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Using Data Analysis to Understand Why Ineffective Teaching Practices Persist Undergraduate Education

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ABSTRACT

Despite existing evidence that more efficient teaching methods exist, United States undergraduate education continues to overwhelmingly use traditional methods which have been proven to have worse student outcomes than alternative methods. This study investigates why these practices persist using a literature review of peer-reviewed publications on pedagogy and a keyword analysis of syllabus data from the Open Syllabus Project. From the literature review, it was found that active learning methods outperform lecture on outcome measures such as pass rates and test results. Simultaneously, lectures were found to produce higher failure rates and lower retention rates. From the keyword analysis, it was found that from 2019-2026, lecture remained dominant overall, though its usage did decline in 2025-2026. The methods that replaced lectures tended to be minimally effective rather than effective. Barriers to the adoption of active learning methods were found to exist at both faculty and institutional levels, including a lack of training, time constraints, and resistance to unfamiliar methods. The most effective solutions are those that target change on the department level, create faculty learning communities, and change teaching incentives.

Keywords: *undergraduate education, teaching methods, active learning, lecture, syllabus analysis, pedagogy, grade inflation, flipped classroom, spaced repetition, evidence-based teaching, faculty barriers, higher education reform*

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INTRODUCTION**The Problem: Education Method Effectiveness Inconsistency**

Over the last two decades, and in particular since the Covid pandemic, United States education has been on the decline. Test scores in math and English have declined to their lowest level in decades, with reading and math scores in 2023 being 7 and 14 points lower than 2012 respectively (NAEP Mathematics Grade 12, 2024; NAEP Reading Grade 12, 2024). Clearly, the way that education was handled in the past is not holding up in the modern day, something which can be attributed to a large degree to teaching methods that are now known to be ineffective persisting in classrooms. For example, it has been known since as far back as 2014 that traditional lecturing, specifically in math environments, has students 1.5 times more likely to fail than an active environment (Freeman et al., 2014). Despite these issues, many schools are resistant to change and continue teaching using standard, unhelpful methods (Apkarian et al., 2021).

These results seem to be connected to the fact that education was stunted after the pandemic, decreasing average student knowledge of subjects. Given that different teaching methods have different efficacies depending on how comfortable a student is with the subject matter, it seems that while in the past these methods would work with most students, as general familiarity with content has declined, the efficacy too has declined to work with a smaller group of students. With all this in mind, now is a better time than ever before to change the way teaching has been handled in order to revitalize the education system for the current generation of students.

The Illusion of Academic Progress

In order to adjust to the lower level of subject matter knowledge that students now have, schools have two approaches: adapt methods and try to meet the students where they are or raise grades and allow students to pass despite not knowing the material. The second option is often referred to as grade inflation, and though most schools do not frame it this way, it achieves the same result and makes the problem of declining aptitude appear to not be statistically significant. In 2025, Harvard reported that 60.2% of all grades were As while in 2005, only 24% were (Report on Grading, 2022). This effect also exists in high school, with the ACT determining that grade inflation was to blame for the increase in average high school GPA by 0.19 grade points from 2010 to 2021 (Home, 2022).

When grade inflation occurs and students appear more qualified than they truly are, two major consequences take place. First, the students that truly care about learning are not given the chance to learn. Lower intensity education means fewer difficult concepts covered and thus a lower level of understanding of

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whatever subject it was that the student wanted to learn. Killing curiosity impedes innovation and fundamental human desires. Secondly, workers with less education enter the workforce. This can mean lower quality work, though whether that actually occurs remains to be seen; the post-Covid generation is the one that has been affected by lower-quality education the most, and these students have not yet entered the workforce. By fixing the way that education is done, these problems can hopefully be prevented.

A Call for Change

With all this in mind, it is clear that American education must begin using more effective methods. Better methods such as active teaching, flipped classrooms, and spaced repetition are not being used because of barriers such as a lack of resources, but this cannot stay an issue forever (Apkarian et al., 2021; Cleary & Robinson, 2025; Freeman et al., 2014). It is necessary that the ineffective methods of pedagogy are addressed so that the overall knowledge of the populace can increase and that test scores and other measurements accurately represent the reality of education. Now, more than ever, as misinformation runs rampant and society's need for critical thinkers continues to grow, it is crucial for students to receive the education needed to be able to decipher fact from fiction and impact their communities.

