POLICY BRIEF
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Addressing the Poor Mathematics Performance of Filipino Learners: Beyond Curricular and Instructional Interventions

Summary of Policy Recommendations

1. Schools and teachers should identify students who are at risk of performing poorly in mathematics at the early stages of instruction, pay attention to their vulnerabilities and needs, and help mitigate the likelihood of failure in mathematics by providing appropriate intervention. The specific vulnerabilities differ in some aspects for students in public schools and in private schools.
2. Sustain and intensify the effort of local government units and private sector groups in providing devices and of telecom companies in expanding access to inexpensive and fast internet in remote areas. As simple access to devices and the internet is not likely to be sufficient, schools and teachers need to teach students how to use the internet in ways that help them in their mathematics learning, especially the development of metacognitive skills for sorting out useful information online (and for verifying potentially fake information), especially in students' mathematics learning.
3. Counselors and psychologists in schools should develop school-based interventions to help students rethink and plan their school and life goals targeting higher-status occupations. Teachers, counselors, and psychologists should create activities in school that will help more students to consider and to strive towards higher educational targets, which require stronger mathematical proficiency and help them develop concrete plans and strategies to attain such targets.
4. Mathematics teachers should be upskilled and reskilled to work more effectively with students who are at risk of failing so they can design learning activities in mathematics classes to keep students engaged and motivated to learn and value mathematics in their attainment of higher occupational aspirations. Teacher development activities in mathematics should focus on strategies to help students who are not learning, which now comprise an overwhelming majority of the students in schools.
5. Schools should continue engaging parents as partners in (a) keeping the students actively participating in school and understanding the value of persistence in difficult subjects like mathematics, (b) appreciating higher educational and occupational goals for their children, and (c) monitoring students' learning behaviors at home.

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6. Review pertinent practices and policies in the basic education system: (a) structure and density of the curriculum and the allocation of time for the subject can determine how deeply (or superficially) students are engaged in mathematical concepts, (b) features of the assessment system, the retention and promotion systems, and other rewards and incentives in schools that are likely to shape teachers' behaviors towards students and students' personal constructions of their own learning experiences and abilities for learning in mathematics, (c) teachers' workload and class sizes which can either constrain or facilitate the level of attention and engagement that teachers have with poor performing students, and (d) performance appraisal and incentive system for teachers (and school head and other administrators) could influence how they engage the poor performing student relative to those who are doing well.

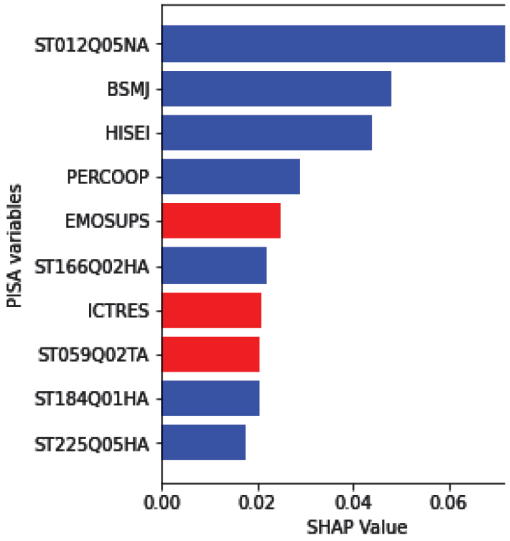
The Philippines has consistently performed poorly in international mathematics large-scale assessments. Results of the 2018 Programme for International Student Assessment (PISA) showed the Philippines ranked 2nd to the last in Mathematics based on country means (Department of Education, 2019). Specifically, 18.5% of the students met the minimum standard defined in the PISA 2018 (i.e., Level 2 or higher), 26.9% were at Level 1 proficiency, and the majority (54.6%) of the Filipino students who participated scored below the lowest proficiency Level 1, the lowest proficiency group. This clearly shows that there are more Filipino students who fall below international standards in terms of mathematics proficiency, indicating insufficient mathematics skills compared to their age group counterparts from other nationalities. In comparison, students from private schools performed slightly better than those from public schools with means of 395 and 343, respectively.

