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Mapping the Research Landscape of Capstone and Final-Year Project Assessment in Computing Education: A Bibliometric Analysis (2020–2026)

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Research Article

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Abstract

Capstone and final-year projects are the culminating requirement of most computing degree programs, yet their assessment remains dominated by subjective, perception-based instruments, and the intellectual structure of research on this topic has not been systematically mapped. This study characterizes the volume, impact, thematic structure, and collaboration patterns of the peer-reviewed literature on capstone and final-year project assessment in computing and cognate technical disciplines. A bibliometric analysis was conducted on 156 documents published between 2020 and 2026, retrieved from the OpenAlex scholarly database using a structured Boolean query restricted to English-language articles and conference papers in computing-related topics. Records were screened following PRISMA principles, and index concept terms were normalized using a curated thesaurus. Performance analysis and science mapping—keyword co-occurrence, co-authorship, direct citation, and bibliographic coupling—were performed in VOSviewer. The corpus is young and lightly cited (mean 3.38 citations per document; 39.1% uncited) but highly accessible (60.3% open access). Keyword co-occurrence resolved four clusters, among which a distinct capstone-assessment cluster stands out: explicit assessment terms occurred infrequently yet carried the highest average citation impact of any terms in the map. Co-authorship, citation, and bibliographic-coupling networks were sparse and fragmented, indicating an emerging field without a consolidated research front. Assessment is thus the most impactful yet least developed theme in computing capstone research, quantifying a clear and timely research gap.

I. Introduction

The capstone or final-year project is widely regarded as the culminating academic experience of undergraduate computing programs. It is the point at which students integrate the knowledge and skills accumulated across their degree into a single, substantial, and often team-based software artifact. Because it sits at the boundary between the university and professional practice, the capstone is also the moment at which programs attempt to demonstrate that their graduates meet stated learning outcomes and accreditation criteria.

Despite this centrality, the assessment of capstone projects has long been criticized as subjective and inconsistent. In many programs, the dominant evidence of quality remains the defense demonstration and a short satisfaction survey administered to a small panel or user group. Such instruments measure perception rather than the demonstrable correctness, reliability, or maintainability of the delivered system. The gap between what capstone assessment claims to measure and what it actually measures has motivated a growing but scattered body of scholarship on rubrics, competency frameworks, and outcome-based evaluation.

While individual studies have proposed assessment instruments, no work has yet mapped the intellectual structure of this literature as a whole. Bibliometric analysis—the quantitative study of publications and their relationships—is well suited to this task, enabling the identification of research trends, influential contributions, thematic clusters, collaboration patterns, and gaps that merit further

investigation. Recent bibliometric studies in adjacent areas, such as the software-quality standard ISO/IEC 25010 [1], demonstrate the value of the method. To date, however, capstone and final-year project assessment in computing has not been the subject of such a synthesis. This study addresses that gap by mapping the peer-reviewed literature published between 2020 and 2026. Four research questions guide the analysis:

RQ1: What is the volume, growth, and citation impact of research on capstone and final-year project assessment in computing? RQ2: Which documents, authors, and collaborations are most influential? RQ3: What thematic clusters characterize the field, and where does assessment sit within them? RQ4: How intellectually consolidated is the field, as reflected in its citation and bibliographic-coupling structure?

II. Materials and Methods

A. Data Source and Justification

Bibliographic data were retrieved from OpenAlex, a fully open index of scholarly works maintained by OurResearch [2]. OpenAlex was selected in preference to subscription databases for three reasons. First, it is openly and freely accessible, supporting full reproducibility without institutional licensing. Second, its coverage is extensive—exceeding 245 million works—and recent evaluations report coverage of computing and conference literature comparable to, and in several respects broader than, Web of Science and Scopus [4], [5]; these subscription databases remain the traditional reference points for such comparisons [3]. Third, OpenAlex is natively supported by VOSviewer, allowing direct, auditable ingestion of query results. The known trade-offs of OpenAlex—most notably occasional imprecision in metadata and concept tagging [6]—were mitigated through the cleaning procedure in Section II-C.

