美国现代教育改革概况

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美国约有 1300 个高等学校以及少数法人团体进行教师培训。这些大学中约有三分之二(通常为比较大的研究型大学)由教育学院进行中级课程教师的培训。约有三分之一的中学教师培训主要在历史较久远的"师范学校"的课程培训系进行,课程培训系与中国传统的中等师范专科相类似。大多数改革源于教育学院。少数源于课程培训领域,而只有一种改革(马德琳·亨特教学, Madeline Hunter Method)产生于院校之外。有一些改革以复杂的教育理念为基础,而其它改革则注重根据经验使用某种特殊的方法或课堂实践。表 1 提供了各种改革得到基本贯彻的时间。本文叙述的改革产生的影响是作者的主观概括,但关于改革的描述和时间线索已征得了同行的确认。

表 1 美国重要课堂教育改革开始基本贯彻的时间表

教改名称	时间
行为目标化教学	1960
程序化教学	1962
个性化教学	1964
开放式课堂	1969
分段选修	1973
跨年龄分班	1974
回归基础	1979
计算机辅助教学	1981
马德琳·亨特教学	1982
科学/技术/社会	1983
"敲警钟"	1983
概念图解法	1983
科学过程教学	1984
范围 - 程序法课程设置	1984
体验型教学	1984
智力型教学	1985
注重阅读教学	1985
注重特殊教育	1986
把关式教学	1987
批判性思维	1987
综合科学教育	1988
全民科学教育	1988
互帮互学	1988
建构主义	1990
结果导教法	1992
标准化教育	1994
长课时课程表	1994
远程教育	1996
探究式教学	1997
主动式学习	1998

1 行为目标化教学

这是最早出现、持续时间最长的方法之一,是在 20 世纪 50 年代末期由芝加哥大学杰出教授本杰明·布卢姆(Benjamin Bloom)所发动的一种书面课程目标化方法。布卢姆教授提出了各种理性的、以情动人的精神动力方法,这些方法使教师能以毫不含糊的语言、明确地表达他们的教学期望,即说明哪些是教师要求学生做到的。书面行为目标化作为一种核心方法,被不断融合到后来的改革方案以及提问技巧中去。

2 程序化教学

程序化学习起始于斯基耐(B. F. Skinner)的限制性学习,它可以由"教学机器"提供。然而,随着布卢姆的明确的行为目标化方法的发展,程序化学习读本变得流行起来,学生利用这种读本的书面解释能够逐步深入内容,回答问题系列,而且根据回答情况,或被引导到下一个概念(如果回答正确的话)或被引导到一种新的解释方式(如果回答不正确的话)。这种学习方法仅仅对有自我学习要求的学生有效,所以它不久便衰落了。随着计算机辅助教学(Computer Aided Instruction, CIA)的出现,程序化教学重又复兴,并渐渐被称为"训练加实践"或"训练加扼杀(扼杀兴趣)"。一般认为程序化教学对于普通教育并不灵验,但在技术培训中仍然具有一定的应用价值。

3 分段选修

该法在中学低年级和高年级推行,具体做法是允许学生选修各种不同的二级学科课程。学生可以在昆虫学、植物学、遗传学等学科中选修 4 个不同的短课程,而不必选读整整一年的生物学。这种教学内容上的改革深受教师和学生的喜爱。因为教师可以讲授他们最喜爱的章节,而学生则可以学习他们欣赏的特殊论题。这种改革大大刺激了对生物学的热情,但确实会造成学生基本知识概念方面的缺陷,故迅速被回归基础的潮流所终止。

4 跨年龄分班

该改革的做法是按照学生的能力、而不是根据年龄将中学新生分班,并使用与学生能力相匹配的教师。这种方法很可能会使优秀生更快地进步。但是,一场重大的反对"因才施教"运动终止了大多数按能力分班的做法,而且这种反对倾向又被所谓"不让一个学生掉队"以及"科学属于全体美国人"的平等主义策略进一步强化,这些策略要求将教学资源转用于帮助差生。

5 计算机辅助教学

这种方法由计算机对定义类问题进行的训练和实践演变而来,用于程序化教学和模拟。虽然充满了期望,早期的尝试却因为计算机低下的记忆能力和速度而导致的低下的响应速度而失败。除非以游戏格式给出,否则计算机辅助教学仍然要求学生自己具有坚实的创造精神和动力。由于这些缺点,"计算机辅助教学"这一术语很少使用,并正为其它计算机教学术语所替代,如"教学技术"。

