

## STATISTICS EDUCATION IN ETHIOPIA: SUCCESSES, CHALLENGES AND OPPORTUNITIES

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*In Ethiopia, efforts to increase enrollment and access to education have placed significant pressures on the training needs of teacher education programs, particularly for programs in Science and Mathematics Education (SMED). SMED is a driving factor in current priorities set forth by the Ethiopian Ministry of Education. Addis Ababa University has initiated several programs and directives focused on preparing well-trained masters and PhD students in SMED to support the expansion of science and mathematics education. In our paper, we take a case-study perspective and review the current Ethiopian curriculum in statistics and probability, and describe ongoing teaching, research and outreach efforts with potential to improve education in statistics, particularly within teacher training programs. Finally, we highlight recent efforts to improve statistical skills and quantitative research for graduate programs in teacher education.*

### BACKGROUND

The current Ethiopian education system relies on the 1994 education and training policy (Transitional Government of Ethiopia, 1994), which emphasizes problem solving capability and democratic culture. As a consequence of the 1994 policy and subsequent directives, extensive efforts were made to realize these intended outcomes by improving and expanding education for Ethiopia's multilingual and multicultural society. To ensure successful implementation, education sector development programs (ESDP) and a general education quality improvement package (GEQIP) have been in place for several years. Currently, as part of the Ministry of Education's (MoE) growth and transformation plan (GTP) (MoE, 2010a), the ESDP IV (from 2010/11 – 2014/15) is being implemented and, following detailed review of GEQIP I, a second phase GEQIP II is in its initial stages of implementation. The following are some key outcomes for general education as outlined in the ESDP IV action plan:

- Access to primary education universalized by 2015, through a continued expansion of formal primary education and when/wherever necessary through alternative basic education centers.
- General secondary education expanded in view of its universalization by 2025 in line with the Middle Income Country Vision (MoE, 2010b).

Equally significant is the Ministry's focus on higher education expansion and quality, for which key outcomes include:

- A balanced distribution of higher education opportunities throughout the country based on widening access to higher education, with particular emphasis on science and technology.
- Increased student learning, personal growth and improved employability through high-quality higher education and relevant professional mix (MoE, 2010b).

Related to these education expansion efforts, the Ministry of Education in Ethiopia has published a professional mix guideline based on a 70:30 annual intake ratio favoring placement of students into science and technology programs over programs in the social sciences and humanities (MoE, 2008). In support of these goals, the current number of primary and secondary schools has reached to 29,482 and 1710 respectively (MoE, 2013). In addition, 32 colleges of teacher education (for primary schools) and 10 universities offering teacher education are engaged in the training of teachers for these schools. Curriculum for both primary and secondary schools were revised in 2009. Within the mathematics curriculum (see Appendix), data handling is now included in early grades as one of the five strands of mathematics, with statistics and probability beginning in grade 8 (MoE, 2009).

## STATISTICS IN THE SCHOOL CURRICULUM

The massive expansion of schools gives access to all age cohorts of students. Yet it also demands context-based education and selection of proper content to help achieve the stretched goals of the nation. Historically, the level and depth of statistics courses and content which used to be offered before the recently implemented curriculum were limited; for example, statistics was offered only at grade 12 as a single chapter. Among higher education institutes, a majority of the universities offered only an introduction to statistics course, while a few were adding probability and statistics as a second course (for specified departments only). Consequently, these limitations contributed to misconceptions towards statistics and statistics education, where it was considered as a discipline any mathematics graduate can do (and/or teach). During those days, mathematics graduates were the ones who were teaching the statistics chapter in grade 12. In fact, the only university that had an established Department of Statistics was Addis Ababa University (AAU). However, statistics graduates were assumed to be only office bearers (e.g., working in government or other offices), and not educators. This situation still persists to some extent in the Ethiopian context. The teaching of statistics in the schools is done as an extension of the mathematics curriculum by teachers who have pedagogical training and knowledge in mathematics and mathematics education but lack a corresponding emphasis on those principles and concepts that lead to good practice in teaching statistics (Opolot-Okurut, Opyene-Eluk and Mwanamoiza, 2008). Given the importance that an understanding of statistics and statistical concepts has for various careers and particularly for emerging careers in data analysis and manipulation, limitations of teacher preparation in statistics may result in a negative impact for Ethiopia's goals. The curriculum review released by the Ministry in 2009 gave considerable shift in emphasis towards including statistics in the school curriculum. Accordingly, statistics in the school curriculum is now considered as one of the five strands of mathematics and is offered from K-12, except in two grade levels (see Table 1 below), although it is still considered as a component of mathematics. The following table presents the distribution of statistics course-periods in the school curriculum.

