–26], little work looked at such influence in engineering education research. More work should explore the interaction between assessment and students' motivation in learning engineering because assessment and motivation both play significant roles in the learning and teaching process in engineering education, and researchers and practitioners should work on advancing knowledge and practice in said topic to improve engineering education [13, 15, 27–30]. Essentially, scholarship on the topic is necessary to advance assessment practice in terms of considering student motivation to learn. This scoping review presents a first step toward identifying the size, extent, and nature of research between assessment and motivation. Here I provide an overview of existing research on the interaction between these two constructs and present future directions on knowledge advancement in learning engineering. In addition, my scoping review presents a warrant to conduct a systematic literature review to further the efforts.

This review is grounded with three major arguments. First, the engineering education community should pursue further scholarship on how various

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assessment approaches (portfolios, tests/exams, project reports, reflective assessments and others) influence students' motivation in learning in engineering education. Second, assessment in various forms is done in most engineering courses, and its pervasive presence in an engineering program can affect how engineering students experience the engineering programs in terms of motivation to learn. Third, more literature is needed on how motivation can be considered when designing assessment approaches to align with course content and delivery as motivation is part of students' background that should be considered in the learning and teaching process. The following section provides a literature review that explains these three arguments.

2. Arguments for this Scoping Review

There are three main reasons why the engineering education community should study the interactions between assessment and student motivation in the undergraduate context, and why this scoping review is essential in setting the foundations toward more scholarship on the topic. Argument one revolves around the need to further scholarship on how assessment approaches influence student motivation to learn in engineering education, and possibly, persisting in engineering. In the context of higher education, Brown [31] argues that one of the purposes of assessment is to motivate students and measure their sense of achievement, which is represented in some of the assessment literature. Seale and colleagues find in their study of a therapy degree course that four factors can influence how assessment impacts students' motivation [22]. These are perceived relevance of assessment, assessment content, enthusiastic lecturers, and group influences. Another study by Norton and colleagues showed that assessment workload is a frequently mentioned cause of stress for students as they feel pressured to perform well in those assessment practices [23]. This is consistent with Brookhart and Durkin's findings on expectations students place on assigned assessment tasks, though Brookhart and Durkin's study focuses on high school setting [24]. In addition, some publications focus on the impact of formative assessment on students' motivation. Black and William argue that, if conducted frequently with appropriate feedback given to the students, formative assessment can be useful in improving student learning [32]. Feedback can help improve engagement from the students and further motivate them to learn [26]. However, a high-school-based study shows that formative assessment has no statistically significant effect on students' motivation, though the authors claim this could be caused by the inconsistency among different teachers and teaching strategies [33]. There is a need to bring such scholarship into engineering education as we continue thinking about how to improve student motivation to learn and persist in engineering.

Argument two concerns the pervasiveness of assessment in undergraduate engineering programs. There are several reasons instructors conduct assessments in higher education. One of the reasons is accountability. Throughout the history of higher education in the United States, there have been calls for quality assurance of the education provided by higher learning institutions [34]. The call for quality assurance has led to the employment and incorporation of outcome assessment in higher education for accountability. Banta and Palomba describe that accountability subsequently falls under the regional accreditation associations in which standards-based learning outcomes are used in accrediting evaluations [34]. In addition, higher learning institutions have now focused more on producing more graduates efficiently to continue providing the country more skilled workers for driving the economy, becoming the "engine of the economy" [35]. These all put pressure on various actors in institutions, such as faculty members, school administrators, and others, to provide more evidence of students' proficiency in stated learning outcomes. Such practice can increase the number of assessments students will face in their undergraduate careers. With increasing expectations of accountability as explained previously, a wide range of assessments are conducted to demonstrate the quality of educational programs to multiple stakeholders, such as regional accreditation, engineering accreditation, governments, students, faculty members [36], and students, the intended benefactor of higher education, can face enormous pressure while confronting with these assessments.

Furthermore, many instructors assess students because they want to know what students know, and such information can help the instructors make course adjustments to better teach the students [4, 11, 31, 37, 38]. With various forms of assessments deployed in classrooms, such as direct, indirect, or embedded, summative or proficiency-based, and formative assessments, students can face many different types of assessment in courses they take [32, 34, 37–39]. Students also tend to take multiple courses in an academic term, compounding the fact that students face an abundance of assessments, whether in quantity or form.

These phenomena imply assessment is done at multiple levels of a student's undergraduate experience, consistent with literature demonstrating that assessments can happen at various levels [40]. These assessment experiences can be pervasive to students throughout their undergraduate educational experience. Engineering education is no exception to the pervasiveness of assessment in the curricula as students are expected to work on homework, exams, reports, and other forms of assignments in their engineering courses. Engineering students may face even more pervasiveness as engineering curricula are usually compact and dense with concept-heavy courses [41, 42]. In addition, students can be asked to participate in surveys, interviews, and focus groups to assist with the program in collecting data for continuous improvement and accreditation purposes. Following argument one that shows possible influences of assessment on student motivation, the pervasiveness of assessment could increase those influences, whether positively or negatively.

Finally, the third argument focuses on the need for scholarship in terms of student motivation to learn and persist while designing learning assessments. There has been calls to incorporate learning sciences in designing pedagogies, which include aligning assessment, content, and delivery in course and curricula design [5, 43]. Student motivation becomes a factor in designing and implementing alignment and pedagogical methods. There are several engineering education publications that explain the importance of motivation in designing courses. In [44], Ambrose and colleagues detail the importance of students' motivation in designing a learning environment and provide recommendations on how to build positive expectancies and promote a positive learning environment to further students' achievement motivation. On the other hand, the MUSIC (stands for eMpowerment, Usefulness, Success, Interest, and Caring) model of academic motivation provides an overall guide on how to incorporate motivation when designing instructional methods [45]. One thing missing from such literature is the consideration of motivation in designing assessments. There have been calls to consider student motivation in designing instruction and content, but not assessment. There is a need for such research in engineering education to make the alignment process more robust and effective.

