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Effectiveness of Models of Teaching in Higher Education: A Comparative Review of Inquiry-Based, Active, Cooperative, and Flipped-Classroom Approaches

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Abstract
Models of teaching remain central to instructional design in higher education, yet the field lacks a consolidated comparative account of how well competing models actually perform against one another. This review synthesizes evidence on the effectiveness of five widely researched models—inquiry training, active learning, cooperative learning, the flipped classroom, and problem-based learning—drawing on meta-analytic and primary quantitative studies published between 1991 and 2025. Across models, effect sizes on learner achievement range from small ($g \approx 0.05$–0.29 for flipped-classroom and problem-based formats) to large ($d \approx 0.7$–1.9 for inquiry training), with cooperative and general active-learning approaches occupying a moderate middle band ($d \approx 0.47$–0.54). The review identifies four recurring mechanisms—active engagement, constructivist cognitive processing, structured feedback, and metacognitive reflection—that explain effectiveness across otherwise dissimilar models, while implementation fidelity, intervention duration, comparison-group rigor, and learner educational level emerge as the principal moderators of observed magnitude. A persistent gap concerns higher education specifically: most primary evidence, particularly for inquiry training, derives from school-level populations, leaving conclusions about undergraduate and graduate contexts comparatively tentative. The review concludes that no single model is universally superior; effectiveness is contingent on alignment between model, discipline, duration, and learner readiness, and it proposes a synthesized framework to guide model selection in higher education practice.

Keywords: Models Of Teaching; Inquiry Training; Active Learning; Cooperative Learning; Flipped Classroom; Problem-Based Learning; Higher Education; Learner Achievement

1. Introduction

The choice of an instructional model shapes, more than almost any other single decision an educator makes, whether students in a course leave it able to merely recall content or able to reason with it. Since Joyce, Weil, and Calhoun formalized the idea that teaching could be organized into discrete, replicable "models"—structured blueprints combining a theoretical rationale, a sequence of phases, and a specified role for the teacher and the learner—researchers have accumulated a large but fragmented literature evaluating how well particular models perform against conventional, lecture-centered instruction [11]. Inquiry training, active learning, cooperative learning, the flipped classroom, and problem-based learning are among the most extensively studied of these models, each grounded in a version of constructivist theory that treats the learner as an active constructor of knowledge rather than a passive recipient of it.

Despite decades of empirical attention, three problems continue to limit the practical usefulness of this literature for higher education. First, most meta-analyses evaluate a single model in isolation, making it difficult for practitioners to judge relative effectiveness when choosing among competing approaches for a given course. Second, evidence specific to undergraduate and graduate populations is thinner than the overall volume of published research suggests, since much of the underlying primary literature was conducted in secondary or middle-school settings and only later generalized upward. Third, reported effect sizes vary so widely—from negligible to very large—that without a comparative frame, readers cannot easily distinguish genuine differences in model efficacy from differences in study design, intervention duration, or the quality of the comparison condition.

This review addresses these problems by synthesizing effect-size evidence for five prominent teaching models, with particular attention to a recent evidence synthesis on the inquiry training model in higher education that forms the empirical anchor of the present analysis [1–10]. The review pursues three aims: to compare the magnitude of effects reported for each model on learner achievement and higher-order cognitive skills; to identify mechanisms that recur across models despite their procedural differences; and to specify the contextual and methodological factors that moderate effectiveness, thereby offering higher education instructors and instructional designers an evidence-based basis for model selection rather than adoption driven by trend or institutional preference.

2. Conceptualizing Models of Teaching

A model of teaching, in the sense used throughout this review, is more than a technique or a classroom activity; it is a coherent instructional design comprising a syntax (sequence of phases), a social system (roles and relationships between instructor and learners), principles of reaction (how the instructor responds to student input), a support system (materials, technology, and environment), and an intended instructional and nurturant effect [11]. This definitional precision matters for a comparative review because it distinguishes, for instance, the inquiry training model—a structured sequence of confrontation, data gathering, experimentation, and explanation—from the broader family of "active learning" strategies, which is better understood as an umbrella term for any approach that engages students in activities beyond passively listening to a lecture [17].

Nearly all of the models examined here trace their theoretical lineage to constructivism, and several explicitly cite Dewey's pragmatist view that learning proceeds through structured experience and reflection [1]. What differentiates the models operationally is less their underlying philosophy than their syntax: inquiry training foregrounds hypothesis generation and evidence-based argumentation; cooperative learning foregrounds positive interdependence among peers; the flipped classroom foregrounds the relocation of direct instruction outside class time so that class time itself can be devoted to application; and problem-based learning foregrounds the presentation of an authentic, ill-structured problem as the point of entry into new content. Because these models differ in syntax while sharing a constructivist rationale, comparing their effect sizes offers a natural test of which structural features of active, learner-centered instruction contribute most reliably to achievement gains.

