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TRENDS AND EFFECTIVENESS OF THE CONCEPT ATTAINMENT MODEL IN EDUCATION: A SYSTEMATIC REVIEW (2020 TO 2024)

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ABSTRACT

The movement toward instruction that builds conceptual reasoning rather than memorisation has renewed interest in the Concept Attainment Model (CAM), yet recent evidence on the model remains scattered across databases and contexts. This review maps emerging trends and evaluates the effectiveness of CAM in education between 2020 and 2024. Following the PRISMA protocol combined with bibliometric and content analysis, 2,180 records retrieved from Scopus, SINTA, and Google Scholar were screened and 45 studies met the inclusion criteria. Publication activity rose across the period and peaked in 2022, with the strongest implementation in secondary level mathematics and science. Quantitative experimental designs dominated (60.0%), followed by classroom action research (17.8%) and research and development studies (15.6%). Reported outcomes included gains in conceptual understanding (82.2%), critical and creative thinking (66.7%), academic achievement (60.0%), and engagement (55.6%). Studies combining CAM with digital platforms, blended formats, or worksheet based scaffolding covered less than a quarter of the corpus. The findings position CAM as a mature yet still developing model whose reach can be extended through methodological diversification and hybrid designs in technology responsive environments.

KEYWORDS: concept attainment model, conceptual learning, instructional design, systematic review

1. INTRODUCTION

Education remains a central force in shaping human capacity and national progress. It equips individuals with the knowledge and skills required to understand and apply concepts across many domains of life, and through it societies cultivate the discipline, innovation, and social balance that sustain economic and cultural development (Arifin et al., 2020; Hanushek et al., 2017). The strength of a nation often rests on the quality of its education system, which prepares citizens to participate in work, community, and governance. Sustained investment in education strengthens the workforce, supports equity, and widens access to opportunity for all members of society (Abadiyah et al., 2025; Omar et al., 2023).

Across its history, education has moved from the rote transmission of information toward a process that cultivates understanding and reasoning. This transformation has accompanied successive industrial and technological changes that demand a more flexible and creative generation of learners (Rudiyanto et al., 2020; Wulandari, 2024). Schools and universities are now expected to develop individuals who can analyse, evaluate, and apply ideas to authentic situations, so instructional practice must guide learners not only to recall information but also to construct meaning and transfer knowledge. The shift from teacher centred to learner centred education has made this priority more urgent (Oktarina et al., 2025; Thibaut et al., 2018; Xing et al., 2023).

Within this changing landscape, a persistent challenge is the gap between the delivery of content and the development of deep understanding. Many students can memorise facts yet struggle to apply them when confronted with unfamiliar problems (Mala et al., 2020; Suharno et al., 2020), which constrains the capacity of education to build reasoning and creativity. Effective learning therefore depends on methods that direct students to identify patterns, make comparisons, and form general principles, approaches that help them organise knowledge into conceptual structures that transfer across contexts (As-Sa'idah et al., 2022; Ismail & Imawan, 2022).

The Concept Attainment Model (CAM) offers a structured route to these goals. Developed within the tradition of inductive learning, the model engages students in identifying the defining attributes of a concept by analysing examples and non examples (Fitria et al., 2025; Ifrianti et al., 2019). The procedure trains learners to reason

critically and to uncover the logic that underlies each concept. Because the model promotes active participation and the construction of meaning rather than the passive reception of information, students build a more durable understanding of subject matter (Asy et al., 2022; Wahyuni, 2021).

Research on CAM has grown steadily across disciplines. Since its introduction, the model has been examined in fields such as mathematics, science, and language learning (Anupan & Chimmalee, 2022; Tresnaningsih et al., 2020), with many studies reporting improved comprehension, achievement, and classroom engagement and suggesting that the approach strengthens both conceptual and procedural knowledge. Despite these advantages, the use of CAM remains limited in many learning environments, and its integration with other instructional strategies is frequently absent (Ernawati, Ferdian, et al., 2023; Halim et al., 2021).

Contemporary education increasingly calls for models that address the intellectual, emotional, and psychomotor dimensions of learning. The expansion of digital platforms and technology supported classrooms has created new contexts for instruction (Fadillah et al., 2023; Statti, 2020), inviting renewed attention to how established models such as CAM can be adapted for modern settings. Research on this question, however, remains fragmented, with studies often focused on narrow subjects or single approaches that do not form a complete picture of how the model operates across levels and contexts (Ifrianti et al., 2019; Jia & Huang, 2023).

