PROBING COLLEGE STATISTICS TEACHERS' INSTRUCTIONAL GOALS AND CLASSROOM PRACTICES WITHIN A STATISTICAL LITERACY FRAMEWORK

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In line with the reform efforts in statistics education that emphasized the development of statistical literacy skills, we explored instructional goals and classroom practices of 12 college statistics teachers and analyzed them using Gal's statistical literacy model. Through focus group discussions, we find that their goals and practices in the teaching-learning-assessment cycle are primarily based on mathematical and statistical knowledge and only three displayed evidence of literacy and context knowledge, and the capability for critical questions. While these teachers indicated positive attitude towards the promotion of statistical literacy, there are gaps between attitude and classroom implementations. Aside from the need for alignment of instruction and assessment with this goal, there is need for concerted efforts towards equipping statistics teachers with the knowledge and resources necessary in the promotion of statistical literacy.

INTRODUCTION

Statistics education research over the last decade has pointed out the development of statistical literacy and interpretive skills as a universally recognized goal of instruction (Rumsey, 2002; delMas, 2002). Consequently, reform movements in teaching statistics have given increasing attention on the development of statistical thinking and reasoning as important skills encompassing statistical literacy. These reform movements have implications on both the curriculum of introductory college statistics and the professional development and preparation of teachers. Chance (1997) argued that as instructional goals in statistics courses change emphasizing statistical literacy skills over procedural calculations, there is need for instructors to accompany these new goals with more authentic assessment techniques to evaluate progress towards these goals.

The importance of instructional goals and objectives to direct the teacher's choice of instructional and assessment activities is emphasized by many curriculum experts. Tyler (cited in Horowitz,1995) contended that while there may be differing goals within content fields, the philosophy that a teacher holds of his or her particular domain will influence classroom activities and assessments. In statistics education, Gal and Garfield (1997) presented a broad instructional goal of statistics education and described eight interrelated basic sub-goals which includes the development of interpretive skills and statistical literacy, among others.

Statistics education research literature provides an expanding definition of the term *statistical literacy*. [See for example, Wallman (1993), delMas (2002), Rumsey (2002), Watson and Callingham (2003) for an extensive treatment of this term.] In this paper, we adopted Gal's conception of adult statistical literacy as "the ability to interpret, critically evaluate, and communicate about statistical information and messages" (Gal, 2002). Gal's statistical literacy model comprises two broad interrelated components; namely: (1) *knowledge component* which consists of five cognitive elements: literacy skills, statistical knowledge, mathematical knowledge, context knowledge, and critical questions; and (2) *dispositional component* which consists of three related but distinct concepts; namely: critical stance, beliefs and attitudes.

In this paper, we probed teachers' instructional goals and classroom practices in teaching introductory college statistics courses and drew implications on their statistical literacy knowledge-base and "dispositions" in the light of Gal's model for adult statistical literacy.

BACKGROUND

For many students in the Philippines, the 3-unit introductory college statistics course is their first and only encounter with statistics as a formal subject. The course is generally regarded as part of the mathematics requirement of baccalaureate degree programs. The teaching of this course has suffered relative neglect over the past decade until recently, the Philippine Statistical Association (PSA) raised issues on the quality of locally-authored college statistics textbooks used in these courses. In its 2005 Annual Conference with the theme *"Are We Teaching Statistics Correctly to Our Youth*?," a textbook review committee reported that all nine textbooks reviewed were written by non-statisticians and "statistical reasoning and logic was largely amateurish, with statistical methods enumerated like recipes in a cookbook."

While the quality of college statistics textbooks is one key factor towards ensuring a more relevant and meaningful statistics education, a more pressing issue in the Philippines is the training and preparation of statistics teachers. There are only two universities in the country that offer BS/MS/PhD Statistics programs and both are in the National Capital Region in the North. Thus, there is a dearth of statistics majors who teach in the provinces and the teaching of introductory statistics courses are primarily assigned to mathematics majors.