3. Purpose Statement and Research Questions

The three arguments presented establish the need for scholarship in interactions between assessment and motivation in engineering education. With that in mind, the purpose of this work in progress research study is to conduct a scoping review on the currently available literature on interactions between learning assessment and student motivation in the undergraduate context. The review will answer the following research questions:

RQ1: *What are the characterizations of the scoped literature that focuses on undergraduate engineering education that studies interactions between learning assessments and student motivation, in terms of literature size, type of methods, study geographical content, study purpose, engineering discipline, and type of courses?*

RQ2: *How do learning assessment and student motivation "interact" in the scoped research?*

A scoping review typically does not lend identification of research gaps of the topic of interest. However, I will recommend possible research gaps based on this scoping review's findings, encouraging those in the research community to examine further the topic to explore these gaps and take actions to begin filling the gaps.

4. Method

This study is inspired by existing scoping review methodologies. There is no unified definition of scoping review in existing literature, though it is commonly described as a form of rapid mapping of the literature of a specific domain within a field [46–49]. A scoping review typically provides a preliminary view and perspective on the size and scope of existing literature in a specific topic and focuses on "characterizing the quantity and quality of literature review, perhaps by study design and other key features." [46, p. 95] In addition, some perform scoping reviews to assess whether a systematic literature review is needed [46, 47, 50]. A systematic literature review differentiates from a scoping review in that a systematic literature review tends to focus on appraisal of existing literature in terms of quality of those research and their findings, and involve an exhaustive search of the literature on the topic [50, 51]. I decided on a scoping review for this study because it allows quick mapping of existing literature on a specific domain, and the review can provide the extent and size of the existing literature [46, 47, 50]. Furthermore, a scoping review can determine the feasibility and relevance of a systematic literature review [46], meaning that before committing to a comprehensive and exhaustive systematic literature review, the scoping review can show whether there is literature on the interaction between assessment and motivation or a review has already been conducted on the topic.

Most of the existing scoping reviews are done in the health science field, though there are some conducted in education [52]. For instance, Constand and colleagues conducted a scoping review to explore existing literature on patient-centered care in the context of communication, partnership, and health promotion [53]. Essentially, the authors leveraged scoping review to understand these three constructs within care models or frameworks in the current literature and found that existing literature has consistently recognized the three constructs as important and essential to care in multiple areas of clinical practice, even though there is no unify and consensus model on them. Another review detailed in [54] employed a scoping review to describe and categorize barriers and strategies that clinical practice confronts. Fischer and colleagues summarized from 69 articles the various barriers, interventions, and strategies that clinical practitioners face, and they concluded that further research on barriers and more structured strategies could promote better implementations. In the educational context, a review scoped research on the use of flipped classrooms in higher education and found that there is perceived positive outcomes from the use of flipped classrooms [55]. However, some educators who employ them may not fully comprehend the underlying philosophies of the pedagogical approach as the authors found some misunderstanding of key elements to flip a classroom successfully [55]. These published articles demonstrate the versatility and usefulness of scoping review in scholarship. Many of these articles show that a scoping review can provide a deeper understanding of existing literature on specific topics in various fields and provide an avenue to categorize and characterize literature to facilitate future research.

For this scoping review, I employed Arksey and O'Malley's guidelines as the foundation and adopted some improved guidelines [47, 49]. Arksey and O'Malley provide four reasons to conduct a scoping review: (1) to examine the extent, range, and nature of research activity, (2) to determine the value for undertaking a full systematic review, (3) to summarize and disseminate research findings, and (4) to identify research gaps in the existing literature [48 p. 6]. Reason (1) inspires this review as my research questions focus on the overall characterizations of existing literature on the topic and how researchers "interact" learning assessment and student motivation in their studies. These are consistent with the extent, range, and nature of research activity as mentioned. This review also leads to a decision on whether a systematic literature review is valuable going forward on this topic, consistent with reason (2). The article then lays out five stages for conducting the review: (1) identifying the research questions, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collating, summarizing, and reporting the results [48, p. 8].

For this scoping review, I designed the review process based on Arksey & O'Malley's guidelines (Table 1). In Stage 1, I identified the research questions based on the review purposes. This was a crucial process as the research question become the guide that led the overall process. As previously mentioned, the purpose of this review is to determine the scope and extent of the topic and whether conducting a systematic literature review may be a valuable endeavor. Based on these purposes, I phrased the research questions as described previously, which then guided the subsequent stages.

In Stage 2, two major components guided the

Table 1. Scoping review stages with details

Stage	Detail
1	• Determined the scoping review purposes. • Determined research questions based on the purposes.
2.A	• Searched for relevant papers and studies in some engineering education and assessment journals with two keywords: "assessment" and "motivation". • Identified the scope of the search (level of education, range of publication years). • Identified more potentially useful keywords beyond "assessment" and "motivation" to expand search for relevant papers and studies. • Obtained the first yield.
2.B	• Searched on engineering education databases with more keywords identified from Stage 2.A. • Decided to limit the scope of search due to limited resources. • Obtained the second yield.
3	• Consolidated the two yields to remove duplicates. • Determined and refined inclusion and exclusion criteria (the level of assessments, was there substantial motivation mentioned). • Screened yield at the abstract level using Rayyan [56] based on the inclusion and exclusion criteria at the first phase. • Screened the included abstracts from the first stage by examining the papers in detail at the second phase.
4	• Identified variables that answer the research questions. • Coded the articles with variables created.
5	• Analyzed Stage 4 results (numerical descriptive analysis and qualitative thematic analysis). • Visualized the data from coding. • Collated and summarized the results.