A further problem is the absence of synthesis across CAM studies, which has produced a limited understanding of the model's broader patterns and impact (Asy et al., 2022; Jiménez et al., 2015). Although many researchers have investigated its application, few have consolidated these results into a unified framework (Ernawati, Tasrif, et al., 2023; Lee et al., 2023), leaving educators without clear guidance on how to adopt or adapt the model for diverse learning needs. A systematic review can address this gap by mapping the development of CAM research, identifying dominant trends, and clarifying the conditions under which the model is most effective (Fitria et al., 2025; Rashid et al., 2021).

The years from 2020 to 2024 mark a period of pronounced change in education. The spread of remote learning, digital transformation, and curriculum reform reshaped how teachers and students interact (Kwilinski, 2023; Timotheou et al., 2023) and encouraged broader experimentation with instructional models, including CAM (Jing et al., 2023; Olaniyi et al., 2024). A range of studies emerged during this window from both national and international journals, yet the findings remain dispersed and have not been connected into a clear account of the model's progress, its strongest subject areas, or the innovations introduced to enhance it (Ernawati et al., 2022; Sawitri et al., 2021).

This study aims to map the emerging trends and evaluate the effectiveness of the Concept Attainment Model in education through a systematic review of research published between 2020 and 2024. Specifically, the review addresses six questions: (1) what are the publication trends in CAM research across this period; (2) how do databases and journals vary in their coverage of CAM studies; (3) which research designs are most frequently employed; (4) which subjects and educational levels are most commonly associated with CAM implementation; (5) what learning outcomes and benefits are reported; and (6) what methodological or media based innovations have been introduced to enhance the model. By answering these questions, the review offers a structured synthesis that clarifies the current state and future direction of CAM as a model for conceptual learning.

2. LITERATURE REVIEW

The weakness of purely transmissive teaching is well documented. Students who memorise material without organising it conceptually struggle to solve unfamiliar problems, and comparative studies consistently favour approaches that engage learners in identifying patterns, making comparisons, and forming general principles (As-Sa'idah et al., 2022; Ismail & Imawan, 2022). Effective instruction therefore depends on models that help learners build conceptual structures capable of transferring across contexts, a demand that has grown sharper as curricula shift from teacher centred delivery toward learner centred construction of meaning (Oktarina et al., 2025; Thibaut et al., 2018; Xing et al., 2023). In several systems, including Indonesia, curriculum reform has made conceptual competence an explicit policy goal (Mala et al., 2020; Suharno et al., 2020).

CAM belongs to the tradition of inductive learning. The model engages students in identifying the defining attributes of a concept by analysing carefully sequenced examples and non examples, testing hypotheses about category membership, and articulating the rule that separates instances from non instances (Fitria et al., 2025; Ifrianti et al., 2019). Because meaning is constructed rather than received, the understanding that results tends to be more durable, and the procedure itself trains critical reasoning (Asy et al., 2022; Wahyuni, 2021). Empirical work has examined the model across mathematics, science, and language learning, reporting improvements in comprehension, achievement, and classroom engagement (Anupan & Chimmalee, 2022; Tresnaningsih et al., 2020). Evidence also links CAM to gains in science process skills and to stronger performance in concept intensive tasks (Ernawati, Tasrif, et al., 2023; Halim et al., 2021). At the same time, adoption remains uneven, and integration with complementary strategies or digital environments is frequently absent, even though technology supported classrooms have created new contexts in which established models can operate (Fadillah et al., 2023; Statti, 2020). Calls to align instruction with digital literacy demands make this question increasingly relevant (Ifrianti et al., 2019; Jia & Huang, 2023).

