Examining Gender and Urban/Rural School Differences in Empirically-derived Achievement Profiles

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ABSTRACT

The present study used a person-oriented approach to examine gender differences at the level of achievement profiles and examine such differences in the context of urban and rural schools. The achievement test scores in English, math, and science of 2,408 tenth-grade students were used to derive achievement profiles through agglomerative-hierarchical and *k*-means clustering techniques. Four profiles were derived: 1) Low Achievers, 2) True Average Achievers, 3) High Achievers with weak math and science skills, and 4) High Achievers with strong math and science skills. Significant gender and urban/rural school differences among the profiles were found after performing cross-tabulation analyses with chi-square testing. The so-called “female advantage” in education was more evident among Low Achievers, but not among the High Achievers. When the urban/rural school context was considered, the female advantage tends to disappear and the urban school advantage becomes more definite. Finally, the High Achievers with weak math and science skills were mostly females in urban schools. The findings suggest that it is important to situate gender differences in a certain context. Implications for practice are provided, as well as recommendations for future research.

KEYWORDS: Gender differences, urban and rural schools, achievement profiles, cluster analysis, Filipino students

1 INTRODUCTION

Many educational institutions all over the world are seeing a reversal of gender disparity in educational attainment. Girls and women are being documented as having higher general achievement than boys and men (Bacharach et al., 2003; Clark et al., 2008; Demie, 2001; Hubbard, 2005), and are over-represented in academic completion and success (Becker, 2014; Cohn et al., 2004; Quenzel & Hurrelmann, 2013; Saunders et al., 2004; see reviews, Buchmann et al., 2008; Hadjar et al., 2014). Most scholars (e.g., Adamuti-Trache et al., 2013; Etim et al., 2016; Legewie & DiPrete, 2012; Lörz et al., 2011) consider this as a significant change from the past that saw the male advantage and, at the same time, a different version of disparity in the access to education. Such is still a problem that invites further research, since this gap will eventually have large-scale impact in various social, political, and economic structures (Berggren, 2011; Klasen & Lamanna, 2009; Seguino, 2000).

Basically, understanding gender disparity in educational attainment and success is done by looking into performance differentials of students in achievement tests. Reviewing this research area, however, depicts a somewhat messy picture. First, studies that focused on domain-specific achievements (e.g., specific math achievement, specific reading achievement) largely point that gender achievement differences are only minimal and negligible (Dimitrov, 1999; Rosén, 1995; Stumpf, 1995; see review, Hyde et al., 1990). Second, investigations using a nested-factor model of achievement, which specifically examined achievement in one subject area while controlling for the influence of general academic achievement (the *g* in education), provides evidence for large gender differences favoring males in terms of math and females in terms of reading (Brunner, 2008; Brunner et al., 2008, 2013). Lastly, research works that focused on achievement differences by gender alone were strongly criticized as being context-free. Consideration of other factors, such as race, SES, and culture, along with gender has been advocated to provide a better picture of gender achievement disparity (Brunner et al., 2013; Chapin, 2006; Dimitrov, 1999; McDaniel et al., 2011; Scott, 1987; see reviews, Buchmann et al., 2008; Legewie & DiPrete, 2012).

Taken together, much of what we understand is that gender achievement disparity creates different scenarios depending on how academic achievement is conceptually and psychometrically framed. In addition, gender difference research may potentially reveal other important information when context is considered. This present study aimed to contribute in this line of research by considering academic achievement as person-oriented; by conceptualizing it as a student profile. This conceptualization is unique as it captures students' academic achievement as a configuration of achievements in different subject areas. Moreover, a commonly neglected school contextual variable, the school location (urban/rural schools), was considered in this study to better situate gender achievement differences.

