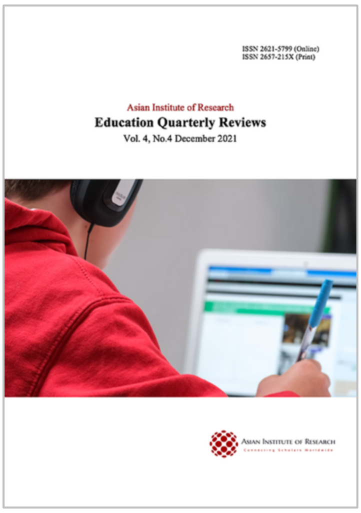

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Equal Opportunities in Learning in Diverse Groups in Nepal in the Pre-COVID Realm: Socioeconomic Status, Mathematics Learning, and the Diverse Groups

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Abstract
The article discusses the diversity and equity issues behind the learning outcomes of mathematics in the pre-COVID context in Nepal. The article intends to give a baseline for the further studies on the effect of COVID-19 pandemic in the educational realm. Datasets from the national assessment of student achievement in Nepal at grades 3 and 5 and grade 8 are reanalyzed based on socioeconomic status (SES), gender, caste-ethnicity, language, and geographical variables. In Nepal, where the society is customarily highly structured, gender-biased, and poverty-driven, SES influences remarkably in mathematics achievement. The datasets show notable relationships between SES and mathematics achievement ($r = 0.35$, 0.27 and 0.30 in grade 3, 5 and 8, respectively). In lower grades, the difference between the highest and lowest SES in the achievement of girls is wider than boys and it is reverse in grade 8. Nepali speakers had high scores when they had high SES but, when SES was very low, the non-Nepali speakers performed better in all grades. The advantageous castes tended to always perform higher irrespective of their level of SES. Nevertheless, it is difficult to know with certainty when average and marginalized caste/ethnic groups perform better.

Keywords: Equity, Equality, Socioeconomic Status, Diversity, Gender, Mathematics Achievement

1. Introduction: Covid-19 pandemic, Educational equity, SES, and Diversities in Nepal

The ongoing global pandemic crisis related to COVID-19 virus from Spring 2020 onwards has "created the largest disruption of education systems in history" as described by United Nations policy brief (UN, 2020, p. 2). The UN estimates that, due to lockdowns all over the world, schools have been closed up to 99 percent in vulnerable low and lower-middle income countries including Nepal. In some countries, mainly in highly developed countries such as Finland, which is used for comparison in the article, within a couple of weeks the schools were functional due to quick digital leap in distant pedagogy and related practices (FINEEC, 2021). In Nepal, the Ministry of Education Science and Technology (MoEST) has issued guidelines and procedures to continue learning through virtually or reopening schools in safe environment or through alternatively learning modalities during the pandemic situation to minimize the learning loss (see MoEST, 2020a for COVID-19 contingency plan; MoEST, 2020b for Student

Facilitation Guidelines; MoEST, 2020c for School Reopening Procedure). Also, the curriculum was condensed to meet the minimum learning outcomes of the curriculum. However, Dawadi, Giri, and Simkhada (2020) evaluate that the pandemic has had serious impacts on students' learning and well-being, and that it potentially widens the gaps between advantaged and disadvantaged children in their equitable access to quality education. The major challenges and constraints in transitioning to online education include, among others, poor network, lack of digital skills, lack of technological support from institutions (Shrestha, Haque, Dawadi, & Giri, 2021). Hence, the worry UN expressed may be reasonable: these kinds of catastrophes tend to increase the difference between the most disadvantageous and the most advantageous countries. "The crisis is exacerbating pre-existing education disparities by reducing the opportunities for many of the most vulnerable children, youth, and adults—those living in poor or rural areas, girls, refugees, persons with disabilities and forcibly displaced persons—to continue their learning" (UN, 2020, p. 2).