Despite the volume of individual studies, few efforts have consolidated CAM research into a unified account of its patterns and impact (Asy et al., 2022; Jiménez et al., 2015), and studies frequently focus on single subjects or isolated interventions, which prevents a complete picture of how the model performs across levels and contexts (Ernawati, Ferdian, et al., 2023; Lee et al., 2023). Systematic reviews and bibliometric mapping offer a recognised

remedy for fragmentation of this kind, since they identify dominant trends, expose neglected territory, and clarify the conditions under which an approach is most effective (Fitria et al., 2025; Rashid et al., 2021).
The period from 2020 to 2024 deserves particular attention. Remote learning, digital transformation, and curriculum reform reshaped instruction during these years (Kwilinski, 2023; Timotheou et al., 2023) and encouraged renewed experimentation with instructional models across national and international journals (Jing et al., 2023; Olaniyi et al., 2024). Related work in design oriented disciplines shows the same movement toward evidence based instructional innovation (Ernawati et al., 2022; Sawitri et al., 2021). Established review protocols such as PRISMA, supported by bibliometric techniques, provide the methodological ground on which the present synthesis is built (Amastini et al., 2025; Fadillah et al., 2024; Samala et al., 2023). In general, previous research demonstrates a gap between the accumulation of individual CAM studies and a consolidated understanding of the model's trajectory. The current study addresses this deficiency by mapping publication trends, methodological preferences, and reported outcomes across the most recent five year window.

3. METHODOLOGY

3.1 Research Design

This study used a systematic literature review integrated with bibliometric and content analysis to map emerging trends and evaluate the effectiveness of the Concept Attainment Model in education. The review followed the PRISMA framework, which structures the identification, screening, eligibility, and inclusion stages of a review and supports transparency in data collection and classification (Amastini et al., 2025; Fadillah et al., 2024; Samala et al., 2023). Bibliometric analysis identified publication growth, preferred methodologies, and the thematic distribution of CAM studies, while content analysis supported the qualitative interpretation of study characteristics and reported outcomes. The full selection sequence is presented in Figure 1. From 2,180 records identified across the three databases, 1,220 duplicates were removed, 960 records were screened by title and abstract, 410 full texts were assessed for eligibility, and 45 studies satisfied all inclusion criteria.

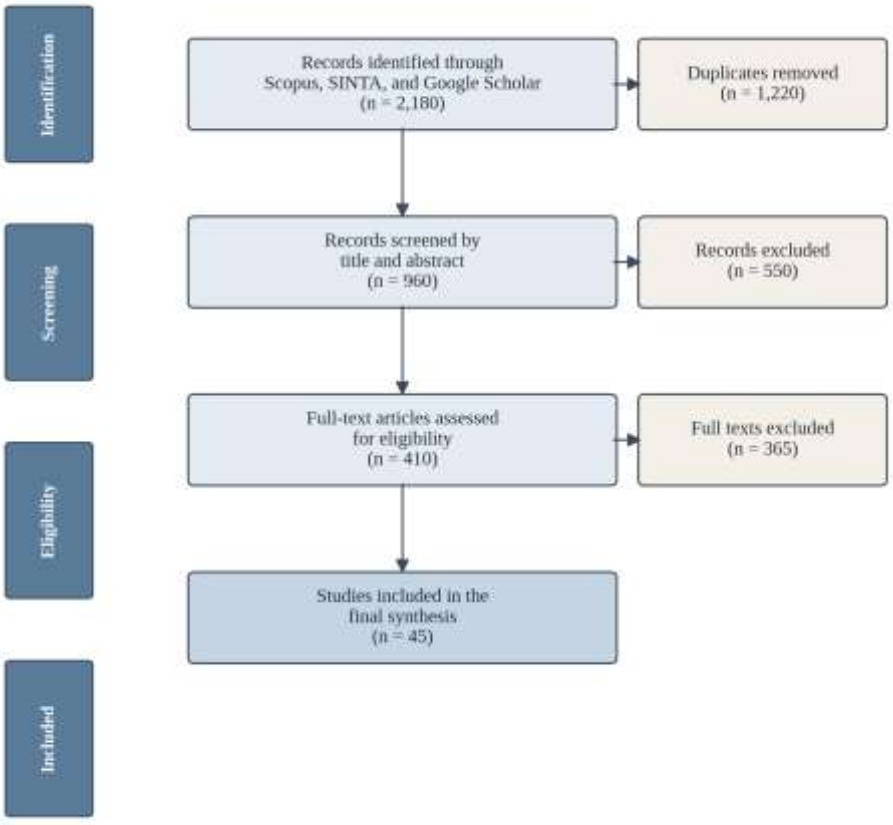

Figure 1. PRISMA flow diagram of the study selection process

3.2 Data Sources and Search Strategy

The dataset was compiled from three databases: SINTA, Scopus, and Google Scholar. SINTA provides a national reference for peer reviewed research managed by the Ministry of Education, Culture, Research, and Technology of Indonesia, while Scopus and Google Scholar extended the international coverage of the search. The search combined the terms concept attainment model, conceptual learning, inductive model, and instructional strategy. Four inclusion criteria guided the selection: articles published between 2020 and 2024; studies that explicitly addressed CAM in the title, abstract, or keywords; research conducted in formal educational contexts; and availability of the full text for coding. After screening, 45 studies met all criteria, covering mathematics, science, and language learning across elementary, secondary, and tertiary levels. Table 1 summarises the contribution of each database.