2 THE IMPORTANCE FOR ACHIEVEMENT PROFILES

The person-oriented approach (Bergman & Wångby, 2014) provides for a theoretical basis for determination of students' academic achievement profiles. The basic proposition of this theory is that an individual is an organized whole with elements operating to achieve a unified functioning system (Bergman & Wångby, 2014; Sterba & Bauer, 2010). This means that there is structure and coherence in the way individuals function. In terms of academic achievement, this means that patterns of achievement in different subject areas can be discerned, thus the term achievement profile.

Surprisingly, extant literature has little to say about achievement profiles. There were works that examined students' achievement profiles but they separately examined achievements in different subject areas. That is, they did not document academic achievement holistically (e.g., Dimitrov, 1999). There were works also that may be described as close to a person-oriented conceptualization, such as the study on math-science expertise of mathematically precocious youth (Lubinski & Benbow, 2006), and the work on secondary school students' achievement profile shapes (Brunner et al., 2013). The latter was particularly interesting as it gave empirical evidence for the idea that students may have a profile of strong in reading but weak in math, and others a profile of strong in math but weak in reading. However, such work was predominantly variable-centered as gender disparity was examined only at the level of specific achievement and not at the profile level.

Several scholars argue that the use of the person-oriented approach allows researchers to make inferences about specific individuals, and not about the variables under study (e.g., Konold & Pianta, 2005; Yukselturk & Top, 2013). As non-overlapping, homogenous groups are inevitably created in doing a person-centered study, interventions and other practical considerations can be addressed directly to specific groups.

In this present study, achievement profiles were derived using tenth-grade students' achievement scores in three subject areas: science, math, and English. The focus on tenth-graders would enable to explore profile-level gender achievement disparity in the junior high school level, which may be tested in the future whether any trend could be replicated in senior high school and higher educational levels. Moreover, the emphasis on the three subject areas was justified since they are considered as the core courses. It is important to note that, with the person-oriented conceptualization of achievement, the profiles would be data-driven, hence the term empirically-derived. No specific hypothesis, or premeditated number of achievement profiles, guided the analysis. However, it was reasonable to expect that the achievement patterns that have been explored in the literature would be replicated: the math-science expertise and/or the high-in-reading-and-low-in-math pattern.

3 GENDER DIFFERENCES IN ACHIEVEMENT AND THE URBAN/RURAL SCHOOLS

Ceci, Williams, and Barnett (2009) proposed a general causal model why there are gender differences in cognitive performance and educational success. This model reinforces the person-oriented approach and solidifies the key theoretical proposition held in this study that there might be urban/rural school differences, aside from gender differences, in achievement profiles.

Accordingly, the interplay of individual and sociocultural factors affects individuals' cognitive performance and success. Ceci and colleagues (2009) mainly proposed that there are broad contextual influences (e.g., cultural beliefs, school location) that shape individual characteristics (motivations, beliefs, and activities), which in turn influence brain development and consequent abilities. These abilities are then manifested in assessed performances, such as achievement test scores. Biological sex enters the picture by directly affecting brain development through hormones or shaping broad contextual/cultural expectations, and by indirectly influencing brain development and abilities. Support to this model has been generally positive (Ackerman et al., 2013; Brunner, 2008; Brunner et al., 2008, 2013; Entwisle et al., 1994; Francis, 2000; Grabner et al., 2003; Johnson et al., 2009; Lubinski & Benbow, 2006).

In explicating the role of context, Brunner and his colleagues (2013) argued that the role of environment, including cultural differences in how education is valued and cross-national differences in educational systems, contributes to gender disparity in achievement. Buchman and his colleagues (2008) also noted that patterns of gender inequalities in education are, in fact, different for developing and highly industrialized societies.

In this study, the concept of urban/rural school was used as a social-contextual factor of gender achievement disparity. In a review article, Bæck (2016) argues that students in rural and urban schools vary in terms of the compositional and contextual effects of their communities. Specifically, for rural school students, compositional effects (e.g., ethnicity, SES and educational background of people in the locality) interact with contextual effects (e.g., local or regional labor markets, rural school management) of their community that impact their psychological attributes related to schooling, such as motivation, choices, preferences, and interests. More specifically, for boys and girls in rural schools, the patriarchal and masculine cultural features of rural societies, including gendered work and social patterns, contribute to gender differences in academic achievement.