3. Review Methodology

This review adopts a narrative-synthesis approach appropriate for integrating heterogeneous meta-analytic and primary evidence across five distinct instructional models. The empirical core for the inquiry training model draws on a systematic evidence map of ten sources—three meta-analyses or systematic reviews and seven primary empirical studies—retrieved through a semantic search of more than 138 million academic records and screened against explicit criteria requiring a higher education or comparable population, an inquiry-based intervention, a quantitative achievement outcome, a comparison condition, and peer-reviewed or institutionally archived publication [1–10]. To situate these findings comparatively, this review additionally incorporates landmark meta-analyses and systematic reviews of active learning in STEM higher education [12], cooperative learning methods [15], the flipped classroom in higher education and engineering contexts [13, 14], and problem-based learning as synthesized within Hattie's meta-meta-analytic barometer of educational influences [16]. Sources were selected for inclusion where they reported a quantifiable effect size (Cohen's d, Hedges' g, or partial eta-squared) on academic achievement or a closely related cognitive outcome, permitting a common metric for cross-model comparison notwithstanding differences in original study design.

4. The Inquiry Training Model: Evidence from Meta-Analyses and Primary Studies

Inquiry training demonstrates some of the largest and most consistently positive effects among the models reviewed here, though the evidence base is weighted more heavily toward school-level than higher education contexts. Across three meta-analyses, aggregate effect sizes on academic achievement ranged from a moderate-to-large 0.688, based on 27 studies, to as high as 1.90 for critical thinking outcomes specifically [1–3]. The Aktamış meta-analysis of nineteen studies reported a large effect on academic achievement ($d = 1.029$), a medium effect on science process skills ($d = 0.742$), and a smaller but still meaningful effect on attitudes toward science ($d = 0.558$), a gradient suggesting that inquiry training influences knowledge acquisition most strongly and affective outcomes more modestly [2]. Primary studies corroborate this pattern with concrete, classroom-level figures: one quasi-experimental study reported achievement scores rising from 53.44 to 80.0 alongside learning completion rates climbing from 12.5% to 87.5% after two instructional cycles [5], and another reported an exceptionally large partial eta-squared of .984, although the authors themselves cautioned that this figure may reflect ceiling effects and limited within-group variability in a small, single-course sample rather than a true population parameter [4].

A critical limitation constrains the direct applicability of this evidence to higher education: only two of the ten reviewed sources examined undergraduate populations explicitly [4, 7], and a further study examined graduate teaching assistants rather than undergraduate learners directly, finding that inquiry-pedagogy training improved teaching effectiveness (partial $\eta^2 = 0.51$, $p = .002$) and downstream student learning outcomes measured against Bloom's revised taxonomy [8]. The remaining sources drew from middle-school populations or did not specify educational level at all [1–3, 6, 9, 10], and one systematic review explicitly flagged this middle-school concentration as a limitation warranting further higher education research [5]. Adding further nuance, one study found that an Advance Organiser Model produced significantly higher learning outcomes and retention than the Inquiry Training Model in a physical science teacher-training context, indicating that inquiry approaches are not universally superior even within closely related constructivist alternatives [9]. Taken together, the inquiry training literature supports a directional conclusion—the model reliably enhances achievement and higher-order cognitive skills such as critical thinking, problem-solving, and scientific reasoning—while leaving the precise magnitude of that benefit for adult learners in higher education comparatively under-determined.

5. Comparative Effectiveness of Other Prominent Teaching Models

Placing inquiry training alongside other well-studied models clarifies where it sits within the broader landscape of instructional effectiveness (Figure 1). The most directly comparable large-scale synthesis is Freeman and colleagues' meta-analysis of 225 controlled studies comparing active learning with traditional lecturing across undergraduate science, technology, engineering, and mathematics courses, which found that examination and concept-inventory performance improved by an average of 0.47 standard deviations under active learning, and that students under traditional lecturing were roughly 1.5 times more likely to fail [12]. Although smaller in magnitude than the upper range reported for inquiry training, this effect is drawn from the largest and most methodologically rigorous meta-analysis of undergraduate STEM instruction published to date, and its robustness across class sizes and disciplines lends it particular practical weight for higher education decision-making [12].