Table 1. Distribution of records and selected studies by database

Database	Records identified	Studies selected	Percentage (%)
SINTA	640	18	40.0
Scopus	980	20	44.4
Google Scholar	560	7	15.6
Total	**2,180**	**45**	**100.0**

3.3 Data Collection Instrument

A content analysis guide served as the main instrument for data extraction. Each selected article was examined through its abstract, method, and discussion sections against seven analytical aspects, as shown in Table 2. Coding each article against these categories allowed cross tabulation and comparison between publication trends and thematic content.

Table 2. Analytical framework used for data extraction

Code	Analytical aspect	Description of data extracted
A1	Publication frequency	Number of CAM studies per year (2020 to 2024)
A2	Research type	Quantitative, qualitative, or mixed method approach
A3	Research design	Experimental, classroom action research, or research and development
A4	Educational level	Elementary, secondary, or higher education
A5	Subject area	Domain of study (for example mathematics, science, language)
A6	Learning outcomes	Main findings on conceptual or cognitive improvement
A7	Integration approach	Media, model, or learning strategy combined with CAM

3.4 Data Analysis

The analysis proceeded in two stages: quantitative bibliometric mapping and qualitative content interpretation. The bibliometric phase measured research productivity, authorship distribution, and thematic clustering. Publication trends were analysed with the growth rate equation presented in Equation (1):

$$PGR = ((Nt - Nt - 1) / Nt - 1) \, x \, 100\% \qquad (1)$$

where PGR is the publication growth rate in percent, Nt is the number of publications in the current year, and Nt-1 is the number of publications in the previous year. The qualitative stage interpreted patterns related to model effectiveness, pedagogical integration, and student outcomes. Studies were grouped into thematic categories such as conceptual comprehension, critical thinking, creativity, and academic performance, and the results were summarised through frequency tables and visualised with charts.

3.5 Validation Strategy

Cross checking and inter rater verification supported data validity. Two independent reviewers coded the dataset, and differences in classification were resolved through discussion until consensus. The inclusion of multiple databases reduced selection bias and improved representativeness, while a detailed coding manual supported reliability. Every step, from identification to synthesis, was documented under the PRISMA protocol so that the procedure can be replicated.

3.6 Ethical Considerations

The study did not involve direct interaction with human participants or the collection of personal data; all material was obtained from publicly accessible articles, so concerns regarding participant rights, confidentiality, or informed consent did not arise. The review nevertheless observed academic ethical principles through accurate citation, proper acknowledgement, and responsible interpretation of all referenced studies.

4. RESULTS

4.1 Publication Trends from 2020 to 2024

The bibliometric analysis identified consistent growth in research on the Concept Attainment Model between 2020 and 2024. Across the 45 selected articles, publication activity rose from 6 studies in 2020 to 10 in 2024, an increase of 66.7% over the five year window. The year 2022 represented a turning point, when publications climbed to 11, the highest annual count in the dataset, driven by studies integrating digital media and classroom based experimentation. The publication growth rate reached 37.5% between 2021 and 2022. Figure 2 presents the annual distribution, and the stable volume across 2023 and 2024 suggests a shift from exploration toward refinement and practical implementation.

