American Statistical Association
732 North Washington Street, Alexandria, VA 22314-1943
(703) 684-1221 ▪ Fax: (703) 684-2037 ▪ Email: asainfo@amstat.org
Web: www.amstat.org

MET II Response
American Statistical Association Review Group

With the adoption of the Common Core State Standards (CCSS) in Mathematics, the role of statistics in the K-12 curriculum, especially at the middle school and high school levels, will change in dramatic ways. With statistics taking a more prominent place, successful implementation of the CCSS will require that the middle school and high school mathematics curricula include statistics content that goes beyond the mechanical and computational aspects of descriptive statistical methods to focus on the conceptual understanding necessary for the development of sound statistical reasoning. We think that overall, the MET II draft document is a strong document that recognizes the challenges that this presents for mathematics teachers at all levels.

The American Statistical Association (ASA) established a review group consisting of K-12 statistics teachers and university level statistics educators with strong ties to K-12 statistics education. This group provided comments on the MET II draft. These comments are the basis for this ASA response and the recommendations that follow.

Because CCSS concentrates most of its statistical content at the middle and high school levels, the majority of the comments and suggestions below are focused on pre-service teacher education at those levels and on the need for professional development opportunities for in-service teachers.

Comments and Recommendations for Chapter 3: Recommendations

To strengthen and clarify the recommendations made in Chapter 3, we offer the following specific comments and suggestions:

(Page 8): In the section devoted to recommendation 2, we strongly support the decision described in the statement "For both middle grades and high school teachers, the recommended statistics-probability courses in this report are quite different from those in the 2001 MET report: they now focus more on data collection, analysis, and interpretation needed to teach the statistics outlined in the CCSS." We believe that this is appropriate, especially given the conceptual and data focus of the CCSS in statistics.

(Page 8): In the second paragraph of the section devoted to recommendation 3, we recommend changing the reference to AP statistics to delete the "AP." With the implementation of CCSS, the statement in this paragraph really applies to all middle and high

school teachers, not just AP statistics teachers. We recommend that the last sentence of this recommendation be changed to read:

> But, that teacher might require further education in mathematics and statistics in order to be well prepared to teach subjects such as precalculus, calculus, statistics, discrete mathematics, and matrix algebra.

Comments and Recommendations for Chapter 4: Elementary teachers

Even though only limited data content is included in the CCSS for elementary grades (primarily in the standards for measurement), the MET II draft notes that in order for teachers at this level to make connections to the statistics and probability content in grades 6 – 8, teachers in the elementary grades do need to understand the methods of descriptive statistics, including the use of basic graphs, the notion of describing variability in data distributions, and the need to take variability into account when comparing distributions. They also need to have a "big picture" understanding of the four-step data analysis process (as described in the ASA GAISE PreK-12 Report*) and of how sample data is used to learn about populations. We concur with these observations (page 14), and we support the recommendation that the preparation of elementary teachers include course work that includes 6 semester hours devoted to additional mathematics topics that would include a data component (page 15).

*www.amstat.org/education/GAISE

Comments and Recommendations for Chapter 5: Middle grades teachers

The study of statistics begins in earnest in grade 6, and the middle school curriculum specified in the CCSS provides the foundation for the inferential concepts that follow in the high school curriculum. The breadth and depth of the statistics content in middle school will be one of the major challenges in the preparation of middle school teachers. Most programs that prepare the "generalist" teacher do not provide the level of preparation needed in order for future teachers to understand and to teach the very demanding statistics content of CCSS.

We agree with the MET II draft report statements that future middle school teachers need to understand the mathematics in the middle grades from a teachers prospective, and that teachers also need to be able to see how the content in the middle school curriculum connects with the high school curriculum. We strongly support the statement "an introductory statistics course should be included to prepare students for the statistics and probability course designed for middle grade teachers" (page 24).

We also agree that the CCSS for Mathematical Practice are intertwined with the content standards and must be made explicit in both pre-service and in-service professional development programs.