Table 1. Total periods allotted at each grade level (K-12) and periods allotted for statistics

| Grade | Total annual periods allotted | Periods allotted for statistics | Percentage (%) |
|-------|-------------------------------|---------------------------------|----------------|
| 1     | 142                           | 5                               | 3.52           |
| 2     | 150                           | 6                               | 4.00           |
| 3     | 150                           | 5                               | 3.33           |
| 4     | 150                           | 10                              | 6.67           |
| 5     | 170                           | 14                              | 8.24           |
| 6     | 170                           | 0                               | 0              |
| 7     | 131                           | 20                              | 15.27          |
| 8     | 155                           | 15                              | 9.68           |
| 9     | 162                           | 22                              | 13.58          |
| 10    | 162                           | 0                               | 0              |
| 11    | Natural Science 179           | 31                              | 17.32          |
|       | Social Science 172            | 31                              | 18.02          |
| 12    | Natural Science 160           | 0                               | 0              |
|       | Social Science 165            | 22                              | 13.33          |

In the Appendix, details are provided regarding expected outcomes for each of the grade levels. Yet despite these efforts to include statistics and data handling in the curriculum, statistics education is poorly understood and the focus given to statistics education, especially at teacher education colleges and universities, is minimal to non-existent.

## TEACHING OF STATISTICS

Clearly, by requiring statistics or data handling to be delivered almost at each grade level, the MoE is addressing the need to include the basics of statistics in the curriculum. But there

remains a corresponding and perhaps more critical need to align instructional design, curriculum and assessment in order to responsibly develop students' statistical reasoning skills. Currently, teacher education does not incorporate statistics as a separate component in its own right. Because of this, most of the mathematics teachers usually do not have a strong background in statistics, thus they fail to present and demonstrate statistics as a useful tool (Zewotir, 2006, 2011). Although the policy mandated by the MoE envisions problem-solving as a primary goal, teaching materials such as textbooks and curriculum guides focus on numeric representations and emphasize computations. This emphasis mirrors that of other African countries; for example, Opolot-Okurut et al (2008) found that at the lower school levels (in Uganda) statistics is characterized by a classic formula-based approach with emphasis on computation and little reference to statistical reasoning and problem-solving. The utility of statistics education, from the part of the statisticians, also doesn't seem to be up to the requirement to focus more on reasoning and problem-solving aspects. In the consecutive five annual conferences (2008 – 2012) of Ethiopian Statistical Association (ESA), no single article addresses issues of statistics education.

Within tertiary and graduate education in general, the status of statistics and its place in the curriculum is daunting. Students' background in statistics is far from expectations and presents limits on university or college research training and research output. Because of this, a significant number of graduate students are twisting towards qualitative research for fear of statistics. Cognizant of the limited statistical background of students, since 2009 AAU has offered preparatory modules in statistics, SPSS and other computer/statistical languages for those who are granted admission to the graduate program. Nonetheless, a majority of those who participated in the module delivery do not themselves have essential background to teach statistics. Adding to this problem, unfortunately, was the termination of this program in 2012.

