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INQUIRY BASED LEARNING VERSUS TRADITIONAL TEACHING: IMPACT ON SCIENCE ACHIEVEMENT OF COLLEGE YOUTH

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Table with 2 columns: Keywords and Abstract. Keywords include Blended learning, Inquiry based learning, Science education, Educational Tech, Personalized learning. Abstract discusses higher education science teaching shifts.



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	ways in science classrooms.
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## **Introduction**

Learning science helps students think clearly, come up with new ideas, solve problems more easily. At colleges offering degrees - particularly for young people shifting out of school into advanced studies - the way science is taught shapes how well they do academically and understand scientific concepts. Usually, teaching science leans on one-way communication: instructors talk, students listen, write down facts, repeat them later. Even though this standard method spreads knowledge quickly when time is tight, experts now doubt whether it truly supports strong grasp of key ideas or logical analysis in science.

Worries about traditional teaching have pushed educators toward methods like inquiry-based learning in science classes. This approach thrives on curiosity, hands-on experiments, open questions, shared discovery - ways that pull students into doing rather than just hearing. Rather than sitting through talks, pupils dive into how scientists work, shaping understanding by watching, testing, thinking.

Science makes sense when students dig into it themselves. Because real science means asking questions, classrooms that follow inquiry methods fit naturally. Trying things out, working with numbers, checking guesses - these actions help ideas stick better than memorizing facts ever could. Group work where everyone shares thoughts often leads to deeper understanding. For twenty years now, researchers have looked closely at how this approach shapes student results. What shows up again and again is stronger test scores, sharper thinking about scientific topics, and greater interest in learning more - all seen clearly in teens and college-level students.

Looking at how teens in college-level science classes learn, this article questions whether asking their own questions works better than standard teaching. Findings from past research come together here, showing where hands-on exploration helps - and where it falls short. Thoughtful classroom changes hang on these details. Surprises hide in the results. Learning shifts when students steer the process. Old methods still hold ground, though. What sticks? A mix of trial, error, and careful thought about what happens inside lecture halls.

## **Idea of Inquiry Based Learning**

Curiosity drives the process when learners explore topics by posing their own questions. Instead of receiving facts directly, they dig into issues, hunting for clues and piecing ideas together. This way of working puts students at the heart of discovery. Teachers step back, offering support rather than lectures. Information flows differently here - less top-down, more hands-on. The classroom shifts, becoming less about answers and more about seeking them.



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Scientists look at nature, then build answers using proof - that is what inquiry means, says the National Research Council. Learning through questioning can be tightly guided, with clear steps set by a teacher. Or it might unfold freely, letting learners shape their own questions, their own ways of finding out.

Several instructional models are associated with inquiry-based learning, including:

Guided inquiry learning

Problem-based learning

The 5E instructional model

Discovery learning

Project-based learning

One way schools often teach science lets students explore while still offering help. This mix gives learners room to think but keeps guidance nearby when needed.

Starting off, students meet a science challenge that grabs attention - this kicks things into motion. Next comes hands-on testing where they poke at ideas using real materials instead of just listening. Talking together, they piece together what happened during those tests, shaping meaning bit by bit. Then they stretch those ideas further, fitting them into new situations to see how well they hold up. As a last step, looking back on what stuck, sorting out what makes sense now versus before.

### **Teaching Science the Usual Way**

Most times, one person at the front talks while others sit and listen. Knowledge moves straight from speaker to notebook. Books carry most answers, repetition locks ideas in place. Pupils rarely question - just accept, copy, stay quiet. Tests measure how well a name or date sticks after hours of sitting still.

Even when old-style teaching gets used a lot because it moves fast through required topics, some say it blocks deeper analysis and real-world use. Following step-by-step lab directions without knowing why - common in standard science classes - is what Brickman and team noticed back in 2009. Learning by repetition instead of curiosity tends to grow where these routines stick around.

Even so, classic teaching methods have their strong points. When it comes to handling big groups of students, these approaches help teachers stay on track without losing grip on timing. Uniform lessons flow smoothly under such systems. Lectures can work well when basic facts need passing along. Yet today's colleges are starting to see a gap - science isn't truly learned by just sitting and absorbing words.