B. Search Strategy and Screening

The search was executed on the OpenAlex works endpoint and restricted to English-language documents of type article, conference paper, or conference abstract, published from 2020 onward, and filtered to computing-related primary topics. The title-and-abstract query combined three concept blocks with the Boolean operator AND. The first captured the culminating-project construct ("capstone project," "final year project," "senior design project," "graduation project," "undergraduate thesis," "culminating project"); the second captured assessment (assessment, evaluation, rubric, grading, "learning outcomes," appraisal); and the third restricted results to computing ("computer science," "information technology," "software engineering," "information systems," computing, "IT education").

The deliberately broad synonym set in the first block reflects regional variation in terminology —"capstone" in North American and Philippine programs, "final-year project" in Commonwealth systems, and "senior design project" in engineering—so that no regional literature would be excluded by vocabulary alone. Records were screened following PRISMA 2020 principles [7]: duplicate and non-

English records were removed, and documents whose title and abstract were unrelated to project-based capstone assessment were excluded. Screening yielded a final corpus of 156 documents.

C. Data Cleaning and Normalization

Because OpenAlex assigns concept tags drawn from a broad, cross-disciplinary vocabulary, the raw term list contained disambiguation artifacts (for example, "work (physics)") and generic tags unrelated to the research focus. A curated VOSviewer thesaurus file was constructed to merge synonymous terms (for example, "software development process" into "software development"), standardize labels (for example, "grading (engineering)" into "grading"), and remove artifacts and off-topic tags. Terms reflecting cross-disciplinary spillover into medical and general education were also removed. Applying the thesaurus reduced the co-occurrence map to 37 substantive terms.

D. Analytical Procedures

Analysis followed the two-component structure recommended for bibliometric reviews [8]: performance analysis and science mapping. Performance analysis quantified annual publication output, citation impact, open-access share, and the most-cited documents and most-productive authors. Science mapping, performed in VOSviewer [9], comprised keyword co-occurrence, co-authorship, direct-citation, and bibliographic-coupling analyses; the R package bibliometrix provides an equivalent toolset [10]. Reporting was guided by the VALOR framework [11], and the query, filters, and thesaurus were logged to support replication [12].

III. Results

A. Publication Output and Growth (RQ1)

The final corpus comprised 156 documents published between 2020 and 2026. Annual output is summarized in Table I. The distribution is uneven: a large share of records (70 documents) is dated 2020, after which annual counts fall before a secondary resurgence in 2024 (34 documents). The 2020 concentration should be interpreted with caution, as it partly reflects a cluster of engineering-education conference proceedings and the tendency of open indexes to assign imprecise dates to proceedings; nonetheless, the renewed output from 2024 onward indicates continuing interest.

TABLE I

Annual Publication Output of the Corpus (N = 156)

Publication year	Documents	Share of corpus
2020	70	44.9%
2021	9	5.8%
2022	12	7.7%
2023	12	7.7%
2024	34	21.8%
2025	13	8.3%
2026 (partial)	6	3.8%
Total	156	100%

B. Citation Impact and Accessibility (RQ1)

The corpus is lightly cited, consistent with an emerging field. The 156 documents accumulated 527 citations in total—a mean of 3.38 per document, with a maximum of 59. A substantial 39.1% (61 of 156) had received no citations at extraction. Accessibility, by contrast, is high: 60.3% (94 of 156) are open access, favoring dissemination and reuse in teaching-oriented communities.

C. Most Influential Documents (RQ2)

Table II lists the ten most-cited documents. Assessment-focused studies dominate the highest ranks: beyond the most-cited paper on professional-skills learning, the leading works address rubrics for senior-design assessment, direct methods for assessing professional skills, effective assessment of computer-science capstone projects, and the factors panels consider when assessing capstone work. This concentration foreshadows the thematic finding in Section III-E.