6　科学/技术/社会(STS)

这一重大的改革运动由衣阿华大学的鲍勃·雅格(Bob Yager)发起。虽然大多数美国教师都会讲解一些概念的应用方面的内容,但 STS 将概念应用于学生生活这一做法作为科学教育的中心,所以授课内容就围绕着诸如人工受精、人口过剩、安乐死等主题来制定,再由这些内容导入基础生物学概念。一些这种改革的推崇者甚至主张,不应当讲授与学生生活无关的内容;而一些反对者则指出,在远没有具备理解这类主题的科学基础知识之前,学生就被要求去理解和表明对这类主题的立场,容易使学生形成不成熟的推测或联想。尽管科学和社会问题仍是美国《国家科学教育标准》的组成部分,但 STS 不再为大多数生物学授课教师所注重,只有当学生对新出现的事件感兴趣时才会将 STS 方法结合到教学中去。

7　科学过程教学

科学过程教学法强调将教科学变为教科学的过程,而不是仅仅提供知识信息。除了用实验提供经验外,也常常要求教会学生观察、建立假设、进行试验、结果整理以及作出结论的科学方法,正如做学问全过程所经历的那样。学生往往只注意记住上述"科学方法"本身,而不注意理解总的探究过程,实际上后者才是科学研究的真正基础;教育学校则通常认为,学生把科学作为大堆事实来学了,并且认为他们只需学会科学研究过程。目前这种争论已经过时,但仍然认为学生需要以探究方式去学习科学。

8　范围—顺序法课程设置

这是由美国科学教师协会协调进行的一种改革,目的在于制订一个更加连贯而紧凑的课程设置方案,方案明确规定课程内容覆盖范围以及基本概念出现顺序。美国科学教师协会认为,将生物学、化学、物理学和地球科学的各个二级学科孤立开来进行教学会产生问题,因为学生不能得到各个学科之间相互关系方面的知识。范围－顺序法课程设置基本上已经被当前的课程标准潮流所取代,目前由各州的课程标准来确定课程设置的范围和顺序。

9　把关式教学

把关式教学是一种非常特殊的概念或技巧的教学方法。它利用精心设计的策略,让学生对有关问题不断重复琢磨,直到学生达标为止。把关式教学经常采用的一个做法是,学生必须反复阅读或朗读课文,直到准确掌握有关概念或技巧,实际上这种做法会降低教学水平,因为其他学生不得不等待反应慢的学生反复接受测试或做其它练习。另外,把关式教学往往会使学生之间的差距扩大。有一些教育类学校仍然在推行这种教学方法。

10　批判性思维

批判性思维与"解决问题"密切相联,包括鼓励学生利用智力性问题本身来进行思考。各种权威人士推出了许多思维的技巧,其中包括集体出妙主意、使用分析法、苏格拉底提问法(Socratic questioning)以及开放式提问法等。许多有经验的教师认为,如果生物学实验和野外实习工作不是一种按照"菜单"进行的按图索骥式的工作,批判性思维应当是这些工作的自然而然的结果。根据对教育咨询人员的调查,目前这种改革还没有失去效用。

11　综合科学教育

综合科学教育是一种国际潮流,它通常以某个主题为基础,将所有学科结合在一块进行教学,例如围绕"水"这个主题,可以同时从生物学、化学和地球科学几方面进行讲解。一些综合科学教育提倡者建议,生物学、化学以及其它学科的教师知识面太窄,这种综合科学教育收效不会太大。几乎有一半数量的州发放"跨学科"教师资格证,这是为了顺应综合化教育的趋势;但大学对综合科学教师培训内容的学科跨度太窄,所涉及的各专业学科深度不够。综合科学课程很快在中学里烟消火灭,但州政府对生物学、化学等专业教师资格证书重新认定的工作进展相当缓慢。