Taken together, gender achievement disparity can be complex when we consider contextual factors, such as urban/rural location of schools. In this present study, however, no specific hypothesis was formulated on gender and urban/rural school differences in achievement profiles since the latter would only be empirically-derived. However, based on the review of literature, it was plausible to generally expect female advantage and urban-school advantage in achievement profiles.

4 THIS STUDY

This study aimed to contribute in the research on gender differences in academic achievement by (a) using a person-oriented approach and (b) considering the context of rural and urban schools. Specifically, two questions guided this study:

1. What achievement profiles can be derived from the achievement scores in science, English, and math of tenth graders?
2. Are there significant differences in empirically-derived achievement profiles when compared according to a) males and females, b) rural and urban schools, and c) males and females in rural and urban schools?

5 METHOD

5.1 Research Design

The appropriate design to use was descriptive, cross-sectional, non-experimental research (Johnson, 2001). Descriptive because this study aimed to describe achievement profiles of tenth-grade students; cross-sectional because comparisons will be made between males and females in rural and urban schools.

5.2 Sample and Data Source

The data used in this study were obtained from the Center of Educational Measurement (CEM), which is an institution that provides testing services for public and private schools all over the Philippines. A total of 2,408 tenth-grade students was randomly selected from their database. These students were from the three major regions of the country: Luzon (23% urban; 20% rural), Visayas (10% urban; 26% rural), and Mindanao (17% urban; 5% rural). The achievement tests, covering English, math, and science, were K-12 curriculum-based tests assessing knowledge and skills for Grade 10 and were administered in the last quarter of school year 2016-2017. Only the total raw scores were used for this study.

5.3 Data Analytic Procedures

Preliminary data analysis was done to perform data cleaning. This mainly involved identification of multivariate outliers using Mahalanobis distance and examination of descriptive statistics for normality.

Cluster analysis was used an exploratory classification technique to answer the first research question. It was performed in two phases: the first was to determine the acceptable range of cluster solutions using agglomerative-hierarchical clustering and the second was to identify the best cluster solution within the identified range using k-means clustering. This technique was used in similar studies (e.g., Collie et al., 2017; Yukselturk & Top, 2013).

For ease of interpretation, the z-scores (M=0; SD=1) of the total raw scores for English, math, and science were used for the analysis. The agglomerative-hierarchical clustering used the Ward's method as the clustering algorithm and the squared Euclidean distance as the proximity measure to extract non-overlapping and homogeneous clusters. Benchmarking on the work of Collie and others (2017), the determination of the acceptable range of cluster solutions was based on the percentage change in agglomeration coefficients of cluster groupings, which should not be lower than 10%. In k-means clustering, the judgment of the best cluster solution was made on the bases of plausibility and relatively-balanced cluster sizes.

The best cluster solution was considered as the set of achievement profiles. Then, cross-tabulations with chi-square testing were done to answer the second research question. Specifically, one-way cross-tabulations were done to examine differences between (1) males and females and (2) urban and rural schools. Two-way cross-tabulation was also done to examine differences among males and females in urban and rural schools.

All analyses were performed using the IBM SPSS Statistics version 23.

6 RESULTS

The final dataset that was analyzed had 2,398 cases after ten outliers were deleted. There was approximately equal representation of rural females (25.10%), rural males (24.85%), urban females (25.06%), and urban males (24.98%). Table 1 displays the descriptive statistics, which generally indicate normality.

Table 1 Descriptive statistics

	M	SD	Skewness		Kurtosis	
			Statistic	Std. Error	Statistic	Std. Error
English	28.633	9.6006	.017	.050	-.956	.100
Math	21.826	8.5343	.672	.050	-.081	.100
Science	22.663	7.8977	.275	.050	-.641	.100

Note: Descriptive statistics were calculated on unstandardized variables.