TABLE II

Ten Most-Cited Documents in the Corpus

#	Document (first author, year)	Cites	Focus
1	Picard and Hardebolle (2021), professional skills in engineering team projects	59	Skills
2	Estell and Hurtig (2020), rubrics for the assessment of senior design projects	41	Assessment
3	Ater Kranov et al. (2020), direct method for assessing professional skills	32	Assessment
4	Abichandani et al. (2023), AI and computer-vision education	25	Curriculum
5	Guerci and Baxter (2020), automating a CAD course to improve evaluation	22	Assessment
6	Abu Salem et al. (2020), effective assessment of CS capstone projects	18	Assessment
7	Khan et al. (2020), RAD versus Agile for computing graduation projects	16	Process
8	Ocampo-López et al. (2022), integrative projects and the design experience	16	Pedagogy
9	Domínguez et al. (2020), factors in the assessment of CS capstone projects	13	Assessment
10	Davis (2020), communication skills in senior-design capstone projects	12	Skills

Citation counts are drawn from the OpenAlex export; full bibliographic details are available in the source dataset.

D. Productive Authors and Collaboration Structure (RQ2, RQ4)

Authorship is highly dispersed. No author dominates: the most frequent contributors appear on only two documents each. The co-authorship network (Fig. 1) is correspondingly sparse. The largest connected component is a single, fully interconnected team of ten authors—every member linked to every other, the signature of one large multi-author paper rather than a sustained collaboration. Beyond this clique, authors are essentially isolated. The field lacks the dense, multi-team collaboration structure of a mature research community.

E. Thematic Structure: Keyword Co-Occurrence (RQ3)

After thesaurus normalization, keyword co-occurrence analysis of the 37 substantive terms resolved four coherent clusters (Fig. 2, Table III). Cluster 1 (engineering education and professional formation) is anchored by engineering, engineering management, engineering education, pedagogy, curriculum, and accreditation. Cluster 2 (software engineering and project/process management) groups software engineering, systems engineering, software development, agile software development, and project management. Cluster 4 forms a compact computing core dominated by computer science—the single most frequent term (137 occurrences). Cluster 3 is the focus of this study: a distinct capstone-

pedagogy-and-assessment cluster comprising capstone, capstone course, project-based learning, and the assessment vocabulary of rubric, formative assessment, summative assessment, and grading.

TABLE III

Thematic Clusters From Keyword Co-Occurrence Analysis

Cluster	Representative terms	Terms	Avg. yr
1	engineering, engineering management, engineering education, pedagogy, curriculum, accreditation, teamwork	12	2021.4
2	software engineering, systems engineering, software development, agile software development, project management, computer security	12	2022.0
3	capstone, capstone course, project-based learning, rubric, formative assessment, summative assessment, grading	10	2022.0
4	computer science, mathematics, human–computer interaction	3	2021.8

A striking pattern emerges when term frequency is compared with citation impact. The most frequent terms are broad disciplinary labels with modest impact (computer science: 137 occurrences, 3.7 average citations; engineering: 118, 3.8). The explicit assessment terms are the inverse—infrequent but highly cited. *Rubric* occurs only nine times yet carries the highest average citation impact of any term in the map, at 11.1 citations; *summative assessment* averages 9.2, *capstone course* 7.4, *grading* 7.2, and *formative assessment* 7.1. The field publishes comparatively little on assessment, but the assessment work it does publish is disproportionately influential.

The temporal overlay identifies the newest growth areas. Terms with the most recent average publication years include higher education (2023.2), computer security (2023.1), grading (2023.0), and summative assessment (2022.8), indicating that assessment-related concerns—and grading in particular—are among the field's rising themes.

F. Intellectual Structure: Citation and Bibliographic Coupling (RQ4)

Both citation-based analyses indicate an intellectually fragmented field. The direct-citation network (Fig. 3) is near-disconnected: only 13 citation links connect the corpus, distributed across six components, the largest containing just six documents. The majority of documents neither cite nor are cited by other corpus members, meaning the literature is not yet building cumulatively on itself.

Bibliographic coupling—which links documents that share references—reveals somewhat more structure but remains weak. Coupling connected 49 documents through 126 links, but the average coupling strength was only 1.17 shared references, indicating that even coupled documents rest on a thin base of common intellectual foundations (Fig. 4). Together, the citation and coupling analyses confirm an emerging, dispersed field lacking a consolidated research front.