12　全民科学教育

全民科学教育是一个重大的教育改革运动,它由现已退休的詹姆斯·卢瑟福(James Rutherford)博士领导的美国科学促进协会发起。这种改革的核心理念是"科学属于全体美国人"以及"科学并非多多益善"。"全民科学"的理念已经被纳入了在许多州使用的教育标准,这种教育标准在某种程度上使得开设课程的选择范围受到了限制;同时,为了力争向全民传播基础科学知识,取消或者不提倡学生感兴趣的程度较深的课程。美国科学促进协会是一个由科学家组成的重要协会,协会科学家对于这种教育改革所持的观点并不一致,有些对"科学并非多多益善"的提法表示了质疑。一般认为,美国《国家科学教育标准》较多地采纳了美国科学促进协会的"全民科学"的理念,而对美国科学

教师协会"范围－顺序法课程设置"的做法采用得比较少。

13 互帮互学

互帮互学是以学生分组学习替代教师授课的一种尝试。学生在学习小组中发挥各自不同作用,但学分通常以小组为单位来评定,即小组每个成员可以获得相同的成绩。这种教学方法得到了约翰斯·霍普金斯大学(Johns Hopkins University)的罗伯特·斯莱温(Robert Slavin)博士的支持。这种方法使课堂上所教的科学基本概念大大减少;好学生通常能完成全部小组作业,而懒散的学生则只能做完少量作业却获得与好学生相同的学分。虽然个别教师仍然偏好这种方法,但是它已经不再广泛使用。

14 建构主义

这基本上是以琼·派盖特(Jena Piaget 1896～1980)的工作为基础的一种教学理念。以科学事实为例,该理念认为,每一个学生对科学事实都会建构自己内心的图象。建构主义适用于所有学科,比如建构主义英语教师有可能允许学生创造自己的独特的拼写系统。在科学教育领域,建构主义在教育学校十分流行,正愈来愈多地被用于促进学生的活力和探索能力。但是,科学家们做实验却是以单个普通的事实为基础的。因此有经验的教师常常对建构主义者抱着批判的态度,认为他们助长了相对主义,而且将科学扭曲为只是许多认识世界的等价的方法之一。作为一种教育理念,建构主义还继续在大学中流行,但对公立学校的影响很小。

15 结果导教法

这是一整套复杂的做法,即所有有关教学内容和方法的决定,都要根据对学生学习成效或结果的评估情况来作出。只有学生的学习"结果"才是优化教学工作的有价值判别依据,而包括图书资料、实验设备、甚至教师的知识等这些所谓的"投入"都被认为是次要的。这种方法的主要影响是会增加教师测试和保存详细的测评记录的负担,并减少用于创造性的实验室和野外工作的时间,虽然结果导教法在公立学校已经沿用了几十年,但它现在刚开始运用到大学教学中。不过在最先采用这种方法的州里,它正开始走下坡路。

16 标准化教育

除了衣阿华州之外的所有美国其它州都采用标准化教育。标准化教材制订教育标准,列出许多科学概念,由各州自己决定哪些是必须教的,哪些是建议教的。美国的授课教师一直有权决定教什么、怎么教以及何时教。但一些教师不认真备课,不能正确使用这种自由权利,于是便出现了标准化运动,以促使教师对学生必须或应当学的内容负责,最终导致了各学科课程标准的编写。这个运动对教学的标准化程度尚难预见,但已经在标准化写作的基础上实行了标准化考试,这使教师受到了新的压力,以使他们的学生在考试中有良好表现。所有这些都会驱动美国教学体制向着应试体制靠拢,提倡记忆而不是鼓励批判性思维和探索等等,就像包括中国在内的其它国家里已经普遍存在的那样。

17 长课时课程表

长课时课程表可以向中学生提供更类似于大学生的课程表,也就是说学生由过去的一周 7 天每天都要上 6～7 节课,每节课时间为 50 分钟,改为一周只上 2～3 天课,一天上 4 节课,每节课时间延长为 1.5 小时。这种课时安排的变化,目在在于让教师放弃讲课并使用更多的小组课堂学习。教师常常发现,长课时课程安排使得较长的实验室工作以及就近进行的野外工作成为可能。艺术、音乐和演讲课对这种课时安排很欢迎,因为这些课需要较长时间;但是数学和外语课却相反,因为这种排课使学生不能每天进行练习并强化概念。这种改革在美国始于 1990 年,现在根据地区的不同已经扩展到 30%～70%的中学,但目前正在开始萎缩,原因是学术收益并不能换来物质利益,而学年总课时的缩减也出现了负面效应。