METHODS**Scope**

This study involved both a literature review and an analysis of syllabus data. The literature review served as the basis for which ideas and methods to track while the data analysis provided a basis for the usage of these methods in the US in undergraduate institutions. Together, these methods provide a way to find the truth between what evidence on teaching methods suggests should be happening and what actually occurs.

Literature Review

The following databases were used to search for peer-reviewed publications on educational method effectiveness: EIRC (Education Resources Information Center), Google Scholar, PubMed, and JSTOR. Key terms used included education method effectiveness, education method persistence, active learning, learning styles, flipped classroom, spaced repetition, problem-based learning, cooperative learning, evidence-based teaching, and faculty pedagogical change. Inclusion criteria included articles written in the English language, those with the United States as its geographic context, with undergraduates as the population target, education taking place at public and private institutions in traditional, academic year timelines (i.e. not study abroad or summer-only programs), and those published after 2000. Exclusion criteria were papers that focused on special

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education programs, non-US universities, and education programs directed at special populations (i.e. older adults, non-traditional learners, foreign learners, English-as-second-language learners), or those before 2000. There were some exceptions to the 2000 barrier, specifically foundational meta-analyses about the field, included due their historical importance. There were also exceptions to the non-US exclusion criterion when the paper was deemed to display results independent of the environment, such as teacher psychology. Articles were collected until information saturation seemed to be reached.

Datasets and University Syllabi Databases

This study also drew upon publicly available educational datasets and syllabi repositories to improve quality of data and gain an understanding of the true state of education. Syllabi are particularly valuable as they contain a professor's actual plan for a course, with the methods they plan to use being particularly important. While syllabi are often not followed to a tee, they present the most comprehensive record of institutional practices that are available at scale.

There are several trends across the repositories. There is a large disparity with accessibility, with datasets like MIT OCW being largely open to the public whereas NSSE data, for example, was much harder to access. Scale greatly differed too, with the Open Syllabus Project containing millions of syllabi and MIT OCW having as low as 2,500 syllabi.

Table 1

Syllabi and course content dataset repositories (online, USA)

Repository / Data Source	Content / Description
MIT OpenCourseWare (OCW)	Course materials: syllabi, lecture notes, assignments, exams, videos, reading lists
UC Irvine OpenCourseWare	Course materials: syllabi, course content (similar to other OCW-style repositories)
University of Texas Syllabi Archive	Course syllabi / curriculum documents (for archived courses)
Harvard School of Public Health syllabi repository	Health-public-policy / public-health course syllabi and related materials
Stanford syllabus portal (many departments)	Course syllabi across multiple departments at Stanford

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National Survey of Student Engagement (NSSE) Data	Campus engagement survey data: student-reported engagement, demographics, time-use, experiences, etc.
Open Syllabus Project (OpenSyllabus.org)	Course syllabi from ~1,500+ colleges/universities; full-text metadata, assigned readings, course fields, institution info, citation metadata, syllabus structure, etc.
Carnegie Mellon Open Learning Initiative	Interactive online courseware, learning objectives, student performance data, educational datasets, etc.

Note. All repositories listed are publicly accessible online sources based in the United States. Accessibility and scale vary significantly across sources. Created by author, 2026.

DATA ANALYSIS

The Open Syllabus Project was selected for analysis as it has the most accessible data out of the repositories listed in Table 1. Due to the limitations from free trial access, the Open Syllabus Project Analytics interface was used to count the number of syllabi containing a certain keyword. These keywords each represented a method; a more comprehensive list of the keywords used for each teaching method is given below. Counts were then calculated as a percentage to determine what fraction of courses within a specific discipline and timeframe used these methods. The selected time frame ranged from 2019-2026.

All computations were performed in Python using the “pandas” library. All figures were generated by the “matplotlib” library. Smoothing was applied to the data.

Effective method keywords: “active learning,” “flipped classroom,” “spaced repetition,” “problem-based learning,” “project-based learning,” “group work.”

Minimally effective methods are low-effort instructional practices, such as discussion, reflection, multimedia, and rote assignments, that are widely used but show limited evidence of consistently improving student learning outcomes, which is further explained in the discussion. Minimally effective method keywords: “discussion,” “reflection,” “multimedia,” “memorization,” “rote learning,” “copying,” “slide-based instruction,” “tutorial,” “exam prep.”