### SUCCESSES, CHALLENGES AND OPPORTUNITIES

Recently, some of the universities in Ethiopia have started offering statistics as a discipline in its own right, which previously was exclusively limited to AAU. In addition to the delivery of statistics, AAU has initiated several programs and directives focused on preparing well-trained masters and PhD students in science and mathematics education (SMED) to support the expansion of science and mathematics education. This is currently the only program of its kind in the country, and is limited to mathematics education, biology education, chemistry education, physics education and physical education. However, the department is laying the foundation to expand its efforts and establish programs for other essential disciplines including statistics and technology education. In part to consolidate these efforts, SMED faculty and staff are encouraging students to complete their research theses related to statistics education at both the Master's and PhD levels. So far, two Master's students have completed their thesis in relation to statistics education, and one PhD student is doing his research in matters related to statistics education, principally supervised by a professor from Oregon State University, USA. These studies are intended to provide information on students' attitudes towards statistics, effects of different teaching methods on statistical reasoning and achievement, and a better understanding of the practice of teaching statistics within Ethiopian schools.

Collaborative efforts are also in place between AAU's College of Education and Behavioral Studies and The Ohio State University, USA, to strengthen student opportunities (as well as opportunities for faculty and staff) related to research methods and statistics, statistics education, and instructional technology, which is fundamental for these fields. As these collaborations continue to grow, benefits are expected to accrue for many programs across the College. In the case of statistics education, and as research in this area expands, critical information regarding how statistics is currently taught across the curriculum and identification of promising teaching methods that work within the Ethiopian context can be identified and promoted.

Even with the experience of initial successes in launching the SMED graduate programs and in building collaborations within the university and abroad, AAU and other universities in Ethiopia remain confronted with several challenges regarding statistics training and statistics education. At the same time, there are far-reaching opportunities. We outline these successes, challenges, and opportunities below.

### *Successes*

Ethiopian successes in statistics and statistics education at primary, secondary and tertiary levels include:

- Statistics has achieved recognition as an important discipline separate from mathematics, and undergraduate programs in statistics are available in six universities this time.
- Statistics is offered in almost every grade level K-12, although as component of the mathematics curriculum.
- Despite being terminated for a while, AAU undertook to offer statistics for all graduate program students (AAU, 2009).
- Graduate students and their advisors have established research programs in statistics and statistics education (as noted above, one PhD candidate and two Master students are completing their theses in topics related to statistics education in primary and secondary schools).

### *Challenges*

There are important challenges to improving the quality of education in statistics at all levels of schooling. Some of these challenges are:

- Statistics education in Ethiopia is at its infant stage, so hard work is needed to lay a solid foundation and stabilize its emergence.
- The involvement of statisticians is limited (much of the effort in statistics and statistics education is still under the expertise of mathematics/mathematicians).
- Ethiopia currently experiences critical limitations in capacity of both human and material resources that affects competence in and delivery of statistical knowledge.
- Teachers and learners are faced with conception gaps which presents further capacity-building needs
- Unfamiliarity with pedagogy and best practices for statistics education
- The quality of implemented education policies were not adequately informed by empirical data, and little effort was made to explore variable use of real data such as census information [conducted by the central statistical agency of Ethiopia] (Zewotir, 2006)
- Preparing teachers to teach statistics is vital to further the improvement of statistics education at all levels, and in all contexts (Zewotir, 2011), but the exclusion of statistics courses in teacher education programs impedes these goals.

### *Opportunities*

Statistics education, though presented with some challenges, is in beginning stages of a reform initiative that has opened several windows of opportunity. Some of these opportunities include:

- Evidence from the experiences of statistics educators around the world indicates that it is the right time to intervene and solidify the basis for statistics education in Ethiopia.
- Graduate students have begun to conduct their research in problems related to statistics education which will be informative and suggestive for further intervention.
- Since 2012, collaboration with faculty at The Ohio State University has opened capacity-building opportunities via successive block teaching on several topics in statistics for graduate students (at AAU as well as at Gondar and Jimma Universities) including Causality and Research Design, Sample Size and Statistical Power, Regression and Multivariate Analysis, Factor Analysis, and Multilevel Modeling. Opportunities for external mentoring and advising have helped to enhance research skills and methodology for AAU graduate students and provides a mechanism for research partnerships with faculty and staff at AAU. Links to research in the schools are beginning. These interconnected opportunities need to be scaled-up to strengthen statistical understanding and simultaneously promote statistics education at all levels.