18 远程教育

远程教育是指教师和学生之间并非面对面的授课方式。20 世纪 60 年代教学电视的开设是美国首次重大的远程教育尝试,当时利用发射塔和飞机播放节目,但用这种办法转播课堂教学未获成功,录像带的发明、卫星电视转播以及因特网的出现重新激起了远程教育的兴趣。与函授教育相比,远程教育对成人计算机运用定点教学十分有用,但对于通常的学员对象和授课内容成功率较低。远程教育对于理科教学就更复杂了,因为需要让学生在实验室体验各种科学现象,锻炼各种实验技巧。尽管信息技术专家抱有热情,远程教育并不会形成高水平的科学文化或者高水平的科学家。

19 探究式教学

探究式教学是最近出现的一种教学方法,目的在于让学生提问并回答他们自己提出的问题,通过这种探究方式而不是教师的解释来获得科学知识。这种方法需要供给有关的材料和实验设备以及提出可能会遇到的问题。教师可以利用一系列问题来训练学生自己提问,但是最终目标是使学生自己能提出创新性问题。与"科学过程教学"不同,探究式教学不注重假设或"菜单"式实验。探究式教学在美国《国家科学教育标准》

中得到了推动,但因贯彻时间太短,所以还不能对这种方法的效果进行估计。

20　主动式学习

主动式学习是与"被动式学习"相反的一种教学实践,后者通常意味着记忆而不是对意义的理解。主动式学习涉及创造性思维、分组互助学习、导向式提问、把关式教学、因特网家庭教育等教育模式。由于主动式学习方法缺乏明确的界定,也没有明朗的提倡者,所以这种方法的作用仅仅是使得一些老的教学改革在它的名义下得以继续存在。

大约 50 年前,本杰明·布卢姆观察到,教育没能构建一种知识体,即没有形成一种能被修正和完善的范本,就如同各种科学范本那样。他宣称,在建成这种知识体之前教育不会成熟为一种职业。上面所谈到的各种教学改革,其中多数很快被放弃了,似乎证实教育仍然缺乏可以信赖的知识基础。◇(宋振勤译)

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A Summary of Modern Education Reforms in the United States

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In the United States, approximately 1300 colleges and universities, and a few corporate entities, train teachers. In approximately two-thirds of these universities, teacher training for secondary level content teachers is managed by schools of education (usually at larger research universities). In about one-third of programs (mostly at the older "normal schools"), high school teacher training is managed in content departments, similar to traditional secondary teacher training programs in China. Most school reforms originated from schools of education but a few are derived from content fields, and one (Madeline Hunter method) was developed outside of academic institutions. Some reforms are based on a complex educational philosophy; other reforms center on using a specific method or classroom practice base based on empirical experience. The following definitions briefly summarize the basic tenets of each reform and its general consequences as seen at this time, although the time of implementation and the effects vary by region across the U.S. Table 1 provides the approximate time of implementation for each reform. The subjective summary of the effect of the reform is mine although colleagues were consulted to verify the timeline and description.

Table 1. Timeline for Major U.S. Education Reforms

Reform	Date
Behavioral Objectives	1960
Programmed Learning	1962
Diagnostic Teaching	1964
Open Classrooms	1969
Phase Elective	1973
Multi-Age Grouping [MAG]	1974
Back-To-Basics	1979
Computer-Assisted Instruction (CAI)	1981
Madeline Hunter Teaching Strategy	1982
STS [Science/Technology/Society]	1983
"At Risk"	1983
Concept Mapping	1983
Science as Process	1984
NSTA Scope-and-Sequence	1984
Hands-On Science	1984
Minds-On Science	1985
Every-Teacher-a-Reading-Teacher	1985
Every-Teacher-a-Special-Education-Teacher	1986
Mastery Learning	1987
Critical Thinking	1987
Integrated Science	1988
AAAS Less-Science-Not-More	1988
Cooperative Learning	1988
Constructivism	1990
Outcomes-Based Education [OBE]	1992
Standards Movement	1994
Block Scheduling	1994
Distance Learning	1996
Inquiry-Based Science	1997
Active Learning	1998

1 **Behavioral Objectives**, one of the earliest and perhaps longest-lasting methods, was a method of writing course objectives promoted by the late distinguished Benjamin Bloom of the University of Chicago in late 1950s. Professor Bloom provided a classification of intellectual, affective, and psychomotor skills that allowed teachers to clearly verbalize their teaching expectations in language that was not ambiguous: what does the teacher want the student to be able to do? Writing behavioral objectives is no longer a major stand-alone methodology, but it continues to be a central methodology incorporated into elements of newer reforms as well as in questioning techniques.