Cooperative learning occupies a similar moderate band. A meta-analysis of 164 studies encompassing eight distinct cooperative learning methods found that every method produced a statistically significant positive effect on achievement, with weighted mean effect sizes in the range of 0.51 to 0.54 when cooperative structures were compared with individualistic or competitive learning arrangements [15]. This consistency across eight procedurally distinct cooperative techniques suggests that the underlying ingredient—structured positive interdependence among peers—rather than any single implementation detail, drives the achievement gain.

The flipped classroom presents a more modest and more heterogeneous picture. A meta-analysis of 114 studies comparing flipped and non-flipped instruction in secondary and postsecondary settings found only a small overall effect on learning outcomes and no significant effect on student satisfaction, alongside considerable heterogeneity between studies [13]. Within a single discipline, however, effects appear stronger: a ten-year meta-analysis of flipped classrooms in engineering education reported a significant overall effect in favor of the flipped format (Hedges' $g = 0.289$, 95% CI [0.165, 0.414]) [14]. The discrepancy between the general and the discipline-specific estimate illustrates a recurring theme in this review: aggregated effect sizes can mask important variation tied to subject matter and implementation quality.

Problem-based learning, by contrast, shows the smallest effects among the models reviewed. Hattie's synthesis of several hundred meta-analyses placed problem-based learning at a low effect size of approximately 0.15, corresponding to roughly eleven percent of students showing an achievement gain attributable to the intervention [16]. This comparatively weak showing, set against the far larger effects attributed to structured, teacher-guided inquiry within the same meta-meta-analytic tradition, has been interpreted as evidence that unstructured, ill-defined problem scenarios may impose a cognitive load on novice learners that offsets the motivational benefits of authentic problem framing, whereas more scaffolded inquiry sequences do not [16].

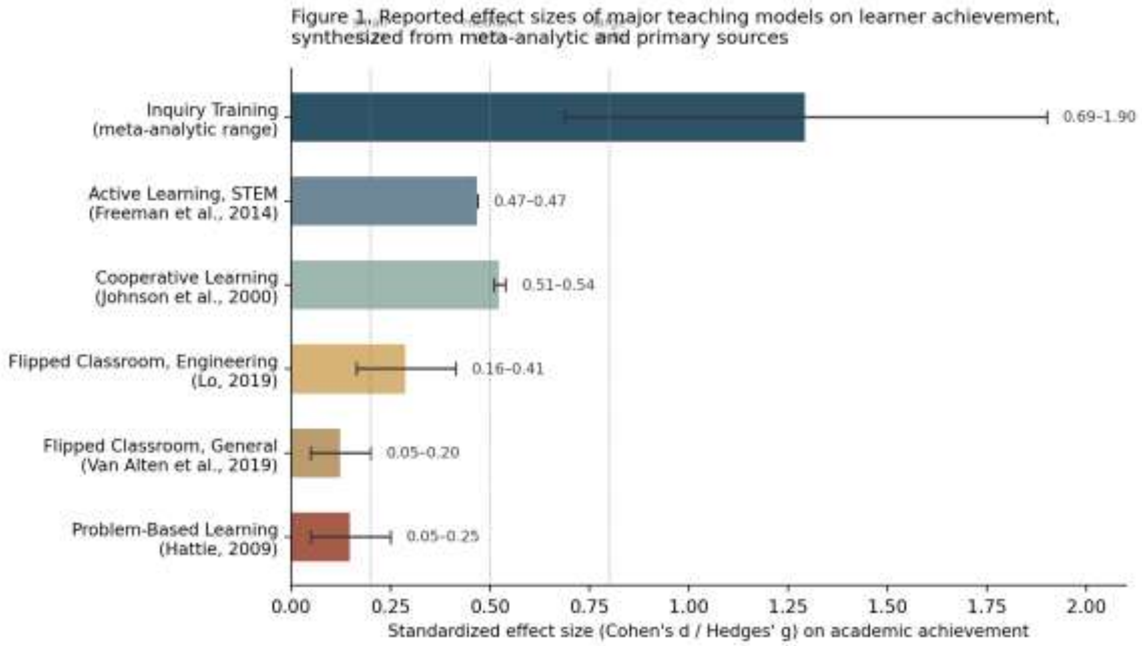

Figure 1. Reported effect sizes of five teaching models on learner achievement, synthesized from meta-analytic and primary sources. Dotted reference lines mark Cohen's conventional thresholds for small, medium, and large effects.

