



Statistics Education in the K-12 Schools of the United States: A Brief History

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Abstract

The purpose of this paper is to provide a brief history of statistics in the K-12 setting in the United States. This is intended to serve as a reminder of how far the discipline has come in its inclusion in the standard curriculum for all students as well as to highlight the need for research in this area.

1. Introduction

The Department of Research on K-12 Statistics Education aims to publish papers that will contribute to our understanding of teaching and learning of statistics in the pre-college setting. Content of such papers may include research related to students' and teachers' dispositions toward and knowledge of statistics, or other issues related to the teaching and learning of statistics in the K-12 setting. It is important to understand the historical foundations behind the appearance of statistics in the curriculum in order for us to build upon the past. This paper is an attempt to provide a brief overview from a statistician's point of view. This is not an exhaustive historical account, but will hopefully set the stage for submissions to the Department of Research on K-12 Statistics Education.

The idea that statistical thinking is of paramount importance in a modern society, and thus should be part of everyone's education, has been developing in American culture for a century, nearly ever since U.S. culture began its unrelenting move from farm to factory. The 1920s saw efforts to include basic statistics as a requirement in mathematics from junior high school onward, with

impetus from industry and business. The 1940s and 1950s saw even stronger interest in broadening statistics education, because of the expanded uses of statistics developed through the war years and in the societal explosions that followed, coupled with expanded college curricula in the sciences and social sciences. The 1960s and 1970s did not show much visible progress in statistics as part of the school curriculum, but groundwork for future change was being laid in the statistics community as emphasis shifted from theory to data analysis. Building on data analysis as the core focus, the 1980s and 1990s saw great progress in the development of programs and materials in statistics that excited both teachers and students, no small part of which was due to the advent of personal computers. Good materials and strong societal demand for statistical thinking, however, do not automatically result in changes to school curricula. In the 2000s progress is being made in that arena, but such progress is slow and demands constant vigilance.

2. The Roaring 1920s and Depressed 1930s

The notion of introducing statistics and statistical thinking into the school curriculum is not a new idea. In fact, it is nearly a century old. No real evidence can be found for such a move in the nineteenth century, but by the 1920s, when the United States was becoming ever more rapidly an industrialized urban nation, many changes in the school mathematics curriculum were proposed. As these changes were often cast in the framework of making mathematics more utilitarian and broadening the scope of its appeal, it is not surprising that some of the changes emphasized statistics as one of the important waves for the future. Among the recommendations found in the *The Reorganization of Mathematics in Secondary Education*, a 1923 report by the newly formed Mathematical Association of America (MAA) ([National Committee on Mathematical Requirements 1923](#)), were that statistics be included in the junior high school curriculum (grades 7, 8 and 9), more from a computational than an algebraic point of view, and that a course in elementary statistics be included in the high school curriculum. These recommendations comprised some of “the best way[s] to reorganize mathematics courses and improve mathematics teaching (p. 1).”

In 1926, Herbert E. Slaught, an educator at the University of Chicago, continued the theme of the societal importance of mathematics, with statistics as an essential aspect, referring to the new curricula in both junior and senior high schools.

One of the most significant evidences that the importance of mathematics is permeating the whole fabric of modern life is shown in the recent unparalleled development of the use of statistical methods in the study of quantitative relations in almost every department of investigation. This appears in the simplest form in all the proposed new curricula for the junior high schools. It is emphasized in the programs for the senior high schools.

It is further developed in the enriched courses for college students not only in all the sciences but also in economics, sociology, anthropology, etc. It is indispensable in all laboratories everywhere, whether in the schools or in the factories, in commerce, in big business of every kind. ... These are phases of mathematics which are gradually growing into the consciousness of the general public. ([Slaught 1926](#), pp. 192-193)

It should be noted that the emphasis on statistics growing in the public consciousness and in “laboratories everywhere” might well be connected to the fact that Walter Shewhart introduced

control charts to American industry in 1924, changing the emphasis in manufacturing from *make them fast and throw out the bad ones at the end* to *improve the process to reduce or eliminate the bad ones*.