Inefficient method keyword: “lecture.”

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A few issues existed with the keyword search implemented for lecture, mainly that too many results were being accounted for. For example, a class could have “no lectures,” something which would be picked up by the search. Another problem was that certain classes, specifically STEM ones, labelled all classes that were not lab periods as lectures.

A three-step plan was implemented to address these issues. First, all syllabi containing the word “lecture” were counted. Next, the number of syllabi containing negative phrases such as “no lecture” and “lecture-free” were subtracted from the total count. Third, if a syllabus contained phrases such as “lecture/lab” or “credit lecture,” it was also excluded from the count. The final remaining count was labelled as “lecture” on future graphs and is the single purely ineffective method in the study. Though not perfect, this approach provides a close approximation of actual lecture usage.

A last issue that could not be addressed through this search was the fact that syllabi reflect plans from professors, not necessarily that those plans are implemented. The assumption made for this analysis is that, for the most part, stated plans for used research methods were implemented to some degree.

The number of syllabi that contained methods was the sum of syllabi counts for every individual keyword. The effective and ineffective methods were grouped, and the percentage of total syllabi that contained methods that they comprised was plotted against time. Minimally effective was combined with ineffective for the purpose of Figure 1. Next, all three categories were individually compared.

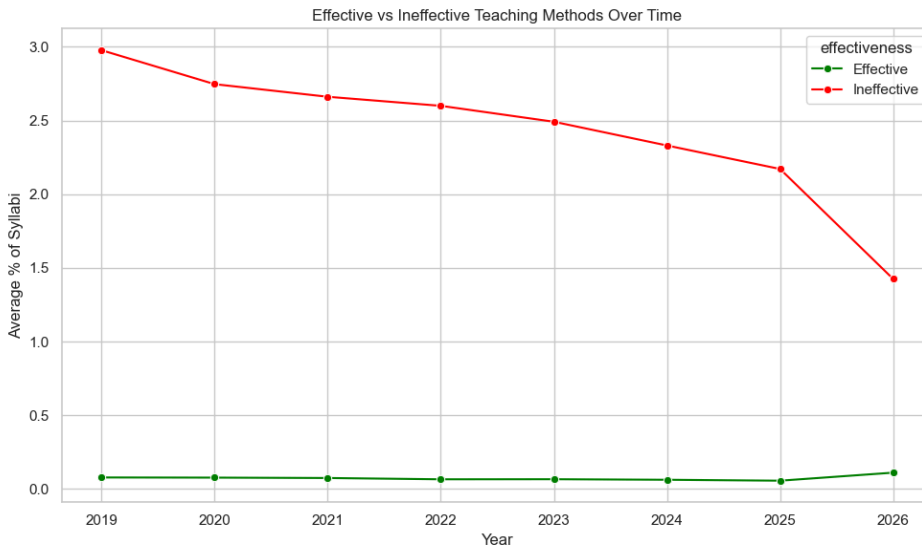
RESULTS

The literature review brought 40 papers from a wide range of journals about education effectiveness which provided information on both the usage and efficacy of teaching methods analyzed. Also present in the literature were analyses of problems resisting change and potential solutions to these problems. When plotted over time, ineffective methods (lecturing) accounted for the vast majority of represented methods in syllabi, though 2025 to 2026 did see a large drop. The first graph shows the percent of syllabi out of total syllabi, while the second and third show percent out of syllabi that have any methods reported. The final graph shows a breakdown of methods between ineffective, minimally effective, and effective. In general, the decline in lecture seems to be accompanied by an increase in minimally effective methods rather than effective ones.

Figure 1

The percent of syllabi using effective versus ineffective methods over time in all syllabi.