6. Mechanisms of Effectiveness Across Models

Despite marked differences in syntax and in observed effect size, the models reviewed here converge on a small set of explanatory mechanisms (Figure 2). The most frequently cited is active engagement: the shift from passive reception of content to student-directed hypothesis development, data analysis, and argumentation [4, 5]. This mechanism is explicit in inquiry training, where students construct and test explanations for observed phenomena [5], and it is functionally identical to the rationale underlying active learning strategies more broadly, whose defining feature is that students are doing something with content rather than merely absorbing it [17].

A second mechanism is structured, staged cognitive processing. Inquiry training's explicit sequence of questioning, hypothesis formation, data collection, and conclusion drawing mirrors the phase structure that distinguishes effective cooperative learning techniques (which similarly stage individual accountability, group interaction, and joint evaluation) from unstructured problem-based scenarios that provide comparatively little scaffolding for novice learners [5, 15, 16]. The comparatively low effect size reported for problem-based learning, relative to inquiry training's more tightly staged sequence, is consistent with the interpretation that structure itself—not merely learner activity—contributes materially to achievement gains.

Third, several studies identify metacognitive development as a distinct pathway, separate from direct content mastery: students are prompted to reflect on and regulate their own thinking processes, a mechanism explicitly named in inquiry training research and implicit in the self-paced, responsibility-shifting design of the flipped classroom, where students must manage their own engagement with instructional material before class [5, 13]. Finally, technology integration recurs as a mediating rather than a primary mechanism: studies incorporating simulations, learning-management platforms, or concept-mapping tools alongside inquiry or flipped formats report enhanced engagement, though the evidence available cannot establish whether technology is a necessary ingredient or simply an amplifier of gains achievable through non-digital versions of the same model [1, 5].

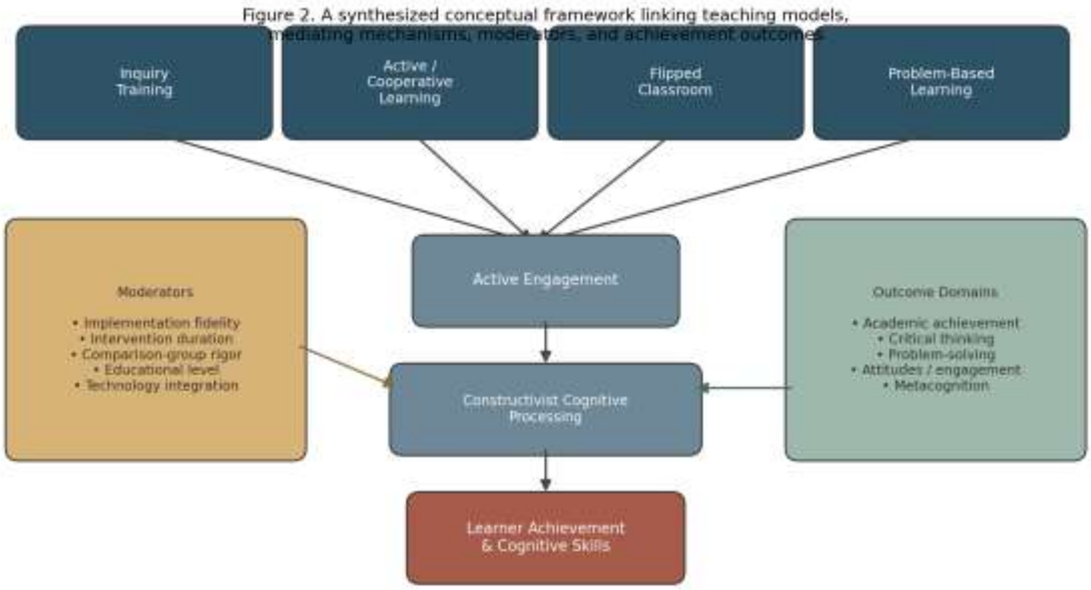

Figure 2. A synthesized conceptual framework linking teaching models, mediating mechanisms, moderating conditions, and achievement outcome domains.

7. Moderating Factors and Contextual Boundaries

The wide range of effect sizes reported across and within models is not evidence of contradictory findings so much as evidence that effectiveness is contingent on identifiable moderators. Intervention duration is among the most consistently documented: a meta-analysis of inquiry-based instruction found that seven- to eight-week interventions produced a substantially larger effect (ES = 1.47) than nine- to eighteen-week programs (ES = 0.61), suggesting a threshold beyond which extended implementation yields diminishing returns, plausibly through novelty wearing off or curricular constraints limiting deeper engagement in longer programs [1].