The selection of student participants in PISA 2018 involved two-stage stratified random sampling beginning with randomly selecting 187 schools from the country's 17 regions. Student participants were then randomly sampled from each identified school. A total of 7,233 participants were sampled from a population of students born in 2002 and enrolled in secondary schools for the school year during the time PISA was conducted. Ages range from 15.25 to 16.17 years old. Data used in the study were culled from the publicly available PISA 2018 database Philippine sample at https://www.oecd.org/pisa/data/2018database/.

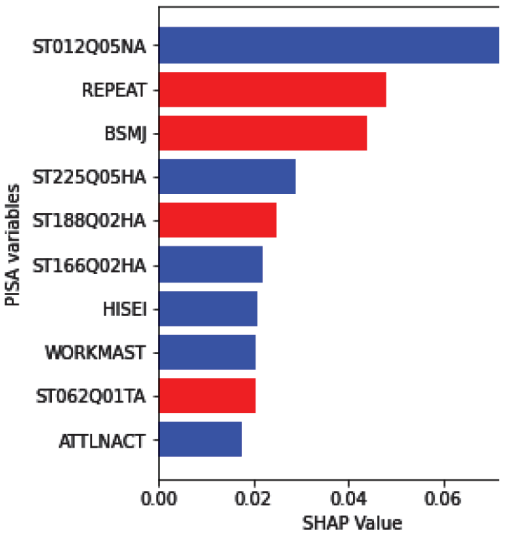
This study aimed to determine predictive models that would identify the most important predictor variables for students in the lowest proficiency group in public schools and private schools. After experimenting with different machine learning approaches, the random forest classifier (SVM) models were found to perform most accurately (Lundberg & Lee, 2017). To identify the most important predictors of being a poor performer in mathematics, Shapley values were generated, which produces a ranked list of several features in descending order. To manage complexity in comparing the key variables for private and public student performance classification, the 10 most significant features for the public and private school groups are analyzed and illustrated in Figure 1. Red bars represent direct relationships, whereas blue bars represent inverse relationships with identifying the poor-performing students in mathematics. Shapley Additive exPlanations (SHAP) values represent the level of variable importance relative to other variables. The bar length of each variable corresponding to the x-axis values shows the strength of the variable's influence in the prediction of the model. The meanings of each important variable are summarized in Table 1, which also highlights the similar and contrasting results for private and public schools.

Figure 1

Visualization Showing the Top 10 Important Variables in Descending Order



Private School



Public School

Table 1
List of Top PISA Variables Identifying Poor Performing Students

<table>
<tr><td>Student Variables</td><td colspan="2">PISA variables associated with low mathematics performance</td></tr>
<tr><td rowspan="8">Socioeconomic Context of Family/Home

and

Non-cognitive Learning Related Behavior</td><td colspan="2">Common to both public and private schools</td></tr>
<tr><td colspan="2">• ST012Q05NA: low number of cell phones with internet access
• ST225Q05HA: low expectation to finish a vocational degree
• HISEI: low parental occupation</td></tr>
<tr><td colspan="2">Contrasting common variables</td></tr>
<tr><td>Private</td><td>Public</td></tr>
<tr><td>• BSMJ: high occupational aspi ration</td><td>• BSMJ: low occupational aspiration</td></tr>
<tr><td colspan="2">School type-specific variables</td></tr>
<tr><td>Private</td><td>Public</td></tr>
<tr><td>• EMOSUPS: high parents' emotional support
• ST184Q01HA: low fixed intelligence mindset</td><td>• WORKMAST: low motivation and persistence
• ATTLNACT: low value of schooling
• ST188Q02HA: proud of one's work
• REPEAT: repeated at least 1 grade level
• ST062Q01TA: high absenteeism</td></tr>
<tr><td>School's Social Context</td><td>• PERCOOP: high perception of student cooperation</td><td>N/A</td></tr>
<tr><td rowspan="2">Metacognitive Skill</td><td colspan="2">Common to both public and private schools</td></tr>
<tr><td colspan="2">• ST166Q02HA: low reaction to email by checking sender's email address</td></tr>
</table>

In both private and public schools, there are three variables that are associated with poor performance in mathematics. These are the low number of cell phones with internet access, low expectations of finishing a vocational degree, and low parental occupations. This means that aside from the resource constraints such as lack of educational gadgets and poor internet access, which are usually identified with poor-performing students, these students have a low expectation of finishing postsecondary vocational education. Although poor-performing students from both public and private schools have parents with low-status jobs, students differ in occupational aspirations, with those from private schools aspiring for better occupations compared to those from public schools. Aspiring higher occupational aspirations among the poor-performing private school students may probably mean they are aiming for a university degree over finishing a vocational certificate, whereas lower occupational aspirations among the public school students mean they are less optimistic about finishing even the vocational education, much less earning a college degree.