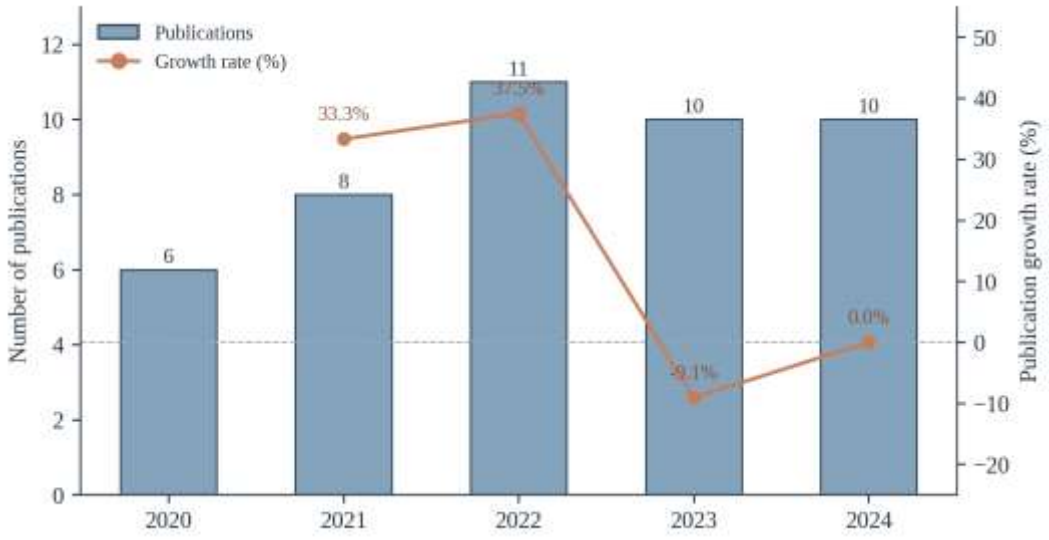

Figure 2. Evolution of CAM publications and annual growth rate, 2020 to 2024

4.2 Distribution by Database and Research Context

Most studies appeared in Scopus indexed journals (20 studies, 44.4%), followed by SINTA indexed journals (18 studies, 40.0%) and Google Scholar accessible repositories (7 studies, 15.6%). Scopus indexed studies generally focused on comparative learning outcomes and conceptual development, while SINTA based studies emphasised instructional design and classroom innovation. Geographically, Asia accounted for 64.4% of all studies, followed by Europe (20.0%) and other regions (15.6%), with Indonesia and India most prominent. The concentration in Asia reflects sustained attention to conceptual pedagogy within formal school systems, while the modest representation of other regions indicates that the evidence base, although growing, is not yet globally balanced.

4.3 Research Designs, Educational Levels, and Subject Domains

Quantitative experimental research dominated the corpus with 27 studies (60.0%), which indicates that most researchers concentrated on measuring the effect of CAM interventions through numerical learning outcomes. Classroom action research followed with 8 studies (17.8%), reflecting interest in iterative classroom improvement cycles, while research and development designs accounted for 7 studies (15.6%) and represented efforts to create CAM based instructional products and digital tools. Purely qualitative investigations formed the smallest group at 3 studies (6.7%). Panel (a) of Figure 3 presents this distribution.

CAM was applied most frequently in secondary education, with 22 studies (48.9%), followed by higher education with 15 studies (33.3%) and primary education with 8 studies (17.8%), as shown in panel (b) of Figure 3. The secondary school emphasis corresponds with subjects that demand strong conceptual reasoning, while higher education studies often examined CAM within blended learning or pre service teacher training. Across subjects, mathematics accounted for 19 studies (42.2%), followed by science (14 studies, 31.1%), language learning (8 studies, 17.8%), and social studies with other fields (4 studies, 8.9%), as shown in panel (c). The dominance of mathematics and science confirms that CAM suits disciplines that rely on conceptual differentiation, definition based understanding, and procedural reasoning.

The content analysis identified four recurring outcomes, with many studies reporting more than one, as summarised in panel (d) of Figure 3. Conceptual understanding appeared in 37 studies (82.2%), where students demonstrated a stronger ability to classify and generalise concepts. Critical and creative thinking was reported in 30 studies (66.7%), academic achievement gains in 27 studies (60.0%), and motivation or engagement improvements in 25 studies (55.6%). The pattern indicates that CAM supports cognitive comprehension as well as affective engagement and reflective skill formation, consistent with its theoretical basis as an inductive approach that fosters concept building through guided discovery.