6.1 Phase 1: Agglomerative Hierarchical Clustering

The identification of achievement profiles using scores in English, math, and science began with performing agglomerative hierarchical clustering with the data. The percent changes in agglomeration coefficients for two to ten clusters were computed, and it was revealed that moving from one to two clusters explained 44.74% variance in cluster groupings. Moreover, moving from two to five clusters explained 39.95%, 17.66%, and 10.72% additional variances, respectively. After this, moving from five to ten clusters explained less than 10% additional variances in cluster groupings. Hence, based on this information, the range of cluster solutions that should be explored further is two to five.

6.2 Phase 2: *k*-means Clustering

The *k*-means clustering was performed to generate two-, three-, four-, and five-cluster solutions with the data. The two- and thee-cluster solutions were first examined. In terms of the sizes of clusters in both solutions, a relatively proportionate representation of the sample is evident. However, in terms of the level of detail, the two-cluster solution reveals a high-in-all cluster and a low-in-all cluster as potential achievement profiles, while the three-cluster solution has a middle ground. Hence, the three-cluster solution was considered more desirable than the two-cluster solution.

Next, the three- and the four-cluster solutions were compared. It was revealed that the low-in-all cluster and the middle-ground cluster in the three-cluster solution are retained in the four-cluster solution. The high-in-all cluster, however, can be seen as being split into two clusters with marked difference in math and science scores. This pattern echoes the previous works of Lubinski and colleagues (2006) on high-achieving students' math-science expertise. That is, one cluster could be the high-achieving math-science expert profile and the other is the high-achieving math-science inexpert profile. Examining the cluster sizes of the four-cluster solution reveals relatively balanced sample representation. Thus, the four-cluster solution was considered more plausible than the three-cluster solution.

Finally, the four- and the five-cluster solutions were examined. In the five-cluster solution, one cluster is clearly the same as the low-in-all cluster seen in previous solutions. However, two clusters are somewhat duplicates of the other two, hence difficult to interpret. In terms of cluster sizes, there is somewhat imbalanced sample representation (e.g., one cluster has 14% and another 29%). The final, deemed most plausible, cluster solution was the four-cluster solution.

In Figure 1, the empirically-derived achievement profiles are shown based on the four-cluster solution. The profiles are labeled Low Achievers, True Average Achievers, High Achievers with Weak Math-Science Skills, and High Achievers with Strong Math-Science Skills, with sample representation of 31%, 30%, 21% and 18% respectively.