In a two-day regional statistical literacy seminar for college statistics teachers sponsored by the University of San Carlos in Cebu City last June 2005, preliminary information provided through a questionnaire distributed to 44 participants revealed that majority (62%) of teachers' undergraduate background was primarily in Mathematics and the remaining 38% had their majors in the natural sciences, engineering and psychology while none of them had a Bachelor's degree in Statistics. Further, 72% of the participants indicated that their content coverage in introductory college statistics is limited to descriptive statistics and probability concepts with very minimal coverage on inferential methods; focus is on procedural computations while statistical reasoning is barely addressed. When asked for insights gained from the seminar, majority of the participants found the statistical literacy ideas (mostly taken from the International Statistical Literacy Project website) we presented as new and beyond their traditional approaches in teaching statistics. They expressed the need for revision of their course syllabus with emphasis on statistical literacy.

These preliminary information provided the impetus for a more in-depth examination of teachers' instructional goals and classroom practices in relation to statistical literacy as the foremost goal in teaching introductory college statistics courses. As part of a two-phase project we proposed to the Commission on Higher Education (CHED) to help prepare teachers for the promotion of statistical literacy among students, we followed-up a sample of 12 statistics teachers through focus group discussions to validate the preliminary information provided in the seminar.

PROFILE OF STUDY PARTICIPANTS

The twelve college statistics teachers (4 males, 8 females) represented 8 colleges and universities in two major cities of Region VII(Central Visayas), Philippines. Of these 12 teachers, 9 are teaching in either state or private higher education institutions in Cebu City (the center of commerce and education in Southern Philippines) while the three others are from a private sectarian university in the neighboring city of Tagbilaran. Their experience in teaching college statistics ranged from 1 to 16 years. As to their educational background, most teachers finished BSEd-Math or BS Math degree and one had a Bachelor's degree in Engineering. Seven teachers finished a Masters degree in Mathematics and five are currently working towards an MS Math degree. Five teachers are currently working on a PhD degree, two are PhD in Statistics candidates while the other three are working for a PhD in Education, major in Research and Evaluation. Of these 12 teachers, 9 attended the statistical literacy seminar we conducted, only one is actively involved in research and most have not attended any other training in teaching statistics.

TEACHERS' INSTRUCTIONAL GOALS, CLASSROOM PRACTICES AND PROBLEMS

Instructional goals are broad, generalized statements of what is to be learned. When asked about their instructional goals in teaching college statistics courses, the most common response is to develop students' ability to compute statistical measures (9 teachers), followed by the ability to interpret results (5 teachers), and the ability to use statistical programs and interpret computer-generated output (4 teachers). Only three teachers mentioned the development of decision-making

skills based on data while only two considered the development of statistical reasoning as part of their goals. None of the teachers explicitly mentioned the development of statistical literacy as their goal and only two teachers included the affective dimension, that is, to develop appreciation on the uses of statistics and its relevance to real life. An analysis of these instructional goals reveal that focus is directed towards the development of computational and data-based problem solving skills. While two teachers indicated the development of statistical reasoning and interpretive skills as an important goal of instruction, they expressed problems on classroom implementation due to a number of factors, including class size, types of students, heavy teaching loads, limited time and facilities, and lack of reference materials and administrative support.

Within the framework of Gal's (2002) model of statistical literacy, we construed that teachers' instructional goals may be a reflection of their own statistical literacy knowledge-base which is primarily on the statistical and mathematical components. Only three teachers reflected evidence on literacy skills, context knowledge, and capability for critical questions. Consequently, classroom activities geared towards teaching-learning and assessment were primarily focused on the development of computational skills and mastery of procedural techniques while the importance of data-awareness in diverse life contexts and statistical reasoning with real-life data has not been addressed by most teachers. Drills and seat works, which were used by all participants, dominated the class activities; only five teachers mentioned projects such as feasibility study, mini-research or survey as part of the class requirements; and three teachers included activities that expose students to the diverse ways that statistics is used in social context, such as evaluating statistical information in newspaper reports, surveys and election polls. One teacher mentioned that motivated by the statistical literacy seminar we conducted earlier, she innovated a class activity that require students to design and evaluate advertisements that contain statistical messages Further, only one teacher involved students in actual data collection within research context and integrated the use of statistical software (*SPSS*) in the classroom with the statistics course having a laboratory component. While most teachers affirm the need to include computer-based description, presentation, analysis and interpretation of the data in their curriculum, they had problems with implementation since statistics has been primarily a lecture course with no laboratory component to justify the use of their institution's computer facilities for their classes.