2 **Programmed Learning** began as a natural application of conditioned learning described by B. F. Skinner and could be delivered by "teaching machines." However, following the development of clear behavioral objectives by Bloom, programmed learning books became common where a student could progress through printed explanations, answer a question set, and depending on the answer was directed to either the next concept (if correct) or to a re-explanation (if incorrect). This procedure was only effective for students who were self-motivated and soon declined. It was resurrected with the advent of computer aided instruction (CAI) where it became known as "drill-and-practice" or "drill-and-kill (interest)." Generally programmed learning is considered ineffectual for general instruction but continues to have some applications in technical training.

3 **Phase Elective** programs in lower and senior high school allowed students to select from a variety of subdiscipline courses. Instead of taking one year of biology classwork, a student could take four different short courses in entomology, botany, genetics problems, etc. This content reform was very popular with both teachers (who could teach the sections they most liked) and students (who could study just the specific topics they enjoyed). This reform generated much enthusiasm for biology but did leave gaps in student knowledge of basic concepts and was abruptly ended by the back-to-basics movement.

4 **Multi-Age Grouping** (MAG) was a strategy for placing elementary school students in classes based on level of ability rather than age. It also involved using peers as models and teachers. There was the possibility that it would move advanced students at a faster pace. However, a major movement against "tracking" ended most ability grouping. This has been further reinforced by egalitarian policies phrased as "leave no student behind" and "science for all Americans" that have shifted resources to helping the low achievers.

5 **Computer-Assisted Instruction** (CAI) has evolved from using computers for drill-and-practice of definition-type questions, to programmed learning, to simulations.

Despite enthusiastic expectations, early attempts failed due to slow computer response due to low memory and speed. Unless presented in a game format, CAI also requires substantial individual student initiative and motivation. Because of these drawbacks, "CAI" is rarely used and other computer education terms are replacing it, such as "IT" (instructional technology).

6 **STS [Science/Technology/Society]** was a major reform movement promoted by Bob Yager at the University of Iowa. Although most U.S. teachers told students about some of the applications of concepts they were teaching, STS promoted making applications to students' lives the central focus of science teaching. Therefore science lessons were constructed around the issues of artificial insemination, overpopulation, euthanasia, etc. which were used to then lead into the basic biological concepts. Some advocates went so far as to contend that nothing should be taught if it didn't directly relate to a student's life. Some critics pointed out that students were often asked to understand and take positions on issues long before they had the science background to understand it, or that STS often led to "premature speculation" by students. While science and society issues are part of the *National Science Education Standards*, STS is no longer a major concern of most classroom biology teachers and is integrated usually when current news events spur student interest.

7 **Science as Process** was a major effort to teach science as a scientific process rather than as a body of information. In addition to providing experience with experiments, the scientific method of observation, hypothesis-formation, test, results, and conclusion was also often taught as the way science was done. Students tended to memorize the steps to this "scientific method" and not internalize the general questioning that is the actual basis for science research. Educations schools generally disparaged students learning science as a large body of facts and asserted they merely needed to learn the science process. Today, this same argument is used but asserting students need to learn science as inquiry.

8 **NSTA Scope-and-Sequence** was an effort coordinated by the National Science Teachers Association to provide a more coherent curriculum by defining the scope of science coverage and the order in which concepts would be taught. One contention of the NSTA program was that teaching the subdisciplines of biology, chemistry, physics, and earth science (as a layer cake) separately was a problem since no relationships between sciences would be learned. This gave impetus to the integrated science movement that ultimately failed. Scope-and-sequence has also been essentially been replaced by the current standards movement where state standards now dictate scope and sequence.