Except for the possible indirect influence of Shewhart, it appears that nearly all of those advocating for the incorporation of statistics in the school curricula during the early part of the 20th century were mathematicians or mathematics educators. This changed with Helen Walker, who taught statistics at Columbia University Teacher's College from 1925 to 1957. One of the first women to teach statistics in the U.S., Professor Walker thought of statistics as a service to the welfare of society. In that spirit, she argued for its inclusion in the high school curriculum.

Any one vitally concerned with the teaching of high school pupils and observant of the rapidly growing public need for some knowledge of quantitative method in social problems must be asking what portions of statistical method can be brought within the comprehension of high school boys and girls, and in what way these can best be presented to them. ([Walker 1931](#), p. 125)

3. The War Years and Their Aftermath (1940s – 1950s)

Back to reality, the grand hopes for change in the mathematics curriculum of the 1920s and early 1930s were dashed by a much bigger issue, and one beyond anyone's direct control—the Depression. Mere survival took precedence over any fine-tuning of the schools. In the years during and after World War II, however, the direction of educational concerns was reversed dramatically, and the role of mathematical science became more prominent than ever. Helen Walker was still very much active as President of the American Statistical Association (ASA) in 1944 and President of the American Educational Research Association (AERA) in 1949-50. She was still arguing for greater acceptance of statistics education as essential for the good of society and as a subject that students should begin learning at the school level. She made these points clear in her ASA presidential address, even chiding her fellow statisticians that their future research funding might depend on it.

Ways must be found to make the general nature of statistical thinking better understood by the average intelligent citizen and particularly by persons ... charged with policy formation ([Walker 1945](#), p. 2).

If the public fails to value and support statistical research, we must take some of the blame ourselves in that we have failed to insist that the nature of statistical thinking is an appropriate topic for inclusion in a liberal education. ([Walker 1945](#), p. 6)

The approximate nature of all measurement should be taught in the secondary school but seldom is. This is a pity, for it is easy to devise simple experiments which will make the inescapable unreliability of measurement unforgettable even to immature students, and will even give them the concept of a frequency distribution of errors of observation. ([Walker 1945](#), p. 7)

There is little question that the war years and their aftermath were a boon for statistics, in both research and teaching. Reporting on the “Personnel and Training Problems Created by the Growth of Applied Statistics in the United States,” the National Research Council’s (NRC) Committee on Applied Mathematical Statistics stated that “Definite advantages would result if

certain aspects of elementary statistics were effectively taught in the secondary schools" ([NRC 1947](#), p. 17). The committee further explained that such progress in teaching statistics, even at the college level, is hindered by a shortage of adequately prepared teachers. This problem remains one of the ever-present issues in teaching statistics below the college level to this day.

In 1948, W. Edwards Deming, an eminent statistician at the U.S. Government's Departments of Agriculture and Census and the National Bureau of Standards before gaining prominence in industrial quality improvement, wrote, "There is a pressing need for introducing very general courses into the high schools and more widely into the colleges so that ... future citizens may have the valuable orientation in quantitative thinking about social affairs which statistics affords." ([Dutka and Kafka 1950](#), p. 6)

These efforts at building a case for statistics to become a standard part of the school curriculum had small victories along the way, but the cumulative effect began to turn the tide in noticeable ways in the 1950s. Prominent among those effecting this change was Frederick Mosteller, a leader in the statistical research community who had a keen eye for and appreciation of statistics education, and was also a member of the College Entrance Examination Board (CEEB). Not satisfied that it was examining, and thus promoting, the right mathematics for the age, the CEEB appointed a Commission on Mathematics in 1955 with the goal of "improving the program of college preparatory mathematics in the secondary schools" ([CEEB 1959](#), p. 1). Along with Professor Mosteller, members of the Commission included statistician Samuel Wilks, Robert Rourke, a high school mathematics teacher, and George Thomas, a college mathematics professor: all interested in improving and expanding the teaching of statistics. The Commission reported

Statistical thinking is part of daily activities, and an introduction to statistical thinking in high school will enhance deductive thinking. Numerical data, frequency distribution tables, averages, medians, means, range, quartiles were to be introduced in 9th grade. A more formal examination of probability concepts should be introduced later (grade 12) ([CEEB 1959](#), p. 5).