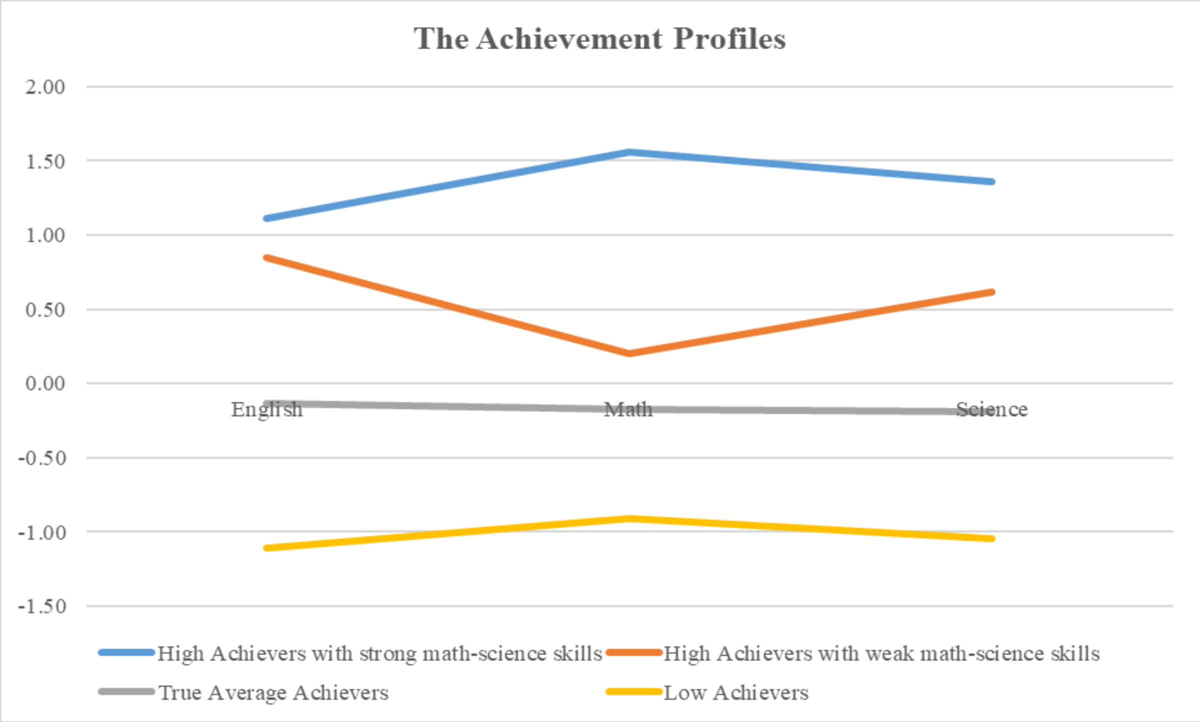

Figure 1: The empirically-derived achievement profiles

6.3 Cross-tabulations and Chi-square Analyses

Figures 2 displays the bar charts of 1) one-way cross-tabulation of gender and achievement profiles, 2) one-way cross-tabulation of urban/rural schools and achievement profiles, and 3) two-way cross-tabulation of gender, urban/rural schools, and achievement profiles. Chi-square tests revealed there are significant differences in achievement profiles when compared according to gender (Pearson's X^2 (3, 2398) = 43.84, $p > .001$, Cramer's $V = .135$) and urban/rural schools (Pearson's X^2 (3, 2398) = 437.79, $p > .001$, Cramer's $V = .427$). Also, there were differences in achievement profiles when females and males in urban and rural schools are compared (Pearson's X^2 (3, 2398) = 467.60, $p > .001$, Cramer's $V = .263$).

7 DISCUSSION

The present study aimed to examine gender and urban/rural school differences at the level of achievement profiles. Using cluster analytic techniques, four achievement profiles were derived from the data: Low Achievers, True Average Achievers, High Achievers with weak math and science skills and High Achievers with strong math and science skills. These profiles are non-overlapping; it can be said that a tenth-grader assumes an achievement profile that is one of the four profiles. While the two profiles are straightforward (the Low Achievers and the True Average Achievers), the other two (the High Achievers who are different in terms of math and science skills) are noteworthy. The studies of Lubinski and colleagues (2008) on the math-science expertise among gifted students were replicated with such finding. Specifically, it can be said that the high-achieving students can differ in terms of whether they are weak or strong in math and science subjects, and this difference cannot be observed among low-achieving and average-achieving students. Further research needs to be done to examine the background information of these students, including their cognitive and motivational characteristics.

