INFORMING POLICY AND PRACTICE

Are College Entrants to STEM Programs Quantitatively Literate?

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HIGHLIGHTS

✓ The overall quantitative literacy and reasoning (QLR) score of freshman students enrolled in college STEM programs is generally low.

✓ Additional data indicate that students with a Senior High School (SHS) STEM background have a significantly higher QLR score than their non-STEM counterparts.

✓ Moreover, between students' achievement in SHS General Mathematics and in Statistics and Probability, only the latter significantly relates to QLR.

INTRODUCTION

Quantitative Literacy and Reasoning (QLR) is the skill set necessary to process quantitative information and the capacity to critique, reflect upon, and apply quantitative information in making decisions (Gaze et al., 2014). This definition emphasizes the ability to apply Mathematics and Statistics to contextualized problems, a higher-order skill rather than just the ability on the content domain of these disciplines.

Unfortunately, QLR assessment appears to remain an uncharted territory for educational researchers, especially in the Philippines, despite the consensus that QLR is a competency that should be developed among students (Association of American Colleges and Universities, 2007; Science Education Institute—Department of Science and Technology & Philippine Council of Mathematics Teacher Education Inc., 2011). Also, pursuing college STEM programs such as bachelor degrees in Mathematics, Statistics, Engineering, etc. is generally a quantitative endeavor (Follette et al., 2015),

yet all students where this study is conducted are admitted regardless of their SHS academic background.

Results of previous studies reveal the contribution of post-secondary education to the development of students' QLR and suggest strategies that can potentially improve students' QLR. Research outputs that emphasize QLR in education have the potential to reduce the widespread perception that Mathematics is irrelevant and that mathematical and statistical excellence is an innate ability.

METHODOLOGY

This study is quantitative-correlational. It involves 255 BSU students enrolled in STEM programs, 45% of whom are SHS STEM graduates. The QLR ability of students was measured using the Quantitative Literacy and Reasoning Assessment (QLRA), a 20-item, adapted questionnaire. A pilot study was conducted to recalibrate QLRA and make sure that it is appropriate for Filipino students and that it passes reliability requirements. The statistical tools used include the mean, skewness, t-test for two independent samples, and multiple linear regression.

FINDINGS

The QLR Scores of Students

The overall mean percentage score of 28.25% only reflects the dismal performance of students under the QLRA (Figure 1). The proportion of correct responses on the majority of items (16 items) was only about 40%, if not lower. The positively skewed distribution of students' overall scores (Figure 2) confirms that more students scored towards the lower end of the QLRA spectrum. .
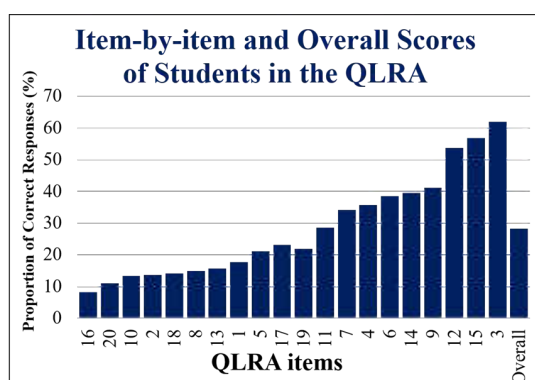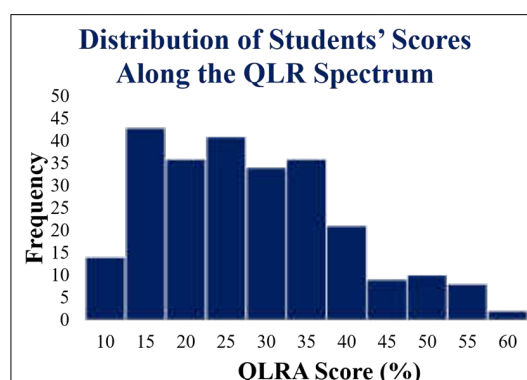

Figure 1. Item-by-item and Overall Scores

Figure 2. Distribution of Scores Along the QLR Spectrum

These results are by far the lowest students' achievement when compared to international studies that made use of similar instruments. For example, the consecutive surveys conducted by Gaze et al. (2014) in 2012 and 2013 on students' quantitative literacy revealed that the success rates were 58.40% and 46.10%, respectively. Also, the Mathematical Reasoning Assessment Committee of the Curriculum Advisory Board for the General Education Program of California State University reports that the mathematical reasoning score of students using the QLR assessment is only 32.55%.