To strengthen and clarify the recommendations made in the section "Preparation Programs for Middle Grades Teachers," we offer the following specific comments and suggestions:

(Page 24): Regarding the description of the course work, the statement

> 1 course in statistics and probability (A recommended prerequisite is an introductory statistics course. This allows the course designed for middle grade teachers to probe deeply into the topics taught in the middle grades.)

may not make it clear to all readers that this is a recommendation for two statistics related courses. We recommend that this be worded as

> 1 course in introductory statistics and 1 course in statistics specifically designed for middle grade teachers that includes deep coverage of the concepts and methods taught in the middle grades

Also, because these courses are not currently part of most middle school teacher preparation programs, we recommend that these courses be described in more detail, similar to what is done in Chapter 6 of the report for high school. The description of the introductory statistics course that appears in Chapter 6 as the last paragraph of the *Statistics and Probability* section on page 29, would also work well here. This course would provide an overview of statistics and allow middle school teachers to make important connections to the high school statistics content.

For the course designed specifically for middle school teachers, we agree that the content of this course should allow deep probing of all CCSS middle school standards in statistics and probability, and that it needs to be a new data-centered course. This course should include both pedagogy and content. Teachers should be exposed to the experiential learning gained from collecting data and using software to organize and analyze data. Because this will be a new course, we recommend describing its content and concepts in more detail, and offer the following suggestion:

> Statistics and Probability: The statistical process as an investigative four-step process as described in the PreK-12 GAISE Report; the use of distributions to describe variability in data (categorical and numerical data, tabular and graphical displays, measures of center and amount of variability, description of shape, identification of outliers); comparison of two or more numerical data sets (similarities and differences between distributions, comparison of shape, center, and spread); distributions for two categorical variables (tabular and graphical displays, association, conditional relative frequency distributions); measures of relationship for numerical variables leading to correlation; random sampling; using data from a random sample to learn about population characteristics (sample statistics, sample-to-sample variability); probability models (sample space, events, simulation).

(Page 24): Because statistical models are widely used in biological, political, social, and physical settings, we recommend that the description of the modeling course be revised to include statistics in the following way:

> A substantive mathematical modeling course can provide prospective teachers with understanding of the ways in which mathematics *and statistics* can be applied.

(Page 25): The CCSS content in statistics and probability is deeper and more conceptual that is typical in the current middle school curriculum. Most in-service middle school teachers will now be expected to include this content, and they are have not been prepared to do this. Successful implementation of CCSS in statistics and probability will have immediate implications for teacher professional development. This will necessitate a large and concerted professional development effort. To call attention to this need, we recommend that this be noted in the section titled *Professional Development for Middle Grades Teachers*. This might be done by changing the second sentence of this section to

> Many teachers prepared before the era of CCSS will need opportunities to study content that they have not previously taught, *particularly in the areas of statistics and probability*.

Comments and Recommendations for Chapter 6: High school teachers

The integration of statistics and probability in the high school curriculum called for in CCSS is timely because statistical literacy and the ability to reason about data have never been more important than they are today. To be effective citizens, educated consumers, and to have productive professional lives, students need to develop the ability to reason statistically as well as mathematically. The primary challenge this presents for mathematics teachers is that statistics differs from mathematics in fundamental ways. Mathematics is built on a foundation of deduction, abstraction, and proof, while the foundation of statistics is based on inference, data analysis, and uncertainty. Adoption of the CCSS means that high school teachers will now have the added responsibility of developing students' abilities to reason inferentially with data.

The MET II draft notes that there is often a disconnect between the mathematics course work of future teachers and what they are then expected to teach when they reach the high school classroom. We emphasize that this disconnect is especially true in the area of statistics, where pre-service teachers are often required to take a single calculus based statistics course designed for engineers and mathematics majors or a mathematical statistics course. At most universities, the content of these courses is very different from the statistics and probability content in CCSS, and does not provide adequate preparation for future teachers. Because of this disconnect, we strongly support the MET II draft in its call for courses that are tailored to the work of teaching.