9 **Mastery Learning** is a method of teaching very specific concepts or skills through minutely-planned teaching strategies that are continued until the student achieves the goal. One symptom of mastery learning as it is often practiced is that the student must repeat the lesson until he or she has achieved mastery of the concept or skill. In practice this can slow down the general level of classwork as classmates wait until the slower students have retaken tests, etc. In addition, mastery learning tends to inflate grades. Some education schools continue to promote mastery learning.

10 **Critical Thinking** is closely associated with "problem solving." It includes many strategies for encouraging students to think through intellectual problems themselves, and a wide range of "authorities" promote a variety of techniques including group brainstorming, use of methods of analysis, Socratic questioning, use of open-ended questioning, etc. Many veteran teachers consider critical thinking to be a natural consequence of biology laboratory and fieldwork if it is not "cookbooked." Based on the number of educational consultants that are still speaking on critical thinking, this reform is not yet fading away.

11 **Integrated Science** was an international movement to teach all sciences together, usually based on a theme (e.g. "water" from biological, chemical, physical and earth science perspectives). While some proponents suggested that chemistry and biology and other teachers cooperate by having their distinct classes address the same theme, extremists felt that science teaching was ineffective because teachers were trained in too narrow fields. Nearly half of the states license science teachers in "broadfield science" which reflects this generalist philosophy. The consequence however is that the university content training of general science teachers is spread too thin across the sciences and is too shallow in any specific discipline. General and integrated science courses are rapidly disappearing in high schools but the states are slow to change certification of teachers back to biology, chemistry, etc.

12 **AAAS Project 2061: Science for All Americans** is a major science education reform effort launched by the American Association for the Advancement of Science under Dr. James Rutherford, now retired. Although the program is complex, the "Science for All Americans" and "Less Science Is More" philosophies are central. The "science for all" philosophy has been incorporated into standards used by many states and in some cases this has narrowed science course offerings and eliminated or discouraged advanced science courses for students interested in science, in the effort to spread a basic science literacy to all. Although the AAAS is a major association of scientists, this education effort does not represent a consensus among scientists, some of whom have expressed concerns that less science is less science, not more. It is generally accepted that the *National Science Education Standards* adopted more from the AAAS Project 2061 than from the competing NSTA Scope and Sequence effort.

13 **Cooperative Learning** was a practice of structuring students to work in groups as an alternative to lecturing students. Students work in various roles in the group and the groups is generally graded as a unit. This method was championed by Dr. Robert Slavin of Johns Hopkins

University. In science classes, the amount of science concepts covered was greatly reduced and good students generally completed all of the group work while lazy students did little work and yet received the same group grade. Although some teachers continue to favor this method, this practice is dropping from widespread usage.

14 **Constructivism** is a philosophy of teaching that is roughly based on the work of Jean Piaget (1896–1980). The term is derived from the overall belief that each student "constructs" their own mental image of "reality" in science, for instance. Constructivism applies to all disciplines; for instance constructivist English teachers might allow a student to invent their own unique spelling system. In science education, constructivism is popular in schools of education and is increasingly used to promote student activities and exploration and condemn lecturing. However, the science community conducts research on the assumption of a single universal reality. Therefore veteran teachers are often critical of constructivists who promote relativism and a science that is merely one of many equal ways of knowing the world. As an educational philosophy, constructivism continues to grow in popularity at universities but has little impact in the public schools.

15 **Outcomes-Based Education [OBE]** is a framework for using assessments of what students are supposed to learn to drive all decisions on teaching content and methods. Only "outcomes" are considered valuable and "inputs" such as library resources, lab equipment, and even teacher knowledge are considered secondary if not unimportant. A common phrase of OBE is to "focus on learning rather than on teaching." Its main effect is to increase the teacher's burden of testing and keeping detailed assessment records, which in turn erodes the time available for creative lab and fieldwork in biology. Although OBE has been used in public schools for a decade, it is beginning to be touted for college level teaching as well. However, it is beginning to fade in those states where it was first adopted.

16 **Standards Movement** has resulted in all but one U.S. state (Iowa) adopting various lists of science concepts that are suggested to be taught, or must be taught, depending on the state. The American classroom teacher has been unique in being responsible for determining what to teach, how to teach it, and when to teach it. Since some poorly-prepared teachers failed to use this freedom responsibility, the movement to hold teachers "accountable" for what students should learn has led to the codification of science standards. The extent this will "standardize" teaching is yet to be seen, but the writing of standards is immediately followed by standardized testing and new pressure on teachers to have their students perform well. This drives the American system toward the teach-to-the-test system that has been common in other countries including China, and promotes memorization rather than critical thinking, inquiry, etc.