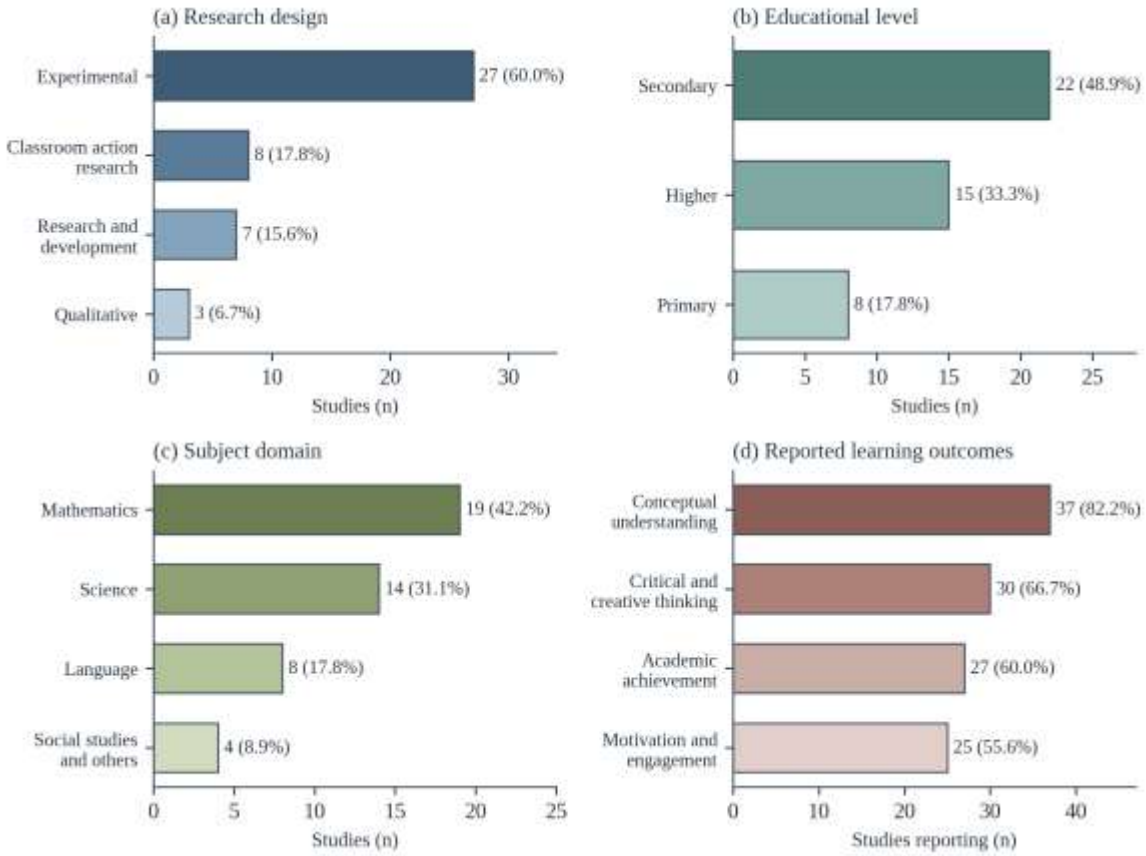

Figure 3. Profile of the reviewed corpus by (a) research design, (b) educational level, (c) subject domain, and (d) reported learning outcomes (n = 45; multiple outcomes per study possible)

4.4 Integration of CAM with Other Models, Methods, and Media

A limited number of studies explored integration with complementary approaches: only 11 of the 45 papers (24.4%) reported hybrid designs. The most common combinations were CAM with problem based learning (4 studies, 8.9%), CAM within blended or e-learning environments (4 studies, 8.9%), and CAM with worksheet or task based learning (3 studies, 6.7%). These hybrid implementations reported improved learner autonomy and cognitive transfer, yet the overall proportion of integrated studies remained low. The gap, summarised in Table 3 and Figure 4, points to a clear opportunity for future research to extend CAM beyond conventional face to face teaching.

Table 3. Integration of CAM with complementary pedagogical approaches

Integration approach	Studies (n)	Percentage (%)	Primary purpose
CAM + problem based learning	4	8.9	Strengthen inquiry and reasoning
CAM + blended or e-learning	4	8.9	Enhance digital concept learning
CAM + worksheet or task based	3	6.7	Support applied understanding
CAM only (no integration)	34	75.6	Independent model implementation
Total	**45**	**100.0**	