IV. Discussion

A. Assessment Is the Field's Most Impactful Yet Least Developed Theme

The central finding is an asymmetry between attention and impact. Across every analysis, assessment is under-represented in volume but over-represented in influence. Explicit assessment terms occur infrequently yet carry the map's highest citation impact, and assessment-focused studies dominate the most-cited documents. This is the quantitative signature of a research gap: the community values work on capstone assessment—as revealed by its citation behavior—more than it produces it. For computing programs seeking to move beyond perception-based evaluation, this asymmetry is both a warning and an opportunity.

B. A Recognizable but Separable Assessment Sub-Field

That the assessment vocabulary organizes into its own cluster, adjacent to but distinct from the capstone, software-engineering, and disciplinary cores, indicates that capstone assessment exists as a recognizable sub-field rather than being fully integrated into computing-education research. Its adjacency to the engineering-education cluster, and the recurrent appearance of rubrics, formative and summative assessment, and accreditation, suggests that the most developed assessment thinking here has been imported from engineering education—a lineage that computing-specific work can build upon deliberately.

C. An Emerging Field Without a Research Front

The sparse co-authorship, near-disconnected citation, and weak bibliographic-coupling networks together describe a field that is active but not yet consolidated. Contributions are dispersed across many single-paper authors who neither collaborate widely nor cite one another systematically. Such fragmentation is characteristic of a pre-paradigmatic field: the literature would benefit from synthesis, shared frameworks, and common instruments that allow studies to accumulate rather than proliferate in isolation.

D. Disciplinary Skew: Computer Science Over Information Technology and Information Systems

A closer reading reveals a pronounced disciplinary skew within computing. The term *computer science* is the single most frequent keyword (137 occurrences) and appears in 12.2% of documents (19 of 156), and the assessment-focused studies at the top of the citation distribution are explicitly framed around computer-science capstones. By contrast, *information technology* appears in only 3.2% (5 of 156) and *information systems* in 1.9% (3 of 156); moreover, the few information-systems mentions refer to information systems as built artifacts—a blind-spot information system, an AI-enabled innovation hub—rather than as a program of study. Neither term survived thesaurus normalization as a distinct node. The literature therefore concentrates on computer science—alongside broader engineering, which frames 62.2% of the corpus—while information-technology and information-systems capstones are markedly underrepresented.

This skew has direct consequences for programs structured along the three computing degrees common in the Philippines and elsewhere. Assessment scholarship maps readily onto the Bachelor of Science in Computer Science (BSCS), but Bachelor of Science in Information Technology (BSIT) and Bachelor of Science in Information Systems (BSIS) capstones—typically more applied, deployment-oriented, and organizationally embedded—are poorly served by instruments and evidence derived from computer-science contexts. The gap is not only one of volume but of disciplinary fit: frameworks validated for BSCS capstones may not transfer cleanly to the applied and information-systems character of BSIT and BSIS projects. This is a specific, addressable gap that the author's subsequent work targets.

E. Implications for Computing Education

For accreditation- and outcome-driven systems—including Philippine computing programs under outcome-based education mandates—these findings argue for transparent, evidence-based capstone assessment instruments in place of, or alongside, satisfaction surveys. The disproportionate impact of rubric- and outcome-based studies suggests that investment in standardized, empirically grounded assessment tooling yields the highest scholarly and practical returns. The rising prominence of grading and summative assessment further indicates this is a timely, not a settled, area for contribution.

F. Limitations

Several limitations apply. First, the analysis draws on a single database; cross-database validation against Scopus or Web of Science would strengthen confidence in completeness. Second, OpenAlex metadata—particularly year assignment for proceedings and automated concept tagging—can be imprecise, as reflected in the 2020 concentration. Third, the corpus spans computing and cognate technical disciplines, so part of the literature originates in engineering rather than computing specifically—a deliberate scoping choice that nonetheless limits domain purity. Finally, citation-based indicators disadvantage the most recent publications.