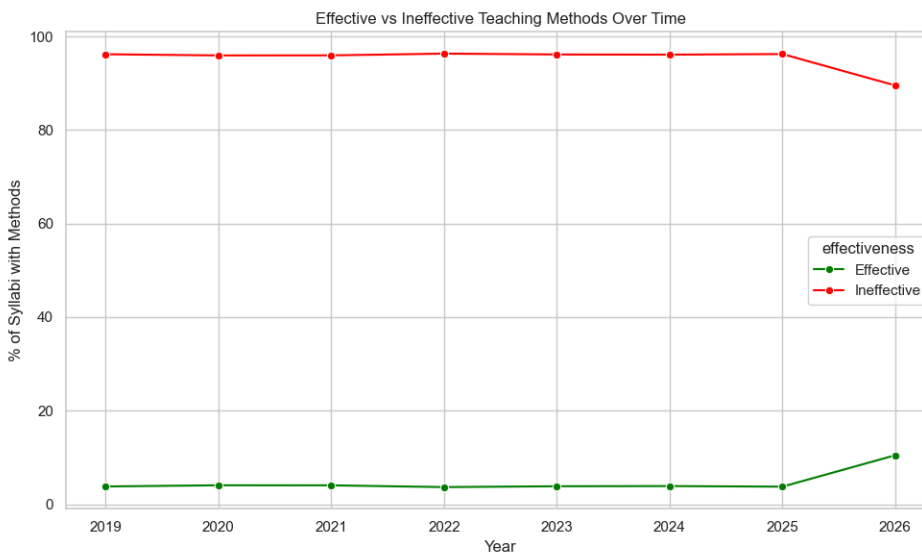
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Note. Effective methods include active learning, flipped classroom, spaced repetition, problem-based learning, project-based learning, and group work. Ineffective and minimally effective methods are combined in this figure. Data sourced from the Open Syllabus Project (2019–2026).

Figure 2

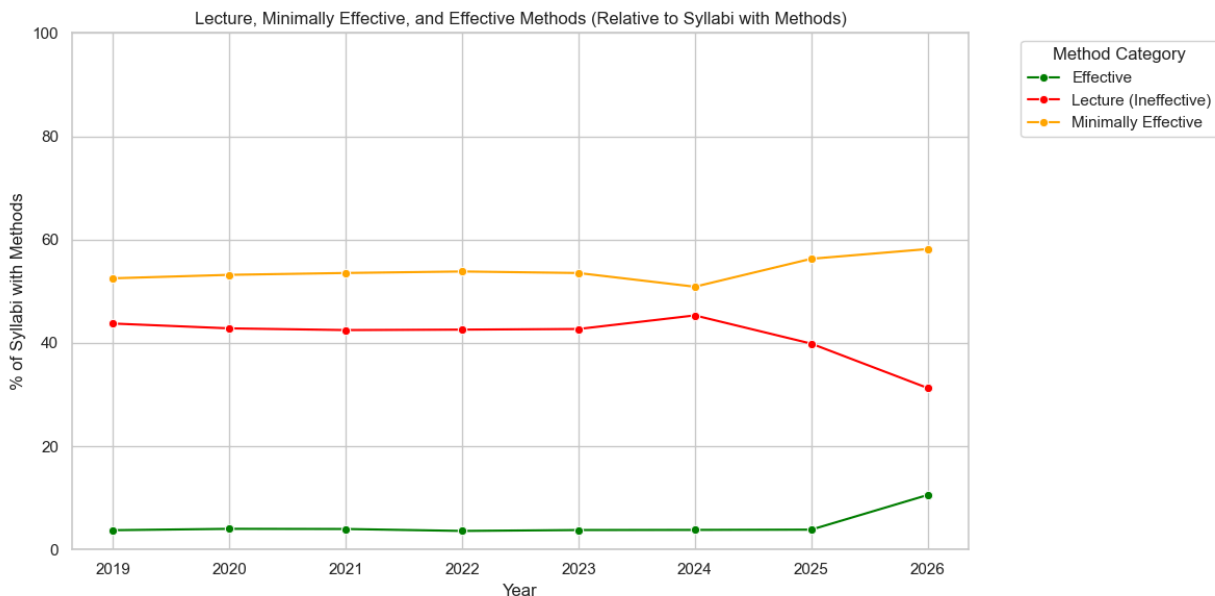
The percent of syllabi using effective versus ineffective methods over time in syllabi that report methods.



Note. This figure filters to only syllabi that explicitly report at least one teaching method. Data sourced from the Open Syllabus Project (2019–2026).

Figure 3

The usage of lecture, minimally effective, and effective methods over time as a percent of syllabi containing methods.



Note. Lecture (ineffective), minimally effective, and effective methods are shown separately. Minimally effective methods include discussion, reflection, multimedia, memorization, rote learning, and related practices. Data sourced from the Open Syllabus Project (2019–2026).