Table 2. Yields from Stage 2.A on selected journals

Journal	Yield (number of articles)
Journal of Engineering Education (JEE)	511
International Journal of Engineering Education (IJEE)	57
Advances in Engineering Education	76
Assessment and Evaluation in Higher Education	116
Assessment in Education	16
Educational Assessment, Evaluation and Accountability	15

search for papers. In Stage 2.A (the pilot phase), I searched for relevant papers and studies in some engineering education and assessment journals using the keywords "assessment" and "motivation" together for the search in each journal. This stage was to quickly understand the lay of the land of the research on the topic, which guided the subsequent stages as I situated myself on the type of articles published that discuss the interactions between learning assessment and student motivation in engineering education. In the process of situating myself, I identified two limiting factors to the search. First, because this review is framed under arguments based on undergraduate engineering education, the search was limited to studies that study undergraduate engineering students. Second, engineering education as scholarship officially began in the year 2005 with established doctoral programs [57, 58]. This is a meaningful milestone in engineering education research and served as a meaningful start year for this review. Stage 2.A began in February 2019. Therefore, the yields in Table 2 represent studies published between 2005 and 2019. These are in line with Levac and colleagues [47] interpretations of Arksey and O'Malley [46] scoping review framework as Stage 2 is an iterative process after multiple searches lead to a better understanding of the existing literature, which results in more relevant information, factor and keywords to refine subsequent searches to ensure the process covers a wide range of the search.

The first three journals are some of the prominent engineering education journals that cover different contexts and areas. JEE is the premier research journal, IJEE focuses on international contexts, and Advances focuses on research to practice. Hence, these three journals became part of Stage 2.A. On assessment journals, I selected the three journals because of their scope and aim. Assessment and Evaluation in Higher Education publishes studies in the higher education contexts, aligning with the undergraduate framing of this scoping review. On Assessment in Education, the journal provided an international perspective as it focuses explicitly on the international contexts. Educational Assessment, Evaluation and Accountability, on the other hand, covers a wide range of assessment-based research in various contexts, providing a good start for this scoping review.

Several keywords emerged as potentially useful for the more extensive search. Throughout Stage 2.A, words such as "project", "summative", "formative", "tests", and "quizzes" emerged in some of the discovered papers that might be proxies for "assessment", while "student perception", "ability", "engagement", "interest", "achievement", and "autonomy" might be for "motivation". These served as important keywords to expand the search in larger databases in Stage 2.B [46, 47].

Stage 2.B started after consolidating lessons from the 2.A. As detailed in Table 3, I identified several databases that contain engineering, engineering education, and assessment journals. These include EBSCOhost Education Research Complete, Engineering Village, ERIC, and IEEE Xplore. EBSCOhost Education Research Complete and ERIC cover various databases on education (including assessment) publications, while Engineering Village and IEEE Xplore cover engineering publications. I selected these four databases because: (1) they provide reasonable coverage of the engineering education literature and (2) they are conveniently accessible databases provided by the university. The following steps generally describe Stage 2.B search process. All steps involved limiting the search to (1) undergraduate engineering students as study sample and (2) years from 2005 to 2019 (this search happened in early 2019). Table 4 shows the search yield after the yields within this stage were cross-checked to ensure no duplicates. Both Engineering Village and IEEE Xplore yields were

Table 3. Steps taken for Stage 2.B

Step	Detail
1	Used both "assessment" and "motivation" as the keywords on the databases.
2	Used the emerged different assessment keywords with the keyword "motivation" on the databases. When the same publications started to emerge from multiple searches, the search stopped due to saturation.
3	Used the emerged different motivation keywords with the keyword "assessment" on the databases. When the same publications started to emerge from multiple searches, the search stopped due to saturation.
4	Uploaded all the yield citations (Stage 2.A and 2.B) to Rayyan, an online systematic review manager.

Table 4. Yields of Stage 2.B

Database	Yield (number of unique articles)
EBSCOhost Education Research Complete	57
ERIC	18
Engineering Village and IEEE Xplore	63

combined because IEEE Xplore is part of the Engineering Village database, a fact realized after searching at IEEE Xplore leading to identical results from those from Engineering Village.

Combining search results of Stage 2.A and 2.B yielded a total of 929 articles. These articles contained any of the keywords after removing all the duplicates that arose from both stages, without considering the study contexts. To further refine the yield into those relevant to this scoping review, I conducted Stage 3 to create the inclusion and exclusion criteria and obtained the final sample of studies for Stage 4 and beyond.

In Stage 3, an iterative process commenced to filter the 929 discovered articles into the final sample [47]. First, the inclusion and exclusion criteria were established for this stage. I conducted several detailed reviews of abstracts and articles to understand the general contexts of what kind of assessments are being discussed and how motivations are being defined and employed in the study. In addition, I also noted whether the articles document empirical research on the topic (interaction between learning assessment and student motivation) or evaluation study on assessment with mention of motivation as part of a subsection of the overall findings. I selected about 15 articles at random for the reviews, and it took several iterations to finalize the inclusion and exclusion criteria, listed as follows.

Criterion 1 – If an article documents an empirical research on the topic, an evaluation study where motivation is mentioned as part of the finding of the evaluation of the assessment, or contains emerged findings of motivation in the study, it will be included. The reason to include evaluations, in addition to empirical research and emerged findings, is to explore the larger pattern of how engineering education researchers discuss assessment and motivation together.

Criterion 2 – If an article documents research/evaluation that studies a sample of undergraduate engineering students, it will be included. If a research/evaluation contains a larger sample of students with a substantial part of engineering students, the article will be included for the review.

Criterion 3 – In terms of assessment, if an article anchors its research on types of learning assessment and feedback that explicitly show how those assessment approaches will benefit students, it will be included. Through the iterative process, how "assessment" is defined changed as the process goes. For instance, project assignment is considered a learning assessment, even though it is a component of an instructional approach (project-based learning) that led to the article being excluded in the first phase.