This article does not study the effect of COVID-19 pandemic itself but, instead, intends to lay a base for further studies related to the effects of the pandemic. The aim is to describe elements of educational equity before the pandemic from the viewpoint of varying subgroups in Nepal. To some extent, Finland is used as a comparison although the comparison is unfair due too vast socioeconomic and cultural differences. However, that would be in line with some earlier comparisons related to realities and teaching in Nepal and Finland (see Metsämuuronen & Metsämuuronen, 2013; Metsämuuronen, 2019).

This section discusses some relevant aspects of equity and equality from the viewpoint of diversity in pupils' and students' families latent to inequalities related to equal opportunities in the realm of education. In the empirical section, three large datasets based on large samples of learning results in mathematics in Nepal are re-analyzed from the equality viewpoint.

1.1 Educational equity, equality, and diversity

Educational equity is a *value* related to fairness and justness related to educational matters and educational equality indicates the level of equity (see discussion in Metsämuuronen, 2019). Levin (2010) defines educational equity as fairness in access to opportunities to benefit from education. Field, Kuczera, and Pont (2007, p. 29) highlight the fairness and inclusion related to diversity issues: "Fairness implies that personal and social circumstances such as gender, socio-economic status or ethnic origin should not be an obstacle to educational success. Inclusion implies a minimum standard of education for all." We may admit that all children within a country should have the moral right to get equal opportunities even though they may come from different backgrounds and they are unique; all children have the "basic equality" to claim to be treated with justness and as equal (see Arneson, 2014; Metsämuuronen, 2019; Nathan, 2014). Aristotle would say "treat the like cases as like" (Aristotle, *Nicomachean Ethics*, V.3. 1131a10-b15; *Politics*, III.9.1280 a8–15, III. 12. 1282b18–23), that is, when two persons have equal status in at least one normatively relevant respect (such as being citizens in the same country), they must be treated equally in this respect (Metsämuuronen, 2019).

The children, pupils and students will always differ from each other because of having, for example, different genes and motivational structures, as well as developmental phases even at the same age. Therefore, there will always be differences in learning outcomes, knowledge base, and skills between individuals even within the groups of individuals we assume to be at the same level as in the same grade in schools. Even though we see individual differences, the equality in *opportunities* (see Rawls, 1999, pp. 73–78) should still be embedded in our educational policy. Though we would even *expect* to see the individuals to differ from each other in their learning outcomes, we should *not expect* to see structural and systematic inequality between the groups of individuals that we assume to have equal opportunities.

Mathematics is one of those subjects that are connected to higher incomes and social leverage; the higher achievement in mathematics in school is related to the higher salary level in the future life (e.g., Altonji & Blank, 1999; Blau, Ferber, & Winkler, 2010; Crawford & Cribb, 2013; James, 2013). Mathematics is an elementary component in the so-called STEM subjects (science, technology, engineering, mathematics); without high knowledge of mathematics, it is difficult to enter the higher education related to the STEM subjects, which would increase, in a natural manner, one's income level and, hence, the socioeconomic status in the society.

Combining the previous ideas, every student should have equal opportunities to learn mathematics and reach her or his full potential once enrolled in the school regardless of their diverse backgrounds. However, students' performance may not be the same despite equal learning opportunities. Some students excel in their learning with high scores whereas some students continuously face disappointments with low scores.

Metsämuuronen (2019) has collected some indicators of educational equity or parity that may be relevant to note here – these are referred to in the latter part of the article. An elementary indicator is *Population Parity*. If the national distribution of student achievement shows several populations instead of only one normally distributed population, this indicates inequality and disparity in the population. Two distinctive student populations (or widened normal distribution) may indicate differences between boys and girls, different geographical areas, or school types. Some related indicators reflecting the status of equality in a country, more specifically, are *Gender Parity*, *Ethnicity Parity*, *Home Language Parity*, *Geographical Parity*, *School type Parity* or *School location Parity*; we should see no differences between the learning outcomes between genders, ethnic groups, language groups, geographical areas or between different types of schools with different location. Family-related indicators like *Parents' education Parity*, *Parents' occupation Parity*, *Home possessions- and accessories Parity* and *Socioeconomic status Parity* are not such that we could forcefully change, but schools should be able to take care that children from the most vulnerable families are able to have equal possibilities to reach their potential. Hence, if we observe systematic disparities in these areas, the educational system has not been able to fulfil the need to offer equal opportunities for all citizens.