DISCUSSION

Defining Methods of Pedagogy

Common Methods

The most commonly used method in all undergraduate classrooms is lecture, and it is defined as a “solo performance by a person engaging in extended one-way verbal communication with an audience, with the intention that the latter learn more about a substantive topic” (Dunkin, 1983, p. 63). Though lecture can also often refer to any class session other than a laboratory environment in science classrooms, the provided definition is the most accurate one for the purposes of this paper. Also very common are methods such as

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memorization and rote-learning. Though not explicitly required by most courses, the nature of instruction leads students to opt for memorization over understanding material. Memorization generally refers to efforts to learn through repetitive exposure to material aimed at ensuring accurate recall without necessarily understanding the concepts (Seban et al., 2025). Finally, active learning refers to “anything that involves students in doing things and thinking about the things they are doing” (Bonwell & Eison, 1991, p. 2). The usage of active learning has increased in recent years and is thus considered common (Varghese et al., 2024). Active learning can include many styles of engaging with student learners.

Uncommon Methods

The other methods are all more uncommon in usage than the three presented above. Firstly, despite having an early wave of popularity, flipped classrooms remain uncommon in university environments. Flipped classrooms describe classrooms in which instruction is done outside of the classroom, usually in the form of students watching videos, while problems are solved in class (Shi-Chun et al., 2014). Another uncommon method is problem-based learning. Problem-based learning “uses a systematic approach, starting with an authentic, real-life problem scenario as a context in which learning is not separated from practice as students collaborate and learn” (Ghani et al., 2021, p. 1199). This strategy integrates real-world scenarios into learning. The final uncommon method analyzed is spaced repetition. This method takes advantage of a phenomenon known as the spacing effect, in which the efficacy of remembering and understanding terms is improved by scheduling exactly when review will be done according to certain algorithms (Kang, 2016).

METHOD EFFECTIVENESS AND EVIDENCE***Positively Effective***

In general, active learning has been seen to improve student outcomes. When classrooms employing active learning were compared to classrooms employing traditional lecturing, exam scores were 0.47 SDs higher under active learning, and students in traditional lecturing environments had 55% higher odds of failing the class (Freeman et al., 2014). Flipped classrooms have also specifically been shown to help students learn. Pass rates improved when classrooms were flipped, with moderate to large improvements being shown for university environments. However, the greatest improvements were shown when in-class time with professors was not cut, as some professors opted to do, assuming that class time was not as needed when instructional content was present online (Alten, 2019; Bredow et al., 2021; Zheng et al., 2020). Spaced repetition has proven to be especially useful in higher education with more complicated material. Classes that distributed information and had calculatedly-spaced review periods had better outcomes than classes that used traditional methods. Results

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were greater when information needed to be remembered for longer periods of time, something especially pertinent for undergraduate education (Mawson & Kang, 2025).

Problem-based learning (PBL) has been shown to be more effective for long-term retention of information and future ease of application, though it loses to traditional methods on short-term application. In other words, PBL produces better results for real-world needs but often fails to provide the results that are desired for standardized exams (Koçoğlu & Kanadlı, 2025; Strobel & Barneveld, 2009). Project-based learning was found to be beneficial in most classroom environments with an SMD of 0.441 compared to traditional models. In general, project-based learning worked better in experimental classes rather than theoretical ones, with an SMD of 0.498 in experimental classes (Zhang & Ma, 2023). Finally, cooperative learning has proven effective, with students who engaged in cooperative learning generally outperforming their peers who did not. It tends to increase engagement and has also been useful in promoting connection in online learning environments where students often feel separated from their peers (Güngör et al., 2026).

Mixed Results

The methods with mixed results are those that generally do not define the efficacy of a classroom's education. When paired with effective methods, they make education more effective, but when paired with lecture, they do not accomplish very much. Class discussions generally do not move the needle in terms of classroom efficacy. The most common type of discussion, unstructured discussion, did not produce results that improved deep learning. The main benefit discussion can accomplish is increasing student engagement, something which only truly matters when content is taught in a way worthy of being engaged in (Murphy et al., 2009). Self-explanation, the closest studied analog to reflection, was seen to have only moderate utility. However, this minor benefit only exists when students explain the logic behind what they have learned; passive reflection on general themes does not accomplish much (Dunlosky et al., 2013).