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### **Theoretical Basics of Learning Through Questions**

Learning by asking questions works well, according to various ideas about education. Built on the idea that people make sense of things through experience, it takes shape when students engage directly with their surroundings instead of just receiving facts. This approach grows stronger because thinkers believe understanding comes from doing, touching, exploring - never just listening.

Learning grows when kids explore on their own - Piaget stressed that. Vygotsky saw it differently; he believed talking, working together, and guidance shape understanding. When learners ask questions, test ideas, then think back, they follow both paths at once.

Learning happens best when people do things first, then think about what happened - David Kolb showed this idea clearly. Instead of just hearing facts, trying something real comes before understanding it deeply. Labs built on asking questions let learners touch, test, and see science up close. Reflection follows doing, making knowledge stick more than lectures ever could.

Starting with how people think, working things out by doing leads to sharper minds compared to just hearing facts. Question-driven classrooms push students to connect ideas, break down problems, then judge solutions - this builds stronger science thinking along with better grades.

### **Examining Research Based on Observations and Experiments**

Finding things out for yourself seems to help students learn science better, at least that is what some research into undergrads and teens suggests. A number of investigations have looked at how hands-on exploring affects test results in science classes. Instead of just listening, doing experiments might boost understanding - evidence from young adults' points that way. When learners ask questions and search for answers, performance can rise, according to several classroom studies. Curiosity-driven methods appear tied to stronger outcomes, especially among younger scholars.

Out of nowhere, Nybo and May dropped into an undergrad exercise physiology class back in 2015, running a quasi-experiment that leaned on real classroom chaos rather than tight lab controls. Inquiry-driven teaching sparked sharper test results when measured against old-school lecturing. Those navigating their own questions pulled down a 45% average - no small gap from the lecture crowd stuck at 31%. While one bunch stayed passive, 65% of the explorers branched off, chasing extra readings beyond requirements. Meanwhile, just 2% in the standard setup bothered to look up anything outside assigned material.

Fating and team in 2024 looked at how well inquiry-based teaching worked for microbiology classes with med undergrads in India. Their findings showed learners in the inquiry method did much better in their studies. Those using guided exploration pulled average marks from 14.0 to 14.6 on a 20-point scale. In contrast, peers taught through standard lectures landed between 8.94 and 9.48.



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Engagement climbed too - students felt more drawn in, stayed focused longer, enjoyed lessons more when they could question and probe ideas themselves.

A team led by Brickman in 2009 looked at around 1,300 college students taking biology across the U.S. Instead of lectures guiding every step, hands-on investigative labs helped learners grasp scientific ideas better. Those who worked through open-ended experiments built stronger analysis abilities than peers following fixed routines. Science understanding grew noticeably - by roughly four percentage points - among those in exploratory settings. Yet a portion found these tasks harder, saying they took too much effort and stretched out over long stretches.

Over two semesters, Pei explored how well the 5E method worked for second-year college learners. Results showed a clear edge for those using inquiry - scores rose over sixteen points above peers in standard classes. Instead of just listening, these students practiced making sense of evidence and building reasoned responses. A closer look found stronger reasoning grew alongside hands-on investigation tasks.

Curiosity led the way when Özgür teamed up with Yilmaz back in 2017 to watch how bright learners tackled acids and bases through hands-on exploration. Instead of lectures, these students dug into questions on their own - turns out that shift sparked deeper grasp of ideas, along with a stronger drive to keep going.

### **Evidence from Meta-Analyses**

Putting together findings from many studies makes meta-analyses more convincing. Though single research papers show one piece, combining them reveals a broader picture through pooled data.

Looking at 55 different research efforts from schools and colleges, Uluçınar (2023) pulled together results across science subjects. Results showed students learned more when using hands-on exploration methods - effect strength was high (Hedges's  $g = 1.009$ ). Instead of lectures, asking questions and testing ideas led to stronger outcomes in topics like physics, plus biology. Even in chemistry, gains stood out clearly under this approach.