1.2. SES influencing the school performance

Researchers have revealed many factors related to the differences in student achievement. Among these, socioeconomic status (SES; APA, 2007) or economic, social, and cultural status (ESCS; OECD, 2012, 2017, p. 339–340) has been emphasized as one of the most influencing factors in a student's performance associated with mathematics (see, e.g., Ahmar & Anwar, 2013; Bowden & Doughney, 2010; Bradley & Corwyn, 2002; Chmielewski, 2019; Levin, 2010; Metsämuuronen & Kafle, 2013; OECD, 2019; Salmela-Aro & Chmielewski, 2019; Willingham, 2012).

The combination of education, occupation, and economy is widely accepted as indicators to measure SES (e.g., APA, 2007; Bradley & Corwyn, 2002; OECD, 2017) even though the best theoretical framework for SES has not been proposed or accepted unanimously. SES influences a range of societal variables explicitly and implicitly related to inequalities in society. It may unpredictably affect students' achievement depending on diverse factors (such as personal abilities and interests, geographical or cultural positions, home language or gender). Studies range from setting up a strong connection between SES and achievement in mathematics (e.g., Metsämuuronen & Kafle, 2013) to mere noteworthy (e.g., Ukkola, Metsämuuronen, & Paananen, 2020) or no relation (e.g., OECD, 2013) between the two depending on various factors. Also, Sirin (2005) noted the inconsistent results of SES effects in the literature and emphasized that *parents' education* is considered as the most stable and influencing indicator between SES and achievement. An OECD report (2012) indicates the performance gaps in another way: students from a low SES perform almost half lower in comparison with the high SES background due to personal and social barriers. Among the countries that participated in the PISA study from 2003 to 2012, some succeeded in reducing the achievement gap between students from low and high SES backgrounds (OECD, 2013).

Because OECD has been very keen on the effect of SES to the achievement (see the PISA reports from 2003 onwards) and is stated mainly in the high SES countries, it is unsure what the effect of SES would be in the fragile or developing countries such as Nepal. However, Aasland and Haug (2011) found out that the perception of Nepali citizens from the traditional low castes was that their leverage in the ladders of society is more dependent on SES factors than caste factors. Acharya, Shakya, and Metsämuuronen (2013; see also MoE, 2015) studied SES and achievement in the Nepalese context and noticed that the correlation between SES (including education, occupation, and economy) and students' performance was around r = 0.30 depending on the grade. Hence, according to these studies, SES seems to play a prominent role in the Nepalese context in explaining the differences in performances though it depends on other diversity factors.

Obviously, with a high achievement level in mathematics at the final stage in basic education, there are more possibilities of entering higher education and prestigious jobs. Parents from high SES know this well and, hence, they tend to support their children in many ways to master mathematics. Since the very beginning of the school life, such parents may try to select a higher-esteemed school where children are proposed to learn high level mathematical skills (Willingham, 2012). High SES parents support their children academically and spend more time with them than low-SES parents (Shakya, 2014). Additionally, parents with high SES also provide for auxiliary materials and create a conducive learning environment necessary for enhancing their children's learning (APA, 2007; Levin, 2010; Willingham, 2012). All those arrangements explicitly and implicitly shape and require one's learning abilities and attitudes towards attaining higher scores than low-SES students (APA, 2007; Bowden & Doughney, 2010). In contrast, low-SES parents tend to concentrate on earning to meet their basic needs