An outline for the recommended statistics course is shown in the [Appendix](#) to this article. Seeing that these discussions were leading to positive recommendations on statistics, Mosteller, Rourke and Thomas wrote a book for a high school statistics course that was approved and published by the CEEB. *Introductory Probability with Statistical Applications: An Experimental Course* (1957) became a best seller for the CEEB, which was not actually in the publishing business. To solve this problem, Mosteller, Rourke and Thomas expanded the material into their popular textbook *Probability With Statistical Applications*, which can probably still be found on the bookshelves of many teachers of introductory statistics. Unfortunately, most of these teachers are found in colleges, not in high schools, but the CEEB effort did raise the awareness of the importance of and possibilities for statistics in the schools, and neither the College Board nor Frederick Mosteller forgot about these possibilities.

4. The Revolutionary 1960s and 1970s

The revolutions of the 1960s in the U.S. were not just in politics or in the promise of television as the cure-all in education. This was also the beginning of a data revolution, prompted in part by a space race and computing power that changed the interest in and practice of statistics.

While president of ASA in 1968, Frederick Mosteller reached out to the National Council of Teachers of Mathematics (NCTM) to establish the *ASA and NCTM Joint Committee on the Curriculum in Probability and Statistics*, and led it in the development of materials for the schools that changed the tone of high school statistics from an emphasis on probability to an emphasis on data. *Statistics: A Guide to the Unknown*, one of the early publications of the Joint Committee, is a collection of essays intended for the lay public, teachers and students. Written by statisticians, the essays describe important real-life applications of statistics and probability. *Statistics by Example*, a series of four booklets, provided real examples with real data for students to analyze from data exploration and description through model building. These set the stage for later publications of the Joint Committee to be described below.

At this juncture, the history of statistics in the schools must reference another key player, even though he would never admit to knowing anything about statistics teaching at the school level. John Tukey, a professor of statistics at Princeton and a colleague of Frederick Mosteller, is credited with steering much of the emphasis in the statistics profession away from mathematical theory and toward data analysis during the 1960s and 1970s. During this time, he invented many of the data analytic procedures in common usage today. Professor Mosteller and the members of the Joint Committee he influenced during and after his term as chair became disciples of the Tukey approach to data analysis and worked on adapting this approach to materials suitable for use at the school level.

Before moving on, one should be clear about what Professor Tukey meant by the term “data analysis.” In his words,

All in all, I have come to feel that my central interest is in data analysis, which I take to include, among other things: procedures for analyzing data, techniques for interpreting the results of such procedures, ways of planning the gathering of data to make its analysis easier, more precise or more accurate, and all the machinery and results of (mathematical) statistics which apply to analyzing data. ([Tukey 1962](#), p. 6)

Adaptations of these four steps play a key role in developing a coherent curriculum in statistics for the schools. (Tukey also gently chided statistics teachers for teaching “cookbookery” rather than the “art of cooking.”)

By the mid 1970s, many interested parties were concerned about the trends in mathematics education, K-12, that had developed since the war years with influence from the space race. To gain insights on these trends, the Conference Board of the Mathematical Sciences formed a National Advisory Committee on Mathematics Education (NACOME). Statistics education is summarized in one key statement: “While probability instruction seems to have made some progress, statistics instruction has yet to get off the ground.” ([NACOME 1975](#), p. 45) The report states that statistics should be given more attention because of its importance in the life of every citizen.

Even though numerical information is encountered everywhere, in newspapers and in magazines, on radio and on television, few people have the training to accept such information critically and to use it effectively. ([NACOME 1975](#), p. 45)

The Committee allowed that there had been some small advances, especially through the Joint Committee, reporting that *Statistics: A Guide to the Unknown* had sold 50,000 copies (but mostly at the college level) and *Statistics by Example* had sold 15,000 copies. Their recommendations on teaching the subject included “use statistical topics to illustrate and motivate mathematics, emphasize statistics as an interdisciplinary subject, and develop several separate courses dealing with statistics to meet varied local conditions.” ([NACOME 1975](#), p. 47) One such course should be about “making sense of numbers” and another should be more probability based.