Surprisingly, differences popped up depending on education level. Those in middle school showed the biggest improvements - high schoolers came next, then college students. It seems this kind of learning hits harder in teenage years, just when thinking skills start reaching deeper levels.

A single look at the findings from Aktamış, Hiğde, and Özden in 2017 shows strong gains when students learn through questioning methods - academic results jumped noticeably. Science abilities grew too, though less sharply than test scores. Feelings about science shifted slightly upward, thanks to how lessons were shaped around exploration instead of answers.

Looking at everything together, it seems students learn well through questioning methods no matter the science subject. What stands out is how this approach builds skills that go past just test results.



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### **Effects on School Performance**

Still, grades and test scores matter a lot when judging how well schools work. In nearly every study checked, students digging into topics themselves did better than those sitting through regular lessons.

Because of how they work, inquiry-based tasks help students grasp ideas more fully. Instead of just remembering separate pieces of information, people dive into real science experiences. By trying things out and talking through results, thinking links to doing. This blend sticks around in memory much longer.

When students ask questions, they start noticing how they think. Their ideas shift when faced with new proof. Mistakes become clear during these moments of pause. Clarity grows because thoughts are tested against facts. Better test results often follow such honest reviews.

When kids ask questions together, thinking grows stronger through teamwork. Talking in small circles helps them shape thoughts out loud while listening closely. One voice builds on another when explanations take turns unfolding slowly. Learning how minds connect happens best during shared moments of curiosity.

It turns out students who explore questions on their own pick up key science abilities - watching closely, forming guesses, testing ideas, making sense of results, tackling challenges. Because of this hands-on approach, grades in science often go up. Skills built through curiosity tend to stick around during exams.

### **Student Engagement and Motivation**

What stands out about inquiry-based learning? Learners lean in, pay closer attention. Lectures, on the flip side, can leave students zoning out, mentally checked away from the lesson. When questions guide the classroom instead of notes being copied, energy shifts - curiosity sparks movement, hands raise without prompting, ideas flow because interest pulls them along.

When students looked into questions on their own, they ended up spending more hours getting ready for lessons. Curiosity sparked deeper attention during science discussions. Working together in small groups made them respond faster, engage more often. Time moved slower for some because they were so caught up in testing ideas. Their energy shifted once hands-on work replaced quiet listening. Exploring unknowns pulled stronger reactions than usual classroom routines.

Curiosity drives the way kids engage when they choose their own path through a topic. Instead of repeating facts just to pass tests, they dig into issues that matter to them personally. What unfolds is learning shaped by personal interest, not outside pressure. Questions become starting points, not assignments handed down. Ownership grows naturally when students follow what puzzles them. Real problems pull attention better than abstract tasks ever could.



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At first, a few learners see inquiry-based tasks as tough. According to Brickman and team in 2009, many thought lab work through questioning felt like an overload. Shifting from sitting back during lessons to digging in themselves takes getting used to - teachers play a key role here.

### **Challenges of Practicing Inquiry Based Learning**

Picking up knowledge through questions isn't always smooth inside college classrooms. Time constraint is a big hurdle. Running inquiry tasks usually means long lab periods, conversations in small groups, or working on projects together. Teachers can find it tough to cover everything needed when class hours are tight.

When rooms are packed, keeping every learner involved gets tricky. Big classes make it hard to give focused attention. Smaller teams work better for hands-on exploration. Watchful guidance matters most when curiosity drives the lesson.

When teachers feel unsure, it shows in how they run inquiry lessons. Those who learned teaching through lectures often hesitate during open-ended tasks. Support like workshops helps them shift gears smoothly. Without guidance tailored to hands-on learning, many stay stuck in old routines.

Getting materials matters a lot. When students explore questions on their own, they might need lab gear, software, online connections, or rooms that allow movement. Schools without strong setups could struggle to make this kind of teaching work well.

When tests focus only on memorized facts, they often miss deeper abilities like problem solving or logical analysis. Because of this mismatch, grading methods should reflect how students actually learn through exploration. What gets measured tends to shape what gets taught - so tools used to judge progress ought to support thoughtful investigation instead. Only then does evaluation truly match the way understanding grows.