Criterion 4 – In terms of motivation, if a research article explicitly employs a motivation theory, the article will be included. If a research/evaluation article mentions "motivation" (not explicit motivation theory) as a student outcome of a learning assessment, it will be included to explore the larger pattern of how engineering education researchers discuss assessment and motivation together.

These four criteria became the guides to include and exclude the articles on Rayyan. After finalizing the criteria, I conducted the first phase of Stage 3 to include and exclude articles based on abstracts (Fig. 1). Although limiting factors (only undergraduate engineering students and publishing year between 2005 and 2019) were applied in Stage 2, many of the 929 abstracts still did not meet the limiting factors. Subsequently, a substantial number (828) of abstracts were excluded from the pool. Some abstracts have vague descriptions, and these were labeled as "Maybe" for later review. After the first phase, 67 articles were included, and 32 were categorized as "Maybe". The second phase then focused on going into the articles themselves to review in more detail on whether these articles truly satisfy the four criteria. After the second phase, 32 articles were included, making this the final sample for this scoping review.

There are two reasons for the drastic drop of articles from the 929 found at Stage 2. First, many of these articles showed up as the yield even though they do not talk substantially about them because the search used keywords. For example, many articles used the word "motivation" to describe the authors' goal and drive to publish the papers instead of talking about motivation as a research construct. Similarly, many papers used the word "assessment" to mean assessing research constructs instead of student learning assessment. Essentially, many articles were "false positive" during Stage 2 as the search did not differentiate articles that use the keywords in some contexts that are not relevant to this scoping review. Second, many of the articles that mentioned or hinted at learning assessment and student motivation did not substantially talked

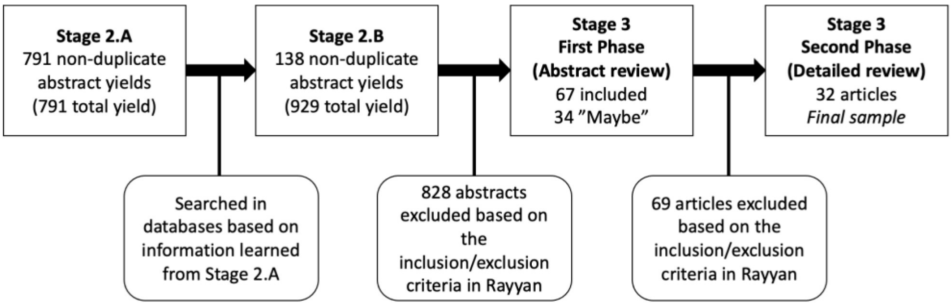

Fig. 1. Stage 3 and the subsequent number of included articles.

about them. Some articles, for instance, mentioned assessment as the "sideshow" of the instructional approaches. This is the same for motivation as many mentioned the word once to twice but failed to further elaborate on how student motivation is relevant to the published research. In short, many articles did not meet the four criteria as they did not expound deeper on both learning assessment and student motivation. After completing the inclusion and exclusion process, I conducted Stage 4 to begin coding the 32 articles for review.

Stage 4 involves extracting data from the included articles. This stage involves determining what variables to extract to answer the research questions and creating a "data charting form" through an iterative process [47, 49]. The researcher should pilot the form with several articles to examine the relevance and alignment of the extracted variables. For this review, the variables that form the data charting form are refined twice through the process. Table 5 tabulates the variables based on the research questions.

RQ1 focuses on the characterization of the overall literature scoped on the topic. The characterizations are described by variables listed in Table 5. In essence, these variables provide an idea of the size of the literature and their characterizations. This aligns with the scoping review purpose to provide an overview of the size, extent, and nature of the literature on the topic [46, 47]. RQ2, on the other hand, focuses on the interaction between the learning assessment studied and motivation theories used in the scoped literature. Three variables answer this question: the type of motivation theories used, the learning assessment approach studied, and the nature of the interaction. By extracting these three variables, the scoping review can describe the extent to which the studies on interaction between assessment and motivation focus on in engineering education. These variables facilitate answering my two research questions, which paves the foundation for the subsequent stage provide a summary of the overall findings from this scoping review in the Discussion section.

In Stage 5, I followed the guidelines to collate, summarize and report the results. In [47], Levac and colleagues lay out three distinct steps for Stage 5: (1) analyzing the coded data by performing descriptive numerical summary analysis and qualitative thematic analysis and answering the research questions with the analysis results, and (2) interpreting and considering the meanings of the findings in relation to the larger existing literature in engineering education, with recommendations for future research. These three steps provided clear procedures on how to proceed with the coded data.

Fig. 2 shows the Step 1 analysis strategies based on the research questions and the different variables. Different variables called for different analysis methods. For RQ1, I obtained a descriptive numerical summary based on most of the variables through quantitative counting of the data coded under these variables. I compiled the data on the coded variables from Stage 4 quantitatively, providing a summary of those variables in terms of numbers. For "research purpose," I conducted a

Table 5. Variables coded with the included articles in relation to the research questions

Research question	Variable
RQ1: What are the characterizations of scoped literature that studies interactions between learning assessments and student motivation?	• Number of included publications. • Research method (quantitative, qualitative, mixed). • Methodologies. • Student samples, • Course that forms the context. • US or non-US context. • Research purpose.
RQ2: How do learning assessment and student motivation "interact" in the scoped research?	• Type of motivation theories used. • Learning assessment approach studied. • Nature of interaction between both constructs.