Comparison of QLR Scores Between STEM & Non-STEM Senior High School (SHS) Students

The QLR scores for both groups are relatively low, but the QLR score of the STEM group is significantly higher. The main statistical results are shown in Figure 3. The significantly higher QLRA scores of SHS STEM students over their non-STEM counterparts partially reveal that more experience in higher or advanced mathematics courses allow higher quantitative skills. However, both of these groups are still lagging overall.

25.36% Non-STEM

31.78% STEM

$t - test\ statistic = 4.14^{**}$
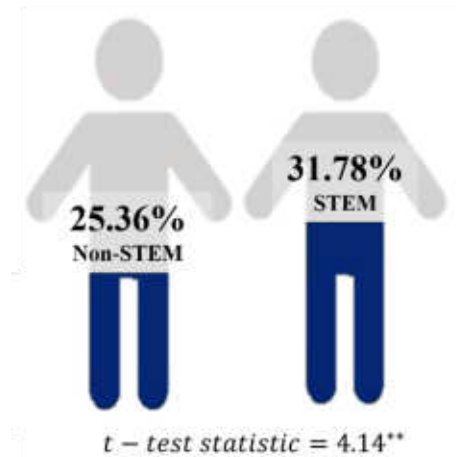
Relationship of Achievement in SHS General Math, and in SHS Statistics and Probability to QLR

Figure 4 describes the relationship between students' achievement in senior high school General Mathematics, and in Statistics and Probability to their QLR scores. Results show that achievement on the latter is the only significant predictor. This may be so because the course Statistics and Probability is geared towards a pedagogical approach that is more context-laden and has more obvious and practical applications than Mathematics. However, the low value of the coefficient of determination (R^2 = 10.30%) suggests that grade does not explain much of the QLR variability. This means that while achievement in SHS Statistics and Probability is a significant predictor of QLR, it does not completely account for the students' QLR. This is because QLR is multi-faceted and involves multiple processes.
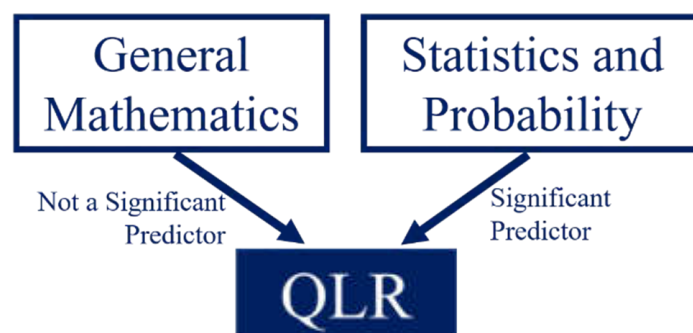

Figure 4. Relationship of Achievements in SHS general Math, and SHS Statistics and Probability

Further investigation of the students' answers brought out a realization that knowledge of Mathematics and/or Statistics does not necessarily make one to be quantitatively literate; applying and communicating them to new contexts does.

CALL TO ACTION

✓ Educators are encouraged to join the **Quantitatively Literacy Movement** by emphasizing the integration of relevant and multiple contexts to traditional instruction. This may be done by connecting Mathematics and Statistics to real-life applications or contexts that are sensitive to students' cultural differences and learning styles and emphasizing students' reasoning and critical thinking.

✓ Administrators may consider curriculum reviews and revisions to embed the principles of QLR.

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ABOUT THE MATERIAL

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