5. The Progressive 1980s and 1990s

The interplay between the Mosteller-Tukey heritage and the efforts of ASA and NCTM through the Joint Committee and otherwise, with considerable help from the National Science Foundation, led to real progress in statistics education during the decade of the 1980s. Quite fortuitously for statistics educators, this began with the publication in 1980 of NCTM’s *An Agenda for Action: Recommendations for School Mathematics of the 1980s*, which included numerous references to statistical topics that should play an increasing role in the mathematics curriculum (often without using the term “statistics”). For example, the section on problem solving recommends more emphasis on methods of gathering, organizing, and interpreting information, drawing and testing inferences from data, and communicating results. The section on basic skills states, “There should be increased emphasis on such activities as: locating and processing quantitative information; collecting data; organizing and presenting data; interpreting data; drawing inferences and predicting from data” ([NCTM 1980](#)). Before tracking this progress, however, another important thread needs to be woven into the cord, and that thread weaves its way across the ocean from England.

Much as in the United States, England had seen an interest in teaching probability and statistics in the schools for many years and saw that interest and effort increase following the war years. Little progress was made at establishing a coherent curriculum in statistics until the Royal Statistical Society (RSS) formed a Committee on Statistical Education in 1967. This Committee established the Schools Council Project on Statistical Education (POSE) to develop teaching materials that would help students become aware of and appreciate the role of statistics in society, while demonstrating the power and limitations of statistical thought. This led to the series called *Statistics in Your World*, which, under the direction of Peter Holmes, produced a massive amount of teaching material centered on everyday events presented in easy to use formats, such as projects for students. Among his many contributions to statistics education, Peter Holmes was the founding editor of the journal *Teaching Statistics*, started in 1979, and led efforts to the establishment of the Centre for Statistical Education, still one of the world’s outstanding bases for statistics education, now under the auspices of the RSS.

Influences of Mosteller, Tukey, early work of the Joint Committee, and the Schools Council Project, all fed into the work of the ASA-NCTM Joint Committee in the 1980s, greatly aided by the advent of desktop computing. The Committee began that decade under the leadership of Jim Swift, who had become a disciple of the Tukey approach to data analysis, the basic elements of which he had been teaching to his own high school students in Toronto. The goal then became to develop materials along these same lines for American schools, and to provide workshops for

teachers in order to introduce a wider audience to this modern, active approach to teaching statistics through data.

After a few years of developmental work followed by a successful effort at obtaining a large grant from the National Science Foundation, the ASA-NCTM Quantitative Literacy Project (QLP) was born. The QLP originally consisted of four booklets, *Exploring Data, Exploring Probability, The Art and Technique of Simulation, and Exploring Surveys and Information from Samples*, and a plan for carrying out many workshops across the country. (See Scheaffer [1986](#) and [1991](#) for more details on the QLP.) The QLP did not foment a revolution, but the booklets sold well and the workshops were successful in influencing a number of teachers and mathematics educators, especially some of those who were to develop NSF-funded teaching materials for elementary and middle school mathematics in the ensuing years, and, fortunately, the NCTM Board of Directors.

During the late 1980s, the NCTM was developing its *Curriculum and Evaluation Standards for School Mathematics*. The NCTM leadership decided to take the opportunity to help make statistics an integral part of the mathematics curriculum by giving it status as one of the five content strands to be taught throughout the school years. Here are a few quotes:

Collecting, organizing, describing and interpreting data ... are skills that are increasingly important in a society based on technology and communication. These processes are particularly appropriate for younger children because they can be used to solve problems that are inherently interesting, represent significant applications of mathematics to practical questions, and offer rich opportunities for mathematical inquiry. ([NCTM 1989](#))

Instructional programs from prekindergarten through grade 12 should enable all students to—

- formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them;
- select and use appropriate statistical methods to analyze data;
- develop and evaluate inferences and predictions that are based on data;
- understand and apply basic concepts of probability.

([NCTM 1989](#))

Throughout the 1980s and 1990s, many other reports and activities came to the support of statistics education. In the early 1980s, about the time the QLP was just getting off the ground, a National Commission on Excellence in Education was appointed to study mathematics education in the country. Their report, *A Nation at Risk*, was highly supportive of statistics and probability, both directly and indirectly.