- There are great opportunities within the in-service programs of teacher preparation based on creative use of technology and e-learning that must be exploited.

## CONCLUSION

Given the importance that statistics and statistics education brings to the public at large, the inclusion of statistics in the school curriculum for both primary and secondary levels is a good beginning, but not sufficient. The inclusion of statistics at tertiary level needs to be investigated seriously. Lack of statistics courses within teacher education programs exacerbate the problems to understand and research issues in teaching and learning of statistics, and these need to be addressed. The AAU initiated program and directives focused on preparing well-trained masters and PhD students in SMED to support the expansion of science and mathematics education in collaboration with the department of statistics can serve as a nucleus for such an effort. The effort made so far in collaboration with Ohio State University is commendable, but requires expansion to launch statistics education at the colleges of teacher education and the universities. Support for this expansion would not only help to overcome the problems related to instruction at the schools but also enhance statistical thinking and research ability at the graduate levels.

Though endowed with several challenges, statistics education is privileged to have many opportunities that can lead to higher quality in statistics, statistical reasoning, and statistical thinking. These include the opening of statistics departments at several universities, the existence of the Ethiopian statisticians' association which can influence policy and practice, the recent inclusion of statistics across the school curriculum, the availability and possibility of using real data for teaching statistics from the central statistics agency, the beginning of collaborative efforts which can be scaled-up to achieve our intentions, and above all the aspirations of the government and the public at large in seeking informed decisions where the knowledge of statistics plays a pivotal role. Through these and other opportunities, the time is right to call upon interested researchers and educators to stretch hands in this effort and help bring statistics education to the fore front and ensure that Ethiopia reaches its goal of becoming a middle income country by 2025.

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## APPENDIX

The outcomes expected of students at the grade levels where statistics is offered in the Ethiopian Curriculum. At each grade level students will be able to:

### Grade 1 Data Handling and pattern (*5 periods*)

- record data using simple pictures like the daily weather
- read data from simple picture graphs
- continue and produce simple patterns of shapes, colours and numbers

### Grade 2 Data handling and patterns (*6 periods*)

- Collect simple data
- Tabulate this data
- Complete and compile simple patterns of shapes and numbers

### Grade 3 Data handling (*5 periods*)

- construct simple picture graphs from data collected
- read data from simple picture graphs

### Grade 4 Data handling (*10 periods*)

- construct bar graphs from data collected
- interpret data from bar graphs
- find average of up to 4 whole numbers

### Grade 5 Data handling (*14 periods*)

- understand simple graphical representation of data
- know and calculate average of a given data

### Grade 7 Data handling (*20 periods*)

- collect data and construct simple line graph, pie charts for a given data
- calculate the mean, mode and median of a given data
- find the range of a given data

### Grade 8 Introduction to probability (*15 periods*)

- understand the concept of certain, uncertain and impossible outcomes
- know specific facts about event, sample space and probability of simple events

### Grade 9 Statistics and Probability (*22 periods*)

- know methods and procedures in collecting and presenting simple statistical data
- know basic concepts about statistical measures
- understand facts and basic principles about probability
- solve simple mathematical problems on statistics and probability

### Grade 11 Statistics and Probability (*31 periods*)

- know specific facts about types of data
- know basic concepts about grouped data
- know principles of counting
- apply facts and principles in computation of probability

### Grade 12 Further on Statistics (*22 periods*)

- know basic concepts about sampling techniques
- construct and interpret statistical graphs
- know specific facts about measurement in statistical data.