As to their assessment practices, the traditional paper-and- pencil tests dominate both formative and summative assessment procedures of all the participants. Two teachers, however, mentioned that they use real data in their tests, 7 teachers included projects and 4 teachers use feasibility studies/surveys as part of their formative assessments. In some cases, their choice of assessment activities are constrained by department prescriptions. In one university, it is a policy that all summative examinations (mid-term and finals) be given in multiple-choice format while in another college, teachers are told to focus on computational problem-solving to prepare students for the government board examinations.

While all teachers affirmed the importance of promoting statistical literacy for students to be effective citizens in their future professional lives, their responses in the focus group interview reflected a lack of familiarity on the broader range of skills and "dispositions" that comprise statistical literacy. They indicated positive attitude towards the relevance of statistical literacy skills in today's information age but there is evident need to develop a critical and questioning attitude in their responses towards statistical information encountered in diverse life contexts.

Other problems encountered by teachers in the integration of statistical literacy activities in their classroom include the lack of institutional and administrative support, lack of time to cover the required course syllabus, and students' poor high school background and English communication skills. Further, two teachers lamented that after attending the statistical literacy seminar we conducted, they were not able to implement their new ideas in the classroom as they were not assigned statistics courses in their teaching load for the next semester. With introductory statistics courses offered as part of the mathematics offering of the Mathematics Departments in most colleges and universities, there is no core group of mathematics teachers trained to teach statistics.

CHALLENGES AND FUTURE DIRECTIONS

Our findings of this focused study provided us deeper insights on the vital role of the teacher as designer and implementer of the curriculum. The promotion of statistical literacy as a basic instructional goal depend primarily on the teacher's knowledge-base and capability to realize this goal in the classroom. The situation portrayed by our group case-study calls for the need for further training and preparation of mathematics teachers teaching statistics in order to break the traditions of formula-based approaches and shift to a data-oriented approach with focus on the development of students' ability to read, interpret and critically evaluate data and statistical messages in this Age of Information.

The challenge of promoting statistical literacy in the teaching of introductory college statistics courses in the Philippines rely heavily upon concerted efforts to upgrade the in-service training and preparation of teachers handling statistics courses. To this end, we propose the following concrete measures:

- At the department level, chairpersons identify a core of mathematics teachers to be trained further to teach statistics.
- At the collegial level, statistics teachers work collaboratively in research projects that expose them to the current research literature in statistics education or expose them to real data in diverse contexts.
- At the institutional level, statistics teachers must be given priority in faculty development funds for further graduate studies or training in the field.
- At the national level, the professional statistical community, such as the PSA, need to work for a legislative agenda for the Commission on Higher Education to recognize Statistics as an independent discipline from Mathematics and consider the training of teachers in the field as a priority for faculty development.

These measures require the concerted efforts among educational policy makers, school administrators, teachers and the professional statistical organizations in the country. With the recent organization of a regional chapter of Philippine Statistical Association in Central Visayas, the challenge is for us to work collaboratively with these teachers for their continuing professional development and preparation in the promotion of statistical literacy.

CONCLUSION

The goal of promoting statistical literacy in introductory college statistics courses necessitates equipping statistics teachers with the knowledge, resources and opportunities to expand their own statistical literacy knowledge-base and develop their own critical stance and questioning attitude in this information-laden society. Aside from curricular restructuring for better alignment of instruction and assessment with this important learning goal, there is need for collegial and institutional support system for the professional development of statistics teachers through graduate studies, in-service training, conferences and research involvement in statistics education.

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