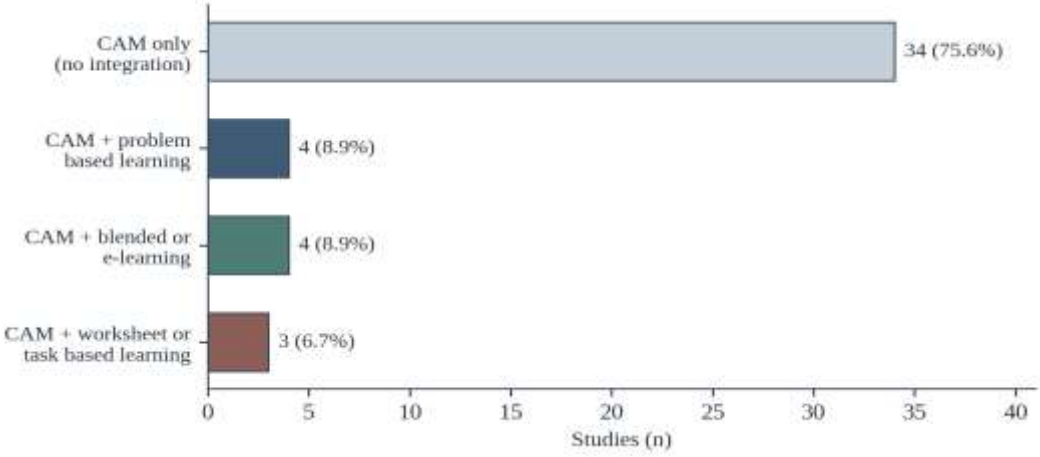

Figure 4. Distribution of integrated and non integrated CAM implementations

4.5 Keyword Co-occurrence Analysis

Figure 5 visualises keyword co-occurrence across CAM publications from 2020 to 2024. The intensity is highest between the Concept Attainment Model and conceptual understanding (37 studies) and critical thinking (30 studies), with a strong association with mathematics (19 studies), confirming that most studies emphasise conceptual mastery in mathematical contexts. Cells involving digital learning remain comparatively sparse, revealing keyword relationships that are still underexplored and marking the territory where future research may expand.

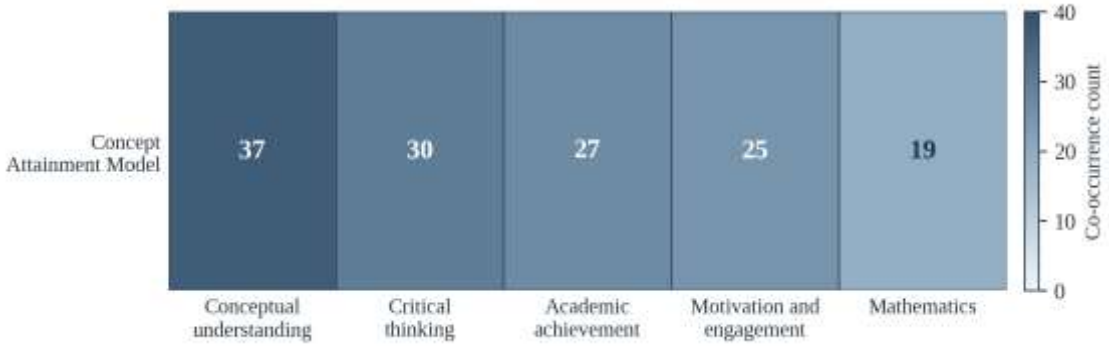

Figure 5. Keyword co-occurrence intensity in CAM research, 2020 to 2024

5. DISCUSSION

The findings reinforce the argument that contemporary education requires learning models which strengthen conceptual reasoning rather than memorisation. CAM answers this requirement through inductive reasoning grounded in examples and non examples, which allows students to identify conceptual attributes through active cognitive processing (Asy et al., 2022; Fitria et al., 2025). The steady increase in CAM publications between 2020 and 2024 indicates that concept building strategies are increasingly regarded as essential for deeper learning, echoing the shift toward analytical and constructive pedagogy described in earlier work (As-Sa'idah et al., 2022; Ismail & Imawan, 2022).

The growth in publication volume is best understood against the backdrop of the period under study. The disruption of conventional instruction during and after the pandemic accelerated interest in approaches that secure understanding rather than recall, and the expansion of digital learning created fresh opportunities to test conceptual models in new formats (Kwilinski, 2023; Timotheou et al., 2023). The rise from six studies in 2020 to a peak of eleven in 2022 is consistent with a research community responding to these conditions with renewed experimentation. The stabilisation at ten publications in 2023 and 2024 then suggests a transition from rapid exploration toward consolidation, a plateau typical of a maturing research theme in which the priority moves from establishing that a model works toward clarifying the conditions under which it works best.