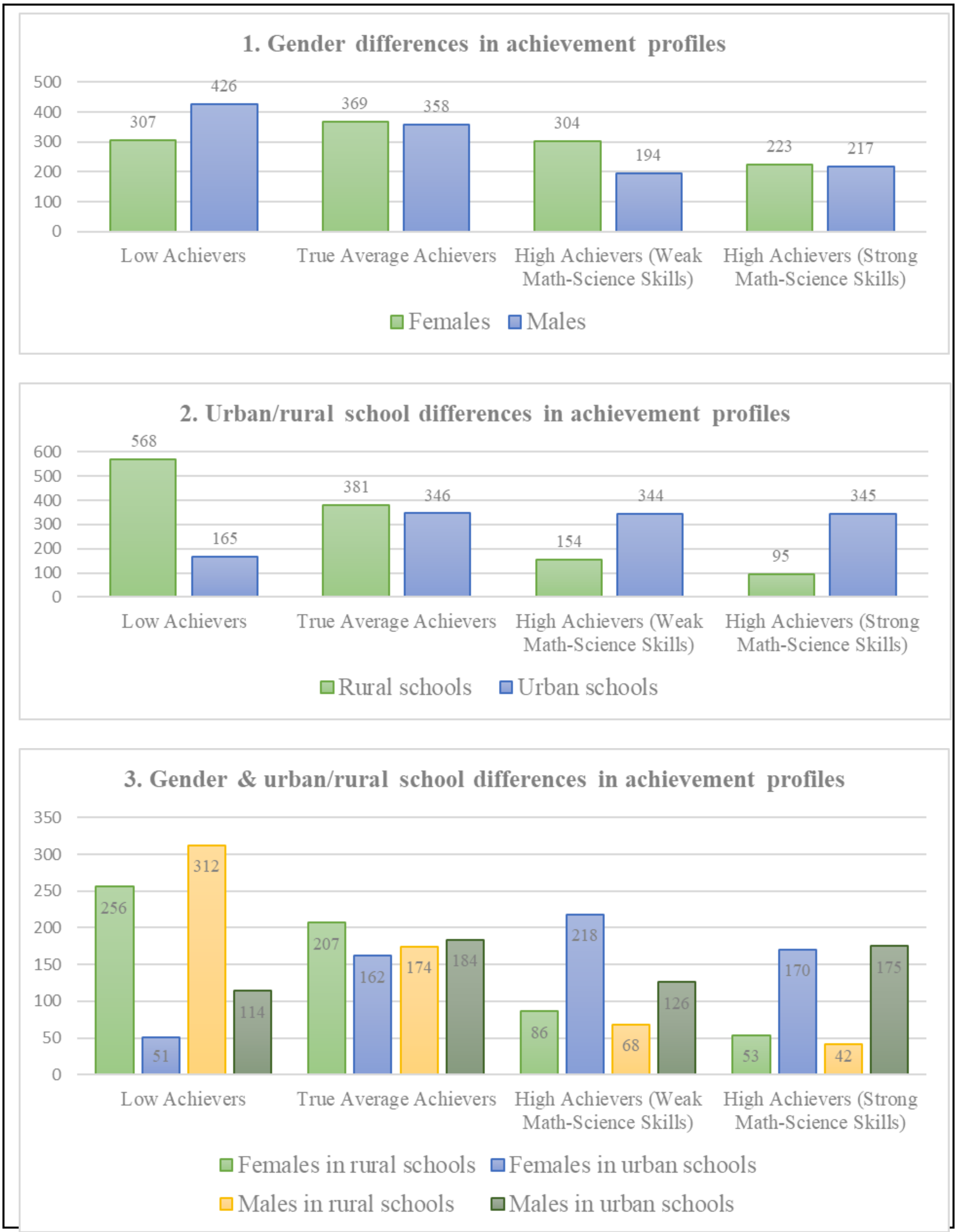

Figure 2: Bar charts of cross-tabulations of gender, urban/rural schools, and achievement profiles

As displayed in the first bar chart in Figure 2, the gender differences in achievement profiles suggest that the female advantage is strong among Low Achievers, but not among High Achievers with strong math and science skills. This unique finding suggests that among the high achievers, there is not much of gender disparity. Further research needs to verify this finding. On the other hand, it is interesting to point that most High Achievers with weak math and science skills are mostly females. This finding might explain why, in senior high school and higher education levels, there is underrepresentation of females in STEM courses (Ceci et al., 2009).