V. Conclusion

This bibliometric analysis mapped 156 documents (2020–2026) on capstone and final-year project assessment in computing and cognate disciplines. The field is young, lightly cited, highly open access, and intellectually fragmented, with no consolidated research front. Keyword co-occurrence revealed four themes, among which a distinct capstone-assessment cluster stands out: although assessment terms appear infrequently, they carry the highest citation impact in the map, and assessment studies dominate the most-cited documents. The literature is also disciplinarily skewed toward computer science, leaving information-technology and information-systems capstones comparatively neglected. Assessment is thus the most impactful yet least developed theme in computing capstone research, quantifying a clear and timely gap and providing an evidentiary basis for advancing empirical capstone assessment frameworks.

Declarations

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Figures

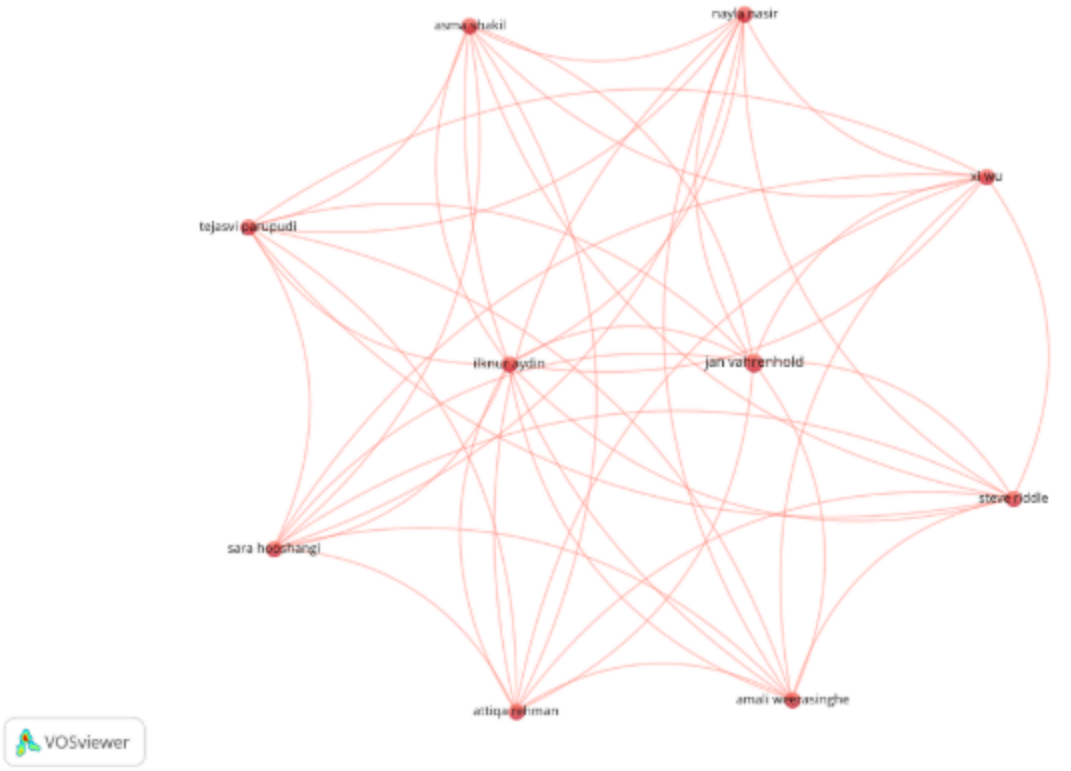


Figure 1

Co-authorship network (largest connected component). The ten-author clique reflects a single multi-author study rather than a sustained inter-team collaboration.



Figure 2

Keyword co-occurrence map after thesaurus normalization (37 terms, four clusters). The assessment vocabulary forms a distinct cluster adjacent to the capstone and computing cores.