The teaching of mathematics in high school should equip graduates to

- understand geometric and algebraic concepts;
- understand elementary probability and statistics;
- apply mathematics in everyday situations; and
- estimate, approximate, measure, and test the accuracy of their calculations.

([National Commission 1983](#), p. 25)

A great boost to both the early and future efforts in statistics education was provided by the Woodrow Wilson Foundation, which, in 1984, funded a series of month-long summer workshops for teachers with the first one being on statistics. QLP materials, although still in draft form, became the basic curriculum for the workshop, and some of the developers of the QLP (including Jim Swift) were chosen as workshop leaders. The Foundation selected 50 of the very best high school mathematics teachers in the country to attend, and then magnified the effect of the workshop by providing the participating teachers with funds to carry out workshops across the country. This network of teachers became, over the years, the backbone of the statistics education community at the school classroom level.

By the 1990s, the National Research Council's Mathematical Sciences Education Board (MSEB) was strongly aligned with the movement toward more statistics in the mathematics curriculum of the schools.

If students are to be better prepared mathematically for vocations as well as for everyday life, the elementary school mathematics must include substantial subject matter other than arithmetic:
...*Data analysis*, including collection, organization, representation, and interpretation of data; construction of statistical tables and diagrams; and the use of data for analytic and predictive purposes;
...*Probability*, introduced with simple experiments and data-gathering ([MSEB 1990](#), p 42)

Secondary school mathematics should introduce the entire spectrum of mathematical sciences: ... data analysis, probability and sampling distributions, and inferential reasoning.
([MSEB 1990](#), p 46)

Indeed, the 1990s were a period of rapid development of state curriculum standards on data analysis, of NSF support of teacher enhancement and materials development projects on statistics, and, not least of all, of AP Statistics. As to the latter, the notion of an advanced placement course in statistics was on the minds of some at the College Board dating back to the days shortly after the CEEB activities described above. Interestingly, it was the AP Calculus Committee that took the lead in seriously considering statistics as a second advanced placement course in the mathematical sciences. After a number of surveys of both high school mathematics specialists and college teachers of mathematics and statistics during the 1980s, statistics won the day; the course was approved in 1995 for testing in 1997. (See [Roberts, et al. 1999](#) for details on the development of AP Statistics.) One of the key questions delaying the approval of this course was the availability of teachers who could teach the subject in high school. Fortunately for the success of the program, good teachers did appear in those early years. Where did many of them come from? The network of teachers built by the Woodrow Wilson Institute participants and their followers!

6. The Turn of the Century (The 2000s)

Events regarding statistics education in the schools continued to move forward in the 21st Century, the century some were calling the “information age.” The College Board (recall the old CEEB) published *College Board Standards for College Success: Mathematics and Statistics*, which included as strong a strand on statistics and probability as the title suggests ([College Board 2006](#)). The National Assessment of Educational Progress (NAEP), the so-called nation’s

report card, included data analysis, statistics and probability as one of the five content areas in its framework for mathematics, directing about 10%, 15% and 25% of the assessment toward this content for grades 4, 8, and 12, respectively ([National Assessment Governing Board 2012](#)). The Conference Board of the Mathematical Sciences published its report on *The Mathematics Education of Teachers*, with statistics included as a vital topic in elementary through high school grades ([CBMS 2001](#)).

As to the school curriculum itself, what may well be the most influential document of the early 21st century is the *Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report* adopted by the American Statistical Association in 2007 ([Franklin 2007](#)). GAISE follows the Tukey model for data analysis in the sense that the guidelines are built around the four-fold model of formulating questions, collecting data, analyzing data and interpreting results. These steps should be encountered at appropriate levels in elementary and secondary grades and should be tied closely to the mathematics being taught, providing illustration, motivation and emphasis on its importance as a useful tool. The GAISE report has influenced those revising state guidelines in mathematics and those developing teaching materials. It also influenced the team producing the Common Core State Standards in mathematics.