17 **Block Scheduling** of courses provides secondary science students with a schedule more like that found in college classes. Instead of six or seven 50-minute classes every day, students usually attend four classes of one-and-a-half hours each day, two or three times a week. This educationist methodology is promoted in order to force teachers to abandon lecturing and use more small group classwork. Science teachers often find that block scheduling permits longer laboratory periods and allows nearby field trips. Art, music, and speech classes like it for longer performance time. However, mathematics and foreign language classes drop behind when students cannot practice and reinforce concepts everyday. This reform which began in 1990 in the U.S. now reaches from 30%–70% of schools, depending on the region, but is beginning to decline as academic benefits fail to materialize and the negative effects of shorter class time per year appear.

18 **Distance Learning** refers to any method of delivering instruction where the teacher and student are not face-to-face. Australia has used radio to link teacher with students. The first major U.S. effort was instructional television in the 1960s; using towers and airplanes to transmit programs, the method was a failure for delivering enriched classroom lessons. The development of videotape, satellite television transmission, and the Internet revived interest in delivering instruction from a distance. However, although useful with site-bound older students and classes about computer usage, success rates remain low for conventional students and topics, and compares with correspondence school levels of completion. Use of distance learning in science is further complicated by the need to provide students with genuine laboratory experiences with science phenomena and to develop their laboratory skills. In spite of the enthusiasm of information technologists, distance learning is not producing higher levels of science literacy or future scientists.

19 **Inquiry-Based Science** is the most recent science teaching strategy aimed at getting students to ask and answer their own questions, thereby developing a science understanding through inquiry rather than from explanations from a teacher. This method includes providing appropriate materials and laboratory equipment and posing potential problems. A teacher may use a series of open-ended questions to practice students in asking questions themselves, but the ultimate goal is to get the students to ask creative and appropriate questions themselves. Unlike science-as-process, there is no emphasis on hypotheses or "cookbook" experiments. Inquiry is promoted in the U.S. *National Science Education Standards* but implementation is too recent to provide any assessment of its widespread effectiveness.

20 **Active Learning** is a recent assortment of practices that are generally contrasted with "passive learning" which usually means memorization without understanding meaning. Active learning has been presented to include creative thinking strategies, group or cooperative learning, formats for guided inquiry and mastery teaching, peer tutoring via the internet, and other education strategies. Lacking a crisp definition or single champion, active learning has been used to give longer life to older reforms that would have otherwise disappeared.

Nearly 50 years ago, Benjamin Bloom observed that education had failed to build a body of knowledge, a paradigm, that could be revised and developed as are the paradigms of science. Until that occurs, he claimed, education would not mature as a profession. This listing of diverse reforms, most of which were soon abandoned, appears to confirm that education still does not have a reliable knowledge base.

[Original submission]

Table 1. Timeline for Major U.S. Education Reforms in the Classroom

Behavioral Objectives	1960----------
Programmed Learning	1962----------
Diagnostic Teaching	1964----------
Open Classrooms	1969--------
Phase Elective	1973--------
Multi-Age Grouping [MAG]	1974----------
Back-To-Basics	1979---------
Computer-Assisted Instruction (CAI)	1981----------
Madeline Hunter Teaching Strategy	1982----------1992
STS [Science/Technology/Society]	1983----------
"At Risk"	1983----------
Concept Mapping	1983----------
Science as Process	1984----------
NSTA Scope-and-Sequence	1984----------
Hands-On Science	1984----------
Minds-On Science	1985-----
Every-Teacher-a-Reading-Teacher	1985----------
Every-Teacher-a-Special-Education-Teacher	1986----------
Mastery Learning	1987----------
Critical Thinking	1987----------
Integrated Science	1988----------
AAAS Less-Science-Not-More	1988----------
Cooperative Learning	1988----------
Constructivism	1990----------
Outcomes-Based Education [OBE]	1992----------
Standards Movement	1994----------
Block Scheduling	1994----------
Distance Learning	1996----------
Inquiry-Based Science	1997----------
Active Learning	1998----------