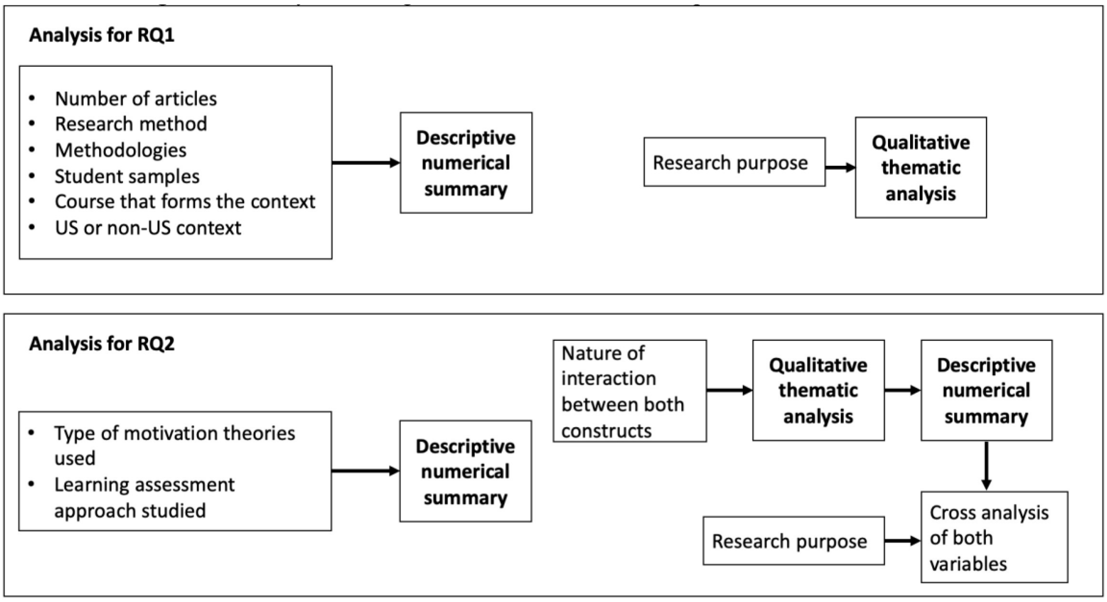

Fig. 2. Analysis strategies based on the research questions and the variables.

qualitative thematic analysis to identify themes in those purposes, and these themes provide nuances to the variable "nature of interaction" created to answer RQ2. For RQ2, I obtained the descriptive numerical summary of the variables on motivation theories and learning assessment approaches, while I conducted qualitative thematic analysis on the nature of the interaction between both constructs. These findings subsequently answered the research questions, as presented in the Results section. For Step 2, I connected the findings to the existing research in engineering education and provided recommendations on potential future research avenues.

5. Limitations

Two limitations must be considered while interpreting the findings of this study. First, one must not extrapolate the findings immediately to characterize the overall state of existing literature on the topic as a scoping review does not provide a comprehensive and exhaustive perspective of the literature like a systematic literature review. Instead, the findings represent an early look at the existing literature with dimensions that characterize the literature. Second, new literature on the topic would have been published when Stage 2 (search of literature), set between 2005 and early 2019, was completed. Thus, the findings do not represent a complete search and analysis of all available literature.

6. Results

For the first research question: *"What are the characterizations of the scoped literature that focuses on undergraduate engineering education that studies interactions between learning assessments and student motivation, in terms of literature size, type of methods, study geographical content, study purpose, engineering discipline, and type of courses,"* the results are organized based on the components shown in Fig. 2.

In terms of the overall size of the literature, between 2005 to 2019, 32 articles publish research or evaluation studies that directly or indirectly address the topic of interaction between learning assessment and student motivation. This is 3.4% of the total yield (929 articles) from Stage 2. The amount of literature scoped is characterized by several variables. Table 6 provides a summary of two of those characterizations.

First, on the type of methods, the final article collection shows a large number of quantitative methods in their research, with the rest being qualitative or mixed methods. Table 7 provides a

Table 6. General summary of the 32 articles in terms of the type of methods and study contexts

Type of methods		**Study contexts**	
Characterization	**Number of articles**	**Characterization**	**Number of articles**
Quantitative	22	US	12
Qualitative	3	Non-US	20
Mixed	7		

Table 7. The methodologies used in the included articles use

Methodology	Number of articles
Cross sectional survey	21
Quasi-experiments	5
Evaluation study	7
Others	6

Table 8. The engineering disciplines that form the sample of undergraduate students in the included articles

Engineering disciplines	Included in [#] of articles
Mechanical, aerospace, material	9
Electrical, computer science, computer engineering	6
Civil, environmental, transportation	8
Others (chemical, marine, industrial)	4
Unspecified	11

more nuanced take on this variable by summarizing the methodologies used in the articles. Studies that engage with assessment and motivation tend to use cross-section surveys as the driving methodology and data collection methods. Also, five studies that employed quasi-experiment or quasi-experiment-inspired methodologies to conduct the study. Seven of them are evaluation studies, which focus on evaluating assessment approaches. Some of these evaluation studies involve motivation as one of the outcomes, and some have motivation emerged from the findings (more in RQ2). It must be noted that the evaluation studies are not specific to one type of method (quantitative, qualitative, mixed). Other methodologies identified include grounded theory-inspired, thematic analysis of interviews, case study research, and some open-ended response-based surveys that I did not categorize as either quantitative or qualitative as there was insufficient information to do so. It must be noted that the total number does not sum to 32 because some studies use multiple methods. For instance, several studies use surveys in their evaluations. Second, in terms of studies' geographical contexts, 20 of the included articles were outside of the United States and the remainder (12) were within the U.S. This possibly shows a gap in engineering education research on the topic of assessment and motivation regarding geographical contexts.

Two additional variables provided further nuance on the study's context. Table 8 provides an overview of the discipline distribution of the undergraduate sample. The table shows that there is an observable disciplinary distribution across the 32 included articles. These categories were developed per Godfrey's recommendations that argue mechanical, electrical, and civil to be three distinct disciplines [59]. These recommendations guided the categorization shown in Table 8. The "Other" category, chemical, marine, and industrial engineering students are studied in four articles. 11 studies did not specify the type of engineering disciplines their student participants majored in. It must be noted that five studies have first-year engineering students in their sample, which were described as undeclared in terms of majors.