In examining the urban/rural schools and the achievement profiles displayed in the second bar chart, the urban school advantage is outstanding and strong. Among Low Achievers, most are from rural schools. Among the High Achievers with strong and weak math and science skills, most are from urban schools. This finding supports the literature that certain compositional effects (e.g., low SES, ethnic minority background, low parental educational background) and contextual effects (e.g., rural school management) of rural schools are detrimental to students' academic achievement (Bæck, 2016). Generally, this finding invites more research to pin down the specific aspects of rural schools that do not facilitate high academic achievement among students. Similarly, more research also needs to be done to identify the specific positive effects of urban schools on students' achievement.

Finally, as displayed in the third bar chart, the differences among females and males in rural and urban schools reveal interesting findings. First, when school location is considered, the female advantage somewhat becomes more of an urban school advantage among Low Achievers and High Achievers with strong math and science skills. That is, the obvious difference is no longer between males and females but between urban and rural schools. This finding is very important as this suggests that gender differences blur when they are put in the context of urban/rural schools. In other words, there are pronounced differences in achievement when we examine between urban and rural schools, and not between males and females. More research needs to be done to verify this finding. Second, there is consistently more females than males who are High Achievers but weak in math and science skills across school locations, and most of these females are indeed from urban schools. This finding is unique, which invites more research to dig into the urban/rural school dichotomy and trace why there are more females with weak math and science in urban schools than in rural schools. Also, it is worth examining what interventions can be designed to target these high-achieving girls with weak math and science to allow them cope with high-achieving peers with strong math and science. Finally, the female advantage totally disappears if we compare high achievers from different school locations. For example, there are more male high achievers in urban schools than there are female high achievers in rural schools. Similarly, there are more female high achievers in urban schools than there are male high achievers in rural schools This finding supports other results that there is likely no gender disparity at all but only disparity between urban and rural schools. More research needs to be conducted to confirm this idea.

In general, it has been fruitful examining at once gender and urban/rural school differences in achievement. At its core, this study sends a message to achievement disparity scholars to focus on the urban/rural school dichotomy instead of males versus females. In addition, deriving achievement profiles has been informative in clarifying how students really differ among one another. The profiles indicate that the traditional classification of students into Low, Average, and High may not be feasible anymore. as differences among High Achievers in terms of math and science expertise can potentially answer who chooses to major STEM courses in senior high school and higher education levels.

8 LIMITATIONS

This study has at least two limitations. First, the sample cannot be readily considered as nationally representative of Filipino students. It may be noted that the data were from students of client-schools of the Center of Educational Measurement (CEM), and most of these schools were, in fact, private institutions. Future researchers who might want to replicate the present findings may consider a nationally representative sample, a sample of students from a post-secondary school level, and/or a sample of students from different countries. Second, the clusters derived empirically need to be validated using an external variable (Pastor & Erbacher, 2019). In the case of the present study, no validation was done. Future researchers who might consider replicating the achievement profiles may do a validation by performing further statistical tests wherein the achievement profiles are the independent variable and theoretically-relevant constructs, such as college admission test performance and career interests, are the dependent variables.

9 IMPLICATIONS FOR PRACTICE

The findings of the present study have at least three implications for practice. First, there is a need to focus on low performers in both rural and urban schools. School administrators and heads may consider looking into their difficulties and formulate appropriate bridging programs to help them cope up with their high-achieving peers. Based on the findings, the focus on the low achievers is as important as remedying gender achievement disparity, since male and female high achievers (with strong math and science) tend to not differ with each other.

Second, there is a need to eliminate the urban/rural school differences as it is the factor that strongly creates achievement disparity among students. The male/female dichotomy may still be ignored, but not the urban/rural school dichotomy. Interventions may be planned to counter the effects of “rurality” of schools. To do this, more researches certainly need to be done, including dissemination of this information to policy makers who decide on resource allocation for urban and rural schools.

Finally, school administrators and teachers may need to identify who among the female high achievers in urban and rural schools are weak in math and science. They need to gather them as they are probably the cause whey there is currently underrepresentation of women in STEM courses. Intervention programs may be designed to remediate their weakness.

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