To strengthen and clarify the recommendations made in the section "Essentials for Future Teachers," we offer the following specific comments and suggestions:

(Page 29): In the first paragraph of the section titled *Statistics and probability*, the use of the term mathematical (as opposed to statistical) models and the phrase "based on randomness" in the last sentence may be confusing to some readers. We suggest rewording this to

> In preparation for teaching this, teachers should see real-world data sets, understand what makes a data set good or bad for answering the question at hand, appreciate the omnipresence of variability, and see the quantification and explanation of variability via *statistical* models *that incorporate variability*.

(Page 29): We support the statement that the statistics course for future engineers and science majors at most institutions is not the appropriate course for future high school mathematics teachers (in the second paragraph of the section titled *Statistics and probability*). Having this course or a mathematical statistics course as the required statistics course for future teachers contributes to the disconnect between the mathematical training of teachers and what they are then expected to teach at the high school level. The description of the content and concepts that should be included in a course for future high school teachers is well done and appropriate for future high school teachers. We recommend that the statement "introduction to the use of randomization in data production and inferential reasoning" be changed to

> Introduction to the use of randomization and simulation in data production and inferential reasoning

(Page 31): In the discussion of modeling, much of what is described involves statistical modeling. We recommend that the title of this section be changed from Modeling to *Mathematical and statistical modeling*.

(Page 32): In the section titled *Experience with technology*, we note that one important use of technology is in the analysis of data. We recommend that the first sentence of this section be revised to read

> Teachers should become familiar with various software programs and technology platforms, learning how to use them to *analyze data*, reduce computational overhead, to build computational models of mathematical objects, and to perform mathematical and *statistical* experiments.

To strengthen and clarify the recommendations made in the section "Topics for Future or Early-career Teachers," we offer the following specific comments and suggestions:

(Page 32): In the section titled *Further statistics*, a second course in statistics is recommended for "teachers who plan to teach statistics." While this second course would almost certainly be needed for any teacher that plans to teach AP Statistics, we believe that this second course is actually something that should be moved up into the previous section as a recommendation for all future high school teachers. The reason for this recommendation is that with the implementation of CCSS, the teaching of statistics will no longer be done by the relatively small group of high school teachers who teach AP Statistics. The statistics content of the high school curriculum *for all students*, as specified by the CCSS, goes well beyond (both conceptually and in terms of content) what has been included in the past. Both of the model pathways (traditional and integrated) that have been associated with CCSS include sophisticated and challenging concepts in probability and statistics in all three years of high school mathematics for all students. This means that virtually all high school mathematics teachers will have the added

responsibility of being statistics teachers as well as mathematics teachers. As a consequence, the recommended second course in statistics "for those who plan to teach statistics" should be a recommended course for all future high school teachers. Further, a second course will allow high school teachers of statistics to make important connections to college and AP level statistics and will ensure that teachers can place what they are teaching within a broader view of the subject by providing them with a foundation that is somewhat broader and deeper than just the content they are expected to teach. For these reasons, we recommend that:

> The *Further statistics* section be moved up to page 29 to the *Statistics and probability* section of *Essentials for Future Teachers*.

(Page 34): The CCSS content in statistics and probability is deeper and more conceptual that is typical in the current high school curriculum. Most in-service high school teachers will now be expected to include this content, and they have not been prepared to do this. Successful implementation of CCSS in statistics and probability will have immediate implications for teacher professional development. This will necessitate a large and concerted professional development effort. To call attention to this need, we recommend that this be noted in the section titled *Experiences for Practicing Teachers*. This might be done by incorporating a statement like the one on page 25 of Chapter 5, with modification to note the particular need in the area of statistics and probability. For example, the following paragraph could be added to the beginning of the *Experiences for Practicing Teachers* section:

> All teachers need continuing opportunities to deepen and strengthen their mathematical knowledge for teaching. Many teachers prepared before the era of CCSS will need opportunities to study content that they have not previously taught, *particularly in the areas of statistics and probability*.