### **Blended Learning Meets Inquiry-Based Science**

Lately, mixing online tools with classroom teaching has helped students explore science through hands-on questions more easily. This mix brings together live lessons and tech resources, creating space for active, adaptable learning moments that shift with student needs.

Screens flash with models that let learners poke at ideas after school ends. When labs live inside computers, complicated stuff starts making sense. Some tools show hidden patterns through moving images instead of static pages. Working together happens without sharing air, just screens linked across distances. Experiments run without glassware, yet results still surprise. These setups respond instantly when questions shift direction. Ideas grow not just from books but clicks, taps, trial. Learning stretches into corners textbooks cannot reach.



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Blended learning, says Garrison and Vaughan (2008), encourages more thoughtful participation when face-to-face discussions meet web-based discovery. Science teaching benefits in particular - where seeing concepts clearly, testing ideas hands-on, along with group interpretation matters most.

Young adults in college usually feel at ease using digital tools. Because of this, mixing online methods with question-driven teaching might boost engagement and reach, also helping students learn on their own. Still, how well it works depends on the way tasks connect to real curiosity.

### **Educational Implications**

Science teaching at degree colleges could shift because of what this review uncovered. A change might ripple through classrooms after these results came in. What turned up here may nudge how labs and lectures evolve down the road. These outcomes sit heavy when thinking about future coursework. Lessons next term could look different thanks to this analysis.

Starting slow helps. Schools might ease into using more question-driven lessons instead of sticking only to lectures. Even if old-school teaching has its place, methods built around exploration tend to build stronger grasp of ideas along with sharper thinking in science. The real gain shows up when students start working through problems themselves.

For one thing, teacher prep courses need to focus more on hands-on learning methods. Helping instructors create lab activities, guide student talks, because better teaching comes from practice. While working through these skills, educators also learn how to measure what students discover during investigations.

Curriculum designers might begin weaving inquiry tasks directly into science courses. Instead of only confirming known results, lab work could shift - focusing on puzzles that demand exploration. What if each experiment posed a question rather than just testing a rule? Learning often deepens when students chase answers, not steps. Problem-driven labs tend to spark more curiosity than scripted ones. Science feels alive once it stops being predictable.

Imagine classrooms built for questions, not just answers - spaces where walls move, labs hum with real tools, desks shift like puzzle pieces. When schools offer gear that works, students touch science instead of memorizing it. Think screens that respond, microscopes that zoom, Wi-Fi strong enough to carry big ideas. Stuff breaks? Fixing it becomes part of the lesson. Learning thrives when the room itself invites testing, failing, trying again.

Last of all, tests ought to measure deep understanding instead of just memory recall. Real-life tasks like projects, talks, personal writings, or hands-on experiments fit better with learning through questioning.

### **Conclusion**



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Looking at today's research, it turns out teens learn science better when they explore questions on their own rather than sit through standard lectures. One after another, studies show learners digging into ideas come away with sharper test results. Deeper grasp of topics appears often in those classrooms where doing takes priority over listening. When lessons focus less on facts by rote and more on figuring things out, performance climbs. What sticks isn't just answers but how to think like a scientist. Students stay tuned in longer if they are testing guesses instead of copying notes.

Even though standard teaching still works well for basics, hands-on investigation lets students dig deep through questioning instead of just listening. Curiosity grows when learners test ideas themselves rather than follow set steps. Thinking like a scientist becomes natural after repeated chances to wonder, discuss, and rethink. Confidence builds alongside knowledge because mistakes turn into clues. Working together on real questions shapes both understanding and persistence. Skills gained this way stick far beyond tests.

Even so, making inquiry-based learning work well means putting thought into design, preparing teachers properly, backing schools with needed help, having fair ways to measure progress. Problems around scheduling, materials, handling student groups can ease when digital tools mix with strong policy guidance.

Looking back, asking questions drives new ways of teaching science at colleges and universities. Done well, this method boosts how much teens learn while building their thinking skills - helping them get ready for careers rooted in discovery and problem solving.

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