In terms of courses the students were taking while being part of the study sample (Table 9), 23 courses are engineering based. I categorized these courses based on the name or implied nature of the courses, such as technical engineering courses, capstone courses, and professional skill courses targeted to engineering students. Four studies have students taking math and science courses, and seven unspecified. Similar to Table 8, the total number in Table 9 does not sum to 32 because some studies have students from multiple courses.

Lastly, Table 10 shows the three themes that summarize the type of studies these articles document regarding the purposes of the articles. 12 articles study the influence of assessment and motivation and vice versa directly. These studies contained explicit mentions of the interaction between learning assessment and student motivation. Seven articles focus on the student perception of assessment, understanding how students perceive the learning assessments employed in learning environments. The rest of the articles are evaluation studies that focus on examining the use of specific assessment approaches. These articles presented various ways of evaluating the assessment approaches, occasionally including student perceptions. Overall, the 32 articles, albeit a small sample, presented a broad and diverse set of research and studies on the interaction between learning assessment and student motivation. These variables characterizing the

Table 9. The courses students enrolled in the included articles documented

Course	Number of articles
Engineering/Computer (include professional skill courses targeted for engineering students)	23
Math and science	4
Unspecified	7

Table 10. The study purpose themes of the 32 articles

Study purpose theme	Number of articles
Influence of assessment on motivation and vice versa	12
Student perception of assessment	7
Evaluation of assessment approaches	13

articles show various methods and methodologies, geographical contexts, and engineering disciplines and courses.

For the second research question*: "How do learning assessment and student motivation "interact" in the scoped research,"* the results are also organized based on Fig. 2, similar to RQ1. Table 11 provides an overview of the learning assessment approaches, motivation theory, and the nature of the interaction between both in the 32 articles. The learning assessment column provides a summary of the type of assessment approaches studied in the articles. As shown, there are various assessment approaches, and there are no specific categories that can summarize these fittingly. Some of the learning assessment approaches are typical in assessment literature, such as self-assessments, E-portfolios, projects, and exams [60–63]. There are some articles that studied gamification of different learning assessments that involved students learning through the use of quests, levels, points, leaderboards, and badges in the students' assignments [64– 66]. There are also studies that explored the different policies and usage of assessments, such as the use of intentional, frequent assessments [29], gradeless assessments [67], self-generated exams [68], exemptions of final exams [69], and online assessment tools [70]. These show the wide range of types of assessments studied on the topic, providing a breadth of view of how engineering educators

Table 11. The learning assessment, motivation theory, and the nature of interaction of both constructs in each of the included articles

Article	Learning assessment	Motivation theory	Nature of interaction
[29]	Frequent assessment that leads to frequent grade and feedback	Intrinsic motivation based on Self-Determination Theory	Intentional
[60]	Peer assessment	No specific theory	Emergent
[61]	Projects under project-based courses	Self-efficacy (design measures)	Intentional
[62]	All assessments in the course studied (quizzes, programming assignments, tests, and final exam)	Expectancy, value, and affect	Intentional
[63]	E-portfolio	No specific theory (use the idea of well-being)	Hinted
[64]	Gamification homework portal	MUSIC model	Intentional
[65]	Web-based gamification assessment	No specific theory	Hinted
[66]	Gamification of open-sourced projects	No specific theory	Hinted
[67]	Gradeless learning	No specific theory	Emergent
[68]	Self-generated exams	No specific theory	Emergent
[69]	Exemption of final term exams	Motivated Strategies for Learning Questionnaire (MSLQ)	Intentional
[70]	Online formative assessment tools	No specific theory	Emergent
[71]	Portfolio	Self-directed learning	Emergent
[72]	Web-based homework platform	No specific theory	Emergent
[73]	Real-world experimental projects	No specific theory	Emergent
[74]	Co-assessment (peer and instructor)	No specific theory	Hinted
[75]	Assignment-quizzes that discourages students from pattern matching	No specific theory	Hinted
[76]	Website instead of traditional project report	No specific theory	Hinted
[77]	Web-based self-assessment	No specific theory	Hinted
[86]	Focused on feedback from several assessment approaches	Self-theory	Intentional
[87]	Self-assessment (confidence-based scoring)	Self-efficacy (framed as confidence)	Intentional
[88]	Low stake assessments	Questionnaire of Current Motivation (QCM)	Intentional
[89]	No specific assessment approach, discuss assessment as a general construct	Externalization (emerged as a construct from the study)	Intentional/ Emergent
[90]	Projects under project-based courses	No specific theory	Hinted
[91]	Projects under project-based courses	Expectancy-value theory	Intentional
[92]	Different exam format	Self-efficacy	Intentional
[93]	Various assessments in project-based courses	No specific theory	Emergent
[94]	Group design projects	Achievement goal	Intentional
[95]	Capstone design projects	Self-regulated learning	Intentional
[96]	Logbook assessment	No specific theory	Hinted
[97]	Weekly 10-minute tests after tutorial	No specific theory	Emergent
[98]	E-portfolio	Intrinsic and extrinsic motivation	Emergent

are assessing their students, and at the same time the type of assessments that engineering education researchers are studying in the context of interaction with student motivation.

In terms of motivation theories, half of the articles (16) do not have a specific motivation construct or any theory anchoring the study. Some of these articles did not discuss specific motivation theories but mention motivation as one of the constructs examined. There are several forms of mentions in these articles. First, some mentioned "motivation" as an effect of the assessment on the students. They were either mentioned by the students in open-ended questions or interviews, or measured in a survey that used the term "motivation" [60, 68, 71–73]. Second, some of the studies did not mention motivation but employed some words that hinted at motivation [66, 74]. Some studies used the word such as "interest," "enjoyment," "empowerment," "encouraged," "caring," and "confidence" to describe the influence of assessment on their students [63, 67, 75–77]. Although the authors did not specify "motivation" in these articles, I made judgments that the authors meant to hint at student motivation and how it is influenced by the assessments. Many of these words are part of the motivation literature. "Enjoyment" and "interest" can be considered as part of the larger interest literature. "Empowerment," "caring," "confidence," and "encouraged" can be considered as part of some motivation theories, such as the MUSIC model [45], Self-Determination Theory [78], Expectancy-Value Theory [79, 80], and Self-Efficacy Theory [81, 82].