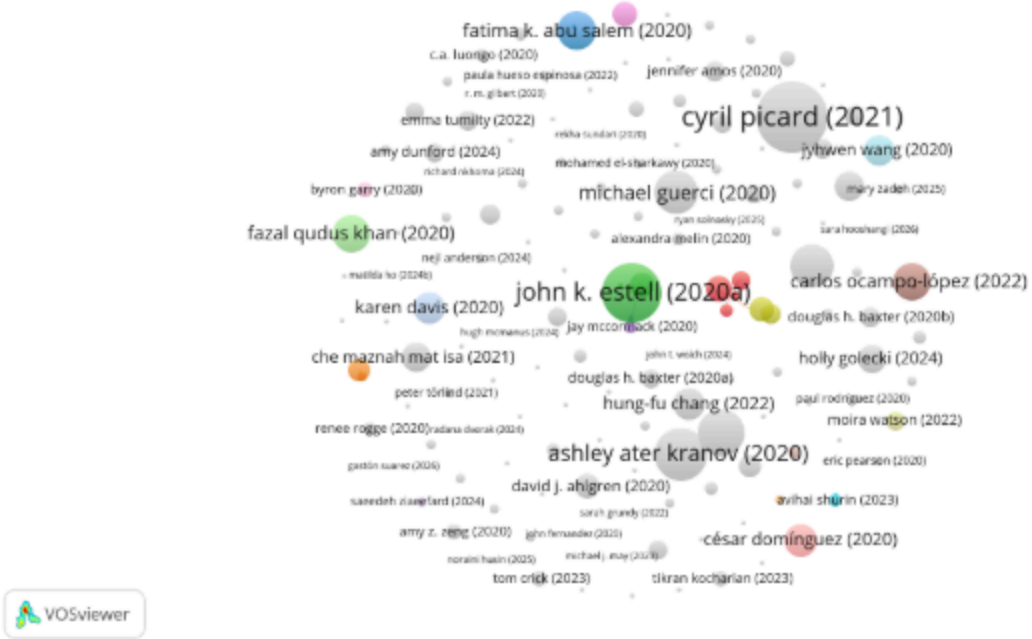


Figure 3

Direct-citation network. Most documents are isolated; the few connected components are small, indicating limited cumulative citation.

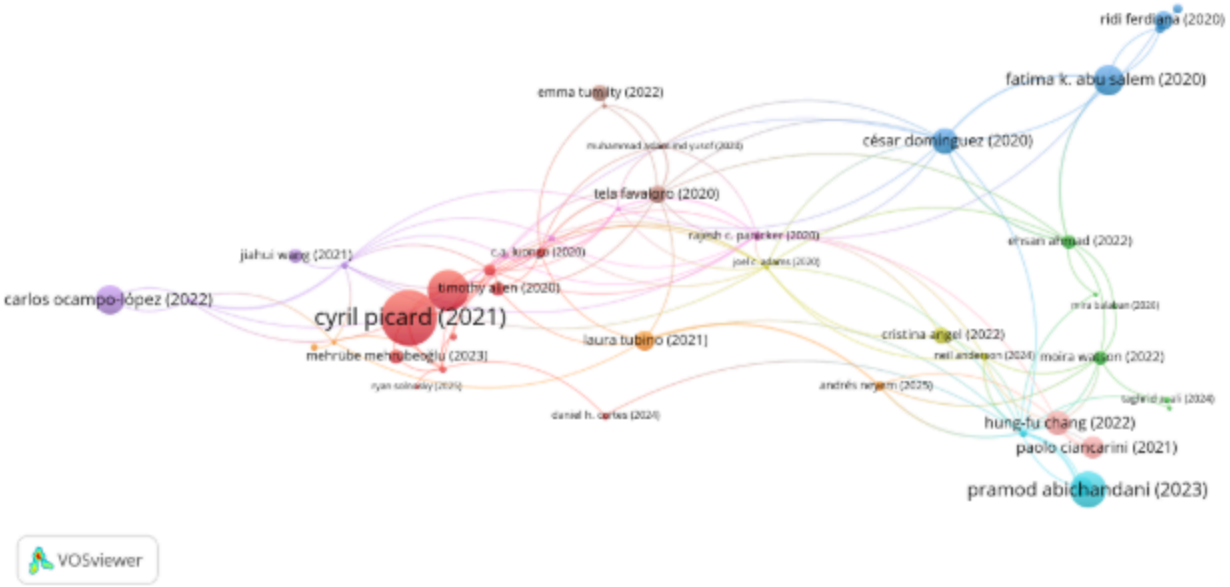


Figure 4

Bibliographic-coupling network. Multiple small clusters and low average coupling strength (1.17 shared references) indicate weak intellectual cohesion.