Finally, of all presented methods, media is the one most shaped by the teaching being used around it. The best understanding of media as a method is that "media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition" (Clark, 1983). Despite this, media can work uniquely well in flipped classroom environments as a way to convey material, so long as it is accompanied with time for students to later ask questions to their professor.

Negatively Effective

The only truly ineffective method commonly present in classrooms is lecture. Students in lecture environments are 1.5 times more likely to fail (Freeman et al., 2014). Furthermore, information retention during

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lectures is generally subpar, with somewhere between 40% to 46% of information being lost by students immediately after listening to and taking notes on a lecture. Such an immediate loss of information is a large negative and waste of time for education (Wilson & Korn, 2007). Finally, students generally believe that they are learning efficiently during lectures when they actually are not, making lecturing a particularly dangerous method as both lecturers and students believe that there is not a large need for change (Deslauriers et al., 2019).

NEGATIVE AND NEUTRAL METHODS PERSIST: WHY?***From the Institution***

There are a variety of reasons why negative and neutral methods continue to be used instead of adopting methods proven to be beneficial. Firstly, there are problems that stem from the institution. Many teachers cite that they feel that they do not have enough resources provided to them in order to use active learning methods; many others also state that they have too much content to cover to spend time using these methods (Bonwell & Eison, 1991). Another common complaint is that there is insufficient training. Though many professors express interest in using new methods, they often do not know what a more student-centered classroom looks like and how best to implement it. This prevents teachers from using more effective styles as they worry about making mistakes as they try new methods (Brownell & Tanner, 2012). A final reason for lack of adoption is that professors are generally more pushed to focus on research than their teaching. Benefits in positions are often given from research results rather than classroom results, meaning there are very few incentives to directly improve teaching caliber. This leads to a direct gap between what the research dictates and what professors actually know as the professors put in less effort to be informed (Brownell & Tanner, 2012; Murray et al., 2012).

From the Professors

Combined with the lack of support from universities is a lack of effort from the professors. Many professors feel more comfortable using the methods they have already become accustomed to, specifying that they did not have enough time and believed that what they were doing was already working to a sufficient degree (Miller & Metz, 2014). Professors also tended to feel discouraged towards using new methods because the student perception of learning was lower during active learning sessions despite actually learning more. This is proposed to occur for two major reasons, being that lectures are more logically organized, giving students a false sense of understanding, and that students generally struggle to quantize how much they understand when learning in a new field; in essence, unfamiliarity with active learning leads to perceived negative results (Deslauriers et al., 2019). This creates significant student pushback to active learning, meaning that as many as 75% of teachers that did try to use these methods eventually quit (Froyd et al., 2013; Henderson et al., 2012).

SOLUTIONS FOR OVERCOMING BOUNDARIES

The first step to solving these problems is understanding what exactly prevents faculty from adopting new methods, and in particular, understanding that it is not due to a lack of knowledge. The idea that teaching professors about evidence-based methods will cause change is flatly false (Henderson & Dancy, 2007).

In order to create real change, departments must be targeted instead of individuals. Peer pressure, norms, and resource allocation all happen within departments, meaning that this is the real opportunity for change. Individual faculty members that adopt evidence-based methods but do not see value in them will easily quit; a department will have a much harder time. Structure, symbols, people, and power dynamics all need to change, not just individual practices (Corbo et al., 2016; Reinholz & Apkarian, 2018). Next, faculty support needs to be constant. The best way found to do this is through faculty learning communities, in which professors can ask each other questions and gain the support they need to continue working with unfamiliar methods. Changes supported by these communities have been shown to last at least two years after the communities stopped regularly meeting, much more successful than changes implemented through one-off workshops (Tinnell et al., 2019). Beyond faculty learning communities, many universities have opted for hiring instructional designers, who help create new curricula to assist professors in moving away from lecture (Intentional Futures, 2016). While staff in these roles can help bridge the technical gap, they may not provide the peer support required to maintain pedagogical change. Finally, incentives must change. As it stands, professors fundamentally are rewarded for research and not teaching, receiving benefits such as tenure and promotions. The biggest change that can be done here is changing the evaluation of teaching; as previously stated, students find themselves to be more confident in lecture environments than active learning environments despite actually learning less. If teaching were gauged by educational quality instead of student perception, flaws would become more apparent and change would happen faster (Corbo et al., 2016).