The rest of the articles (16) have specific motivation theories employed in their study. Studies documented in these 16 articles used a range of theories and concepts. The theories include Self-Efficacy, Expectancy-Value, Achievement Goal [83], Self-Regulated Learning [84], Self-Determination, Intrinsic and Extrinsic Motivation [78], Self-Theory [85], and the MUSIC model. These studies designed their study on assessment around these theories, with measurement and descriptions of the motivation theories. Similar to the learning assessment studied, the wide range of motivation theories involved in these articles show a breadth of motivation scholarship that engineering education researchers are leveraging in understanding student motivation in the context of assessments.

In terms of the nature of interaction, I categorized them into three distinct groups: Intentional (13 articles), hinted (9 articles), and emergent (11 articles). I coded an article "intentional" when the research explicitly studied how assessment and motivation influence each other. Many of the articles coded as "intentional" have a clear articulation of the type of assessment and motivation theory employed in the study, as shown in Table 11. Most of the articles coded as "intentional" have specific motivation theories explained, described, and leveraged in the research. For instance, Abadi and colleagues [92] studied how different exam formats and implementations can influence students' item-specific self-efficacy, meaning the students' confidence in successfully solving problems in those exams. In this example, the authors clearly describe the learning assessment of interest (different exam format and implementations) and how they define student motivation (self-efficacy/confidence). Articles that demonstrate a similar pattern are part of the "intentional" group.

For "hinted", the reasoning is the same as those described previously on the motivation theories. In short, many studies did not define "motivation" with specific theories and used some words that I judged as authors implication to student motivation, such as the general word "motivation," "interest," "enjoyment," "empowerment," "encouraged," "caring," and "confidence." One example is from [66] in which the authors studied how gaming elements in open source software projects can motivate students to contribute to the projects. In this case, Diniz and colleagues did not define what they meant by "motivation" specifically, but they used the word "motivation" in survey instrument for students to understand how the gamification of the assignments influences student motivation, essentially hinting at motivation without using specific motivation theories. This is also similar to the article by Reyes and colleagues in which the authors explored how co-assessment or peer and instructor on assignments influence student motivation to study specific modules [74].

Third, for "emergent", these articles show that motivation constructs emerged from the findings, typically when the authors were evaluating the assessment approaches. The study by Cole and Spence shows that students mentioned several motivation-related comments on continuous assessment in a first-year fluid course [97]. Some students, in the open-ended part of the course evaluation questionnaires, described the assessment as exhausting but motivating to consistently review materials. It must be noted that the authors did not plan to study student motivation in the study, making it "emergent" for this analysis as the motivational influence of the learning assessment of interest emerged in the findings of research on the learning assessments, whether they are about student perception or evaluation of the assessment approaches. Another article shows emerging comments from students who experienced project-based assessments, with some mentioning that the teamwork aspect helped motivate the student learning, while some thought that projects did not allow an easier path toward high grades, demotivating some of them to learn [93].

There is one article that I coded "intentional/emergent" as shown in Table 11. This article, authored by Walters and colleagues, focuses on understanding student motivational attitudes on assessment in general using the grounded theory approach [89]. Specifically, the authors argued the need to consider motivation as part of the learner-centered approach in pedagogies, aligning with the arguments made for this scoping review. The study invoked Deci and Ryan's Self-Determination Theory to discuss motivation in the context of assessment. However, the notion of "externalization" in which students "describe an assessment, or a reaction to an assessment, as if it is out of their control [75, p. 2]," emerged from the analysis. This led to the dual coding of "intentional" and "emergent" for this specific article. These three groups become the categorization and characterization of nature of interaction between learning assessment and student motivation in these articles.

Cross analyzing the nature of interaction with the study purpose provides next level nuances to the findings. Table 12 shows the tally. Unsurprisingly, studies that with research purpose focusing on the influence of assessment and motivation and vice versa tend to have intentional nature of interaction (learning assessment with specific motivation theory in the study). The three articles categorized as "hinted" do not define motivation with specific theories. Hence, they are not "intentional" in the sense as the other nine studies as described previously. On student perception of assessment, the findings are as expected as some studies have intentional use of motivation theories in understanding the learning assessment, while the rest have the findings emerged from the data. Lastly, the results of the evaluation studies show that most of them are either in the "hinted" or "emergent" categories. Similar to the other two themes, the results make sense as these studies focused on evaluating the learning assessment approaches, and motivation would be mentioned as a general construct without a theory (hinting) or emerge from data collected for the evaluation (emergent). Overall, the scoping review has provided a view of the type of learning assessment and motivation theory employed in the 32 articles. The review has also shed light on how these studies "interact" the learning assessment approaches and motivation construct in understanding how these two constructs influence each other in engineering education.

7. Discussion

The results described previously answer the two research questions framed to scope existing literature that studies the interaction between learning assessment and student motivation. From the results, I identified two major discussion points explained as follows.

7.1 Intentional Research on Interaction between Learning Assessment and Student Motivation is Limited

The results have shown that engineering education scholarship has limited research on the topic, considering the intentionality on researching the topic. First, out of 32 articles included for analysis, less than half (13) of the articles demonstrate intentional interaction between assessment and motivation in terms of research. This means these 13 articles specifically understand the learning assessment and how those interact with student motivation, whether in terms of direct influence on the student, student perception, or as part of an evaluation of the assessment approach. In addition, out of the 13 articles, only nine employ motivation theories in understanding student motivation in the context of the learning assessment, further showing the limited intentional research exist in engineering education on the interaction.