The distribution of studies across databases reflects the gradual internationalisation of CAM research. The slightly larger share of Scopus indexed articles indicates that the topic has moved beyond local dissemination into wider academic discussion (Jing et al., 2023; Rashid et al., 2021), while the thematic contrast between the sources, experimental validation in Scopus work and classroom innovation in SINTA work, signals a productive division of labour. The geographic concentration in Asia, particularly Indonesia and India, points to sustained attention to conceptual pedagogy in systems where structured curricula and examination cultures place a premium on secure conceptual mastery.

The methodological profile of the corpus, in which quantitative experimental designs account for the majority of studies, reflects a shared emphasis on measuring conceptual change and achievement through comparison with control conditions. This preference is consistent with the studies that reported gains in comprehension and critical thinking after CAM instruction (Asy et al., 2022; Wahyuni, 2021). The concentration of research in mathematics and science aligns with the cognitive demands of these disciplines, which rely on abstraction, categorisation, and procedural logic; concept attainment maps naturally onto content in which meaning depends on distinguishing defining from non defining attributes (Anupan & Chimmalee, 2022; Tresnaningsih et al., 2020). The prominence of secondary education likewise fits the view that adolescence is a formative stage for analytical thinking, in which CAM scaffolds the movement from concrete description toward abstract reasoning.

The outcome profile shows that CAM supports more than cognitive comprehension alone. The recurrence of affective alongside cognitive gains is consistent with the model's reliance on active participation, in which learners test hypotheses about category membership and receive feedback that sustains involvement. Against these benefits, the scarcity of integrated implementations stands out as the clearest gap in the field. With roughly three quarters of studies applying CAM in isolation, the evidence on how the model behaves alongside problem based learning, blended environments, or worksheet based scaffolding remains thin (Ernawati, Ferdian, et al., 2023; Halim et al., 2021). The hybrid studies that do exist report gains in learner autonomy and cognitive transfer, which marks integration as a promising direction, yet the corpus does not permit firm conclusions about which combinations work best.

This review contributes to conceptual learning theory by synthesising research patterns that describe how CAM supports concept formation across levels of education. The evidence indicates that the model encourages

structured reasoning through exposure to example and non example sets, strengthening generalisation and classification skills, and that it can be combined with digital instruction, worksheet media, and inquiry based frameworks. These findings give curriculum planners and teachers a basis for designing instruction that shifts from information delivery toward concept construction, and they can inform teacher training programmes that aim to develop inductive teaching skill, particularly in mathematics and science.

The scope of this review is restricted to studies indexed in SINTA, Scopus, and Google Scholar during the 2020 to 2024 period, so the synthesis may not represent research movements outside those databases. Most reviewed studies relied on quantitative measurement focused on test score outcomes, which limits insight into affective responses, learning processes, and long term retention. The integration of CAM with digital tools and mixed pedagogical models also remained scarce. Future research should expand toward qualitative inquiry, classroom observation, and longitudinal evaluation, and should test hybrid models that combine CAM with technology, project work, and assessment scaffolds across a wider range of disciplines.

6. CONCLUSION

This systematic review mapped publication growth, methodological preferences, and learning outcome patterns related to the Concept Attainment Model in education between 2020 and 2024. The analysis shows a steady rise in research volume, a dominance of quantitative experimental designs, and strong application within mathematics and science at the secondary level. Across the reviewed studies, CAM supports concept formation, strengthens classification and reasoning, and improves achievement and engagement, which demonstrates its value as a model that prioritises conceptual depth over memorisation. Although hybrid designs remain limited, the presence of digital integration and inquiry based adaptations signals a shift toward more innovative instructional ecosystems. The scope of this review is restricted to studies indexed in SINTA, Scopus, and Google Scholar during the 2020 to 2024 period, and most reviewed studies relied on quantitative measurement focused on test score outcomes, which limits insight into affective responses, learning processes, and long term retention. Future research should expand toward qualitative inquiry, classroom observation, and longitudinal evaluation, and should test hybrid models that combine CAM with technology, project work, and assessment scaffolds across a wider range of disciplines. These findings position CAM as a feasible model for curriculum enhancement wherever conceptual mastery is a core learning outcome.

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