The lack of optimism to finish a degree, low value of school, and low job ambition among poor-performing public school students explain why they lack achievement motivation, put less importance on exerting effort, and have lower persistence to do well in school. Exerting less effort, repeating at least one grade level, and yet feeling proud of their school achievement also indicates being contented with what they have achieved. This illustrates the *pwede na* [This will do.] or *okay na yan* [This is okay.] mediocrity mentality, which comes as no surprise as it is being identified here as common among poor-performing students.

On the other hand, what distinguishes poor-performing students in mathematics from private schools are higher parents' emotional support, low growth intelligence mindset, and high perception of student cooperation. This may indicate a permissive or "indulgent" parenting style showing warm and loving parents but unwilling to impose limits, which is closely associated with low self-control and self-reliant child behavior (Power, 2013). This explains why higher parenting emotional support could pose more harm than good in terms of maximizing their children's potential. Low fixed mindset or higher growth intelligence mindset is usually associated with high achievers. Students with a high growth mindset believe that mathematics can be developed through hard work and dedication. However, based on the results of this study, this also describes poor-performing students in mathematics in private schools. A plausible explanation could be that this belief is not translated into action due to other conflicting values, such as low achievement motivation and low value for schooling. Nonetheless, this may still be further investigated in future studies. Private school students who perform poorly in mathematics find cooperation to be important in learning, and they find their peers cooperative. This positive perception and belief could be advantageous if

utilized properly, as students could see different perspectives and gain immediate feedback when interacting and actively learning mathematics together. However, its misuse in the likes of free ridings, such as copying assignments or dividing tasks individually without feedbacking, might be detrimental and counterproductive to learning.

Public school students performing poorly in mathematics perceived the school to be of less value. Consistent with this idea, they tend to skip class days. Some reasons for absenteeism in the Philippines include feeling helpless in learning the lessons, especially if they cannot afford to hire a tutor, non-conducive learning environments, lack of money for transportation to school, having an empty stomach (Jabar, 2021), having other priorities such as helping in their family's livelihood, among others (Clores, 2009). Mathematics as a discipline is integrative as one concept and skill is built upon previously learned concepts and skills. Thus, skipping classes can definitely have adverse effects on mathematics learning.

Lastly, it can also be noted that both groups of students have low reactions to emails in terms of checking the sender's email address. This indicates that students are not critical of the emails they receive and suggests inadequate metacognitive skills (Lindberg et al., 2010). Metacognitive strategies are important in the Mathematics classroom because it helps students in knowledge acquisition, connecting previously learned knowledge and skills to the current lesson, forming habits of mathematical thinking such as observing patterns, formulating conjecture, acquiring computational skills and problem-solving skills, and mathematical reasoning (Desoete & De Craene, 2019).

In conclusion, poor-performing Filipino students in mathematics can be identified in terms of socioeconomic conditions and non-cognitive and metacognitive behavior. These students in both public and private schools mostly do not have mobile cellphones with internet access, have parents with low status, do not expect to finish a vocational degree, and have underdeveloped discerning and critical thinking skills. In particular, low proficient private school students in mathematics aspire for higher occupational status than their parents, have their parents' emotional support, have a high growth mindset, and value cooperation. Student counterparts in public schools can readily be identified by their lack of motivation and persistence, low educational and occupational aspirations, low appreciation of education, absenteeism, have repeated a grade level, and yet are proud of their work.

On the basis of these results, the proponents recommend policies or amendments to existing policies beyond curricular and instructional interventions that could help address the poor mathematics performance of Filipino learners. Please see the summary of policy recommendations on the first two pages.

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Details of the study may be found at **https://doi.org/10.3390/educsci11100628**

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