The 13 articles that demonstrate intentional research and use of motivation theories also show limited types of motivation theories and usage of those theories. Based on the results, most of the theories used are typical ones that have been leveraged in engineering education research. These theories include Self-Determination, Self-Efficacy, Expectancy-Value, and Self-Regulated Learning. Brown et al. support this claim [20]. In the systematic literature review on the use of motivation theory in engineering education research by Brown and colleagues, they found that Self-Determination, Expectancy-Value, and Self-Efficacy form a substantial part of the motivation theories used in

Table 12. Cross analyzing of study purpose themes and nature of interaction

Study purpose themes	**Intentional**	**Hinted**	**Emergent**
Influence of assessment on motivation and vice versa	9	3	0
Student perception of assessment	3	0	4
Evaluation of assessment approaches	1	6	7

engineering education research. I found a similar pattern in which eight of the 13 articles coded "intentional" use part or whole of these theories. This shows a supported perspective on the limited usage of different motivation theories in engineering education research, and in this scoping review, in terms of learning assessments. Articles coded "hinted" also align with Browns and colleagues' finding on inconsistent usage of motivation theories in these studies. Browns and colleagues argued that many engineering education research publications demonstrate inconsistent use of motivation theories, especially invoking motivation as a research construct without defining a motivation framework, which is consistent with the "hinted" label in my scoping review analysis, and as Brown and colleagues described, the use of a general term of "motivation" tends to "hinder interpretability" [pg. 195] as motivation research is vast and contains a large number of theories and perspectives [45]. In short, my scoping review has found a lack of intentional research on the interaction between learning assessment and student motivation, and this assertion is supported by existing literature in engineering education.

Lastly, a large number of these scoped articles appear to be evaluations of learning assessment in which a majority of them either have "hinted" or "emergent" interaction between learning assessment and student motivation. This is a sign that engineering education research should involve more motivation theories and constructs in evaluations of assessment because assessments are integral part of the learning process, and a learner's backgrounds and characteristics, motivation included, should be considered as part of the evaluation [13, 99]. This aligns appropriately with the learner-centered approaches in engineering education pedagogy. The findings support this call as motivation was either hinted in or emerged from most of these evaluations, meaning that having a more intentional approach may contribute to a more robust understanding of how assessment interact with motivation in engineering learning environments.

7.2 Research on the Topic is Dominated by Quantitative Paradigms

Another observation from the scoping review results is the dominant form of research methods in the 32 articles. As shown in the previous section, the majority of the articles employed quantitative research methods for various study purposes. A large number of them also employ cross-sectional surveys to conduct the research. This is not a surprising observation as engineering education researchers have shown to prefer quantitative methods over qualitative or mixed methods in conducting research [100]. It must also be noted that engineering education research is a relatively young field of scholarship, and we are still working on diversifying methods used in our research [57, 58, 100]. In the context of interaction between assessment and motivation, the pattern on research method is consistent with what we know about engineering education research.

It is encouraging, however, to find that there are about 10 articles that employ qualitative or mixed methods in the published research. These studies tend to use qualitative interviews, grounded-theory-inspired procedures, and case study research. However, to further advance our knowledge of the topic, it is important to consider qualitative and mixed methods to understand the phenomenon in question. Qualitative methods, for instance, tend to allow a deeper understanding of phenomena in education, allowing one to explore at a more detailed level how assessment and motivation interact with each other [100, 101]. Mixed methods too can achieve such goals, providing robust and powerful ways to study phenomena that may not be easily observed or understood using only quantitative or qualitative methods [102, 103]. For instance, for an evaluation of a specific form of learning assessment in an engineering classroom with motivation as part of the evaluation, one can imagine employing mixed methods, such as conducting cross-sectional surveys that are followed by individual interviews with students, to understand better how learning assessment influence students' motivation to learn. The method would provide an overall cross-sectional view of how students perceive the learning assessment in the context of their motivation, and detail meanings made by the students to understand the quantitative data collected. This is just one example that engineering education researchers can do with different methods. It must be noted that I am not discouraging quantitative research on the topic. Instead, researchers should be pragmatic in selecting methods to study the interactions, allowing research questions and conceptual frameworks to guide the study [102, 104]. Also, leveraging the vast literature on research methods can facilitate a better understanding of the topic, advancing scholarship and practice in engineering education.

8. Implications

In response to the relatively under-studied topic of interaction between learning assessment and student motivation in engineering education research, this scoping review has presented an overall view of the existing literature that focuses on the topic in various natures (intentionally interacted, their interactions are hinted, or emerged from findings). Overall, there is limited research on the topic between the year 2005 and early 2019. The findings have several implications for engineering education research and practice. First, a systematic literature review that further explores the literature on the topic is necessary to advance our understanding of the research on the interactions. As previously explained, a systematic literature review differs from a scoping review in that it provides a more detailed analysis not just on the characteristics of the literature as presented in this article, but also examines the findings of the existing literature to provide an overview of the state of researching findings on the interaction between assessment and motivation in engineering education. This can provide more information to make judgments and claims on the research gaps that engineering education researchers may need to address on the topic. In addition, this scoping review is limited to undergraduate education based on the arguments made. However, I propose an expanded scope for future systematic literature reviews that potentially examine literature situated in P-12 and graduate education, and various contexts such as types of courses (first-year, engineering science, capstone, etc.) and evaluation levels (course, program, department, and institution).

Second, based on the findings of this scoping review, engineering education researchers interested in advancing our knowledge in the topic should consider a more central use of diverse sets of motivation theories. Currently, the motivation theories employed in existing literature are common with engineering education overall literature. This is not a negative development. However, the engineering education community can benefit from a more diverse perspective on student motivation in the context of learning assessment, as this can further our knowledge on pedagogies and practice in engineering learning environments. Lastly, researchers should also employ diverse research methods to explore the interaction. Using various forms of methods can provide a diverse set of perspectives on the topic and advancing our knowledge on the topic and methods.

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