LIMITATIONS

Several limitations should be acknowledged while interpreting this study's findings. First, the data analysis was done through syllabus keyword frequency, meaning that the charts represented the intentions of the professors rather than their actual actions. Courses that say they use lecture may use it to varying degrees, and courses that say "active learning" may use it anywhere between its full potential and some watered-down version that hardly deserves the title. There is a well-documented gap between pedagogical plans and implementations, which means that there are likely overestimates in the analysis (Henderson & Dancy, 2007).

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Second, there is a noticeable decline in lecture usage and increase in effective method usage from 2025 to 2026. From the available tools, it is impossible to discern whether this is an artifact of Open Syllabus Project, a change in the style of writing syllabi, actual pedagogical change, or something else entirely. One fact which could skew the data is the fact that 2026 data is partial, meaning that the results could be skewed compared to full-year data; for example, it is possible that the professors that publish their syllabi early are the ones that put more perceived effort into it, which may correlate with increased effective method usage. It is also possible that the rapid surge in LLM capabilities has made professors more aware of effective methods and have made introducing them into existing curricula easier. Conversely, it could also mean that syllabi are being reviewed by LLMs, which are then adding effective method buzzwords to seem more appealing. Regardless of what the reasoning is, there is positive movement being shown, as effective methods are filling the gap created by lecture.

Finally, not all data was publicly available, making some analysis impossible to conduct. Most colleges keep their data private, only accessible for actual enrolled students, making data entirely inaccessible for research purposes. For example, the Open Syllabus Project is not a random sampling of colleges and may underrepresent smaller institutions. Third, the keyword search was subject to measurement error. Many of the searched terms had immense variability in their implementation, with terms like “discussion” and “group work” being stand-ins for many different types of instruction. Furthermore, professors can use smaller examples of active learning without feeling the need to note it in their syllabus, underrepresenting certain methods. Finally, the literature read overrepresents STEM disciplines, with physics and biology being the most commonly studied fields. Evidence in the humanities, social sciences, and arts has not been as studied historically and is therefore missing from this study. The extent to which these results generalize to those fields therefore remains unclear.

CONCLUSION

This study analyzed the causes of ineffective teaching methods persisting in undergraduate education, using both a literature review and data analysis through syllabus data. These methods both agreed that lecture remains the dominant teaching method and is associated with significantly worse student outcomes than other presented evidence-based methods. The syllabus analysis revealed that lecture remains dominant, though its usage has begun to slightly decline, especially from 2025-2026. However, the methods replacing lecture tend to be minimally effective such as the incorporation of multimedia and unstructured discussion rather than the largely effective methods such as active learning and flipped classrooms. The data suggests that the awareness that lectures are harmful is growing, but professors do not know what to use to fill the gap.

The barriers to adopting evidence-based methods exist in the individual and institutional levels as characterized by literature. Faculty face pushback to trying new methods and time constraints while simultaneously struggling with the adoption of new, unfamiliar methods. They also largely struggle against the

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illusion of learning that students feel with lecture. Institutions worsen this problem by not providing training for professors in new evidence-based methods and reward research instead of teaching. These barriers build upon each other cyclically, with unhelpful institutions creating faculty that do not want change and therefore do not work to change the harmful institutions. Therefore, the presented solutions emphasize targeting departments over individuals to create lasting change. Faculty learning communities ought to be created to provide the lasting support that professors need to shift their styles. Finally, incentives need to be changed to make teaching worth the professors' time and not something done on the side with research being the primary focus.

The problems presented have only become more urgent over time as student achievement has declined since the COVID-19 pandemic. Grade inflation hides the full extent of learning deficits, making it harder for change to be made. There is evidently a growing need for critical thinking skills, and this need demands change in higher education. The evidence exists; what remains is the willingness of institutions to act. Future research can be pursued on multiple fronts. First, better analysis of syllabi can be conducted using tools such as natural language processing to gain a more accurate view of what kinds of methods are being used and how. Secondly, programs that have implemented changes can be tracked to make a strong case for creating change across the country. Third, the evidence should be extended beyond just STEM fields to ensure that these findings are generalizable. Finally, examining the correlation between the use of certain methods and factors like job placement and workforce readiness could create a strong argument for institutional reform.

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