7. Looking Forward

At this writing, the future of statistics in the school mathematics curriculum largely depends on the success or failure of the Common Core State Standards in Mathematics (CCSS-M) (<http://www.corestandards.org/>), to which 45 states and the District of Columbia have initially ascribed. These Standards include a strong strand in statistics and probability in grades 6 through 12, but not much of a direct nature in the elementary grades. A rough outline of these standards follows:

- K-5: No specifics, but opportunities are present in Measurement and Data
- 6: Explore univariate data
- 7: Produce data through randomization; informal inference (simulation); single event probability
- 8: Explore bivariate data
- 9-12: summarize and interpret data (normal model; simple linear regression); design randomized studies; informal inference (margin of error, statistical significance)

In addition, the modeling standards tie modeling to statistics, as well as to algebra and geometry. What will determine the success of the CCSS-M are the assessments that go with them, which are yet to be completed at the time of this article.

Supporting of the CCSS-M and seeing the need for enhanced teacher education if these standards are to positively impact mathematics teaching, the Conference Board of the Mathematical Sciences has updated its booklet on *The Mathematical Education of Teachers* to *The Mathematical Education of Teachers II* ([CBMS 2012](#)). The report makes clear that statistics departments are to be considered in parallel to mathematics departments in all aspects of the report, even though “and statistics” is not added at every reference to mathematics. Here are a

few of the recommendations that statistics departments and statistics teaching units in colleges across the country should take to heart.

General Recommendations for Mathematics and Statistics Departments

1. Prospective teachers need mathematics courses that develop a solid understanding of the mathematics they will teach.
3. Throughout their careers teachers need opportunities for continued professional growth in their mathematical knowledge.
5. More mathematics faculty need to become deeply involved in PreK-12 mathematics education by participating in preparation and professional development for teachers and becoming involved with local schools and districts.

([CBMS 2012](#), pp. 17-19)

Course recommendations in statistics can be summarized briefly as follows:

Elementary Grades (K-5): Data exploration at least at the level of the grade six recommendation in the CCSS-M

Middle Grades (6-8): A modern introductory statistics course plus a course emphasizing the teaching of statistics

High School Grades: Two courses in statistical content; additional material in professional development or graduate school contexts, especially for those planning to teach AP Statistics

Recognizing that these recommendations are generally outside the scope and interests of most present-day statistics programs, ASA organized a team of statistics and mathematics educators to develop a document on the statistics education of teachers, building upon *MET II*, that will provide more detailed guidance on the types of changes that need to take place in teacher education. (At this writing, that document is under development.) Changing the culture of statistics programs in order to adapt to the needs of teachers will be a major challenge for both the statistics and mathematics education communities, but it is an essential cultural shift that can be achieved by these two communities working together.

8. Conclusion

Writing in the 19th century, an early father of the use statistics in the social sciences, Adolphe Quetelet, said, “The statistician keeps his finger on the pulse of humanity, and gives the necessary warning when things are not as they should be” ([Walker 1945](#), p. 10). The “pulse of humanity” is now too complex for any one profession (statistics, for example) to check and give warning. All educated persons must be involved as alert consumers, informed citizens and skilled workers. For nearly a century, many groups and individuals have argued that statistical thinking should be an integral part of the knowledge base of every educated person, and the

development of that knowledge must begin at the school level. Much progress has been made toward this objective, and rich groundwork has been laid, but there is still work to be done.

The JSE Department of Research on K-12 Statistics Education aims to serve as an outlet for statistics education researchers to share their work with statisticians and education researchers so the field will continue to improve the teaching and learning of statistics in the K-12 setting. We encourage members of the mathematics and statistics education communities conducting work in this area to submit manuscripts for review. Articles submitted for this new department will go through the same peer review process as other submissions to JSE. Let's ensure the historical efforts that have been made to include statistics in the curriculum are not forgotten and we build upon the great work of those who came before us.

Appendix

Report of the Commission on Mathematics College Entrance Examination Board-1959

Introductory Probability with Statistical Applications

- I. The nature of probability and statistics.
- II. Organization and presentation of data—the frequency distribution.
- III. Summarizing a set of measurements—the mean and standard deviation.
- IV. Intuitive approach to probability.
- V. Formal approach to probability.
- VI. The law of chance for repeated trials—the binomial distribution.
- VII. Applications of binomial distribution.
- VIII. Using samples for estimation—sampling from a finite population.
- IX. (Supplementary) The laws of uncertainty—probability distributions.
- X. (Supplementary) Relations between two variables—fitting a straight line.

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