Comparison-group rigor is a second major moderator. Studies that characterized their control condition only as generic "traditional" or "conventional" instruction risk inflating apparent effects if that condition represents unusually weak teaching rather than competent conventional practice, whereas studies with tightly specified comparison conditions and statistical controls for baseline differences, such as analysis of covariance on pre-test scores, produce more defensible estimates [4]. The design comparing inquiry-pedagogy training against general "best practices" training for teaching assistants is a particularly strong example, since it isolated inquiry-specific elements from generic teaching-quality improvements and still found a significant advantage for inquiry training [8].

Educational level constitutes a third and, for this review's purposes, especially consequential moderator. Most of the primary evidence underlying inquiry training's largest reported effects originates in middle-school populations, and higher education-specific findings remain comparatively sparse [5, 6]. Because undergraduate and graduate learners typically bring greater prior knowledge, more developed metacognitive skill, and different motivational profiles than younger learners, effect sizes calibrated on school-age samples should be generalized to higher education with caution, even though the limited higher-education-specific evidence available points in a similarly positive direction [4, 7, 8]. Finally, implementation fidelity—the extent to which an inquiry or active learning activity is planned and executed as intended—was identified as a decisive factor independent of which model was nominally in use, reinforcing that the label attached to an instructional approach matters less than the quality of its execution [1].

8. Implications for Higher Education Practice

For instructors and instructional designers in higher education, three practical implications follow from this comparative synthesis. First, model selection should be guided by disciplinary and durational fit rather than by a presumption that any one constructivist model is uniformly superior: active learning's STEM-wide, methodologically robust effect of 0.47 standard deviations makes it a defensible default for lecture-heavy undergraduate courses, while inquiry training's larger but less consistently higher-education-tested effects may be most appropriate where instructors can commit to a well-scaffolded, moderate-duration (seven- to eight-week) implementation [1, 12]. Second, structure and scaffolding should not be sacrificed in the pursuit of authenticity: the comparatively weak performance of unscaffolded problem-based learning relative to more tightly sequenced inquiry and cooperative formats suggests that presenting students with an authentic problem is insufficient on its own, and that explicit staging of investigation, feedback, and reflection remains necessary even within learner-centered designs [15, 16]. Third, given the moderate-to-strong dependence of effectiveness on implementation fidelity and duration, institutions adopting any of these models should invest as much in faculty development and structured planning time as in the model's conceptual adoption itself [1].

9. Limitations of the Evidence Base and Future Directions

This review inherits the limitations of the underlying primary literature. The inquiry training evidence base in particular includes several sources available only as abstracts, restricting depth of information about implementation fidelity and measurement instruments in exactly the cases where such detail would be most useful [2, 6, 9, 10]. Sample sizes in several primary studies were small, ranging from thirty to sixty participants, limiting statistical power and the confidence with which findings generalize beyond the specific course or institution studied [4, 9]. Cross-model comparison is further complicated by heterogeneity in outcome measures, since achievement was operationalized variably as standardized test scores, course grades, or researcher-designed assessments, and by the fact that meta-analyses for different models were conducted using different statistical models and inclusion criteria [1–3, 12, 13, 15]. Future research would benefit from head-to-head experimental comparisons of two or more models within the same higher education course and discipline, longer-term follow-up to determine whether achievement gains persist beyond the immediate post-intervention assessment, and a more deliberate research agenda targeting undergraduate and graduate populations specifically.

10. Conclusion

Across five well-researched teaching models, the evidence converges on a qualified but genuinely encouraging conclusion: learner-centered, constructivist models of teaching outperform traditional, lecture-centered instruction on academic achievement and higher-order cognitive skills, though the size of that advantage varies considerably—from a modest 0.15 to 0.29 for problem-based learning and general flipped-classroom formats, through a consistent moderate band of 0.47 to 0.54 for active and cooperative learning, up to a large 0.7 to 1.9 for inquiry training. This variation is neither arbitrary nor evidence against the value of constructivist instruction; rather, it reflects differences in structural scaffolding, implementation fidelity, intervention duration, and the rigor of the comparison condition against which each model was tested. For higher education specifically, the evidence base remains thinner than its overall volume suggests, particularly for inquiry training, where undergraduate- and graduate-specific studies are still the exception rather than the rule. Institutions and instructors seeking to adopt any of these models should therefore treat model selection as a contingent design decision—sensitive to discipline, duration, and learner readiness—rather than as a choice between a single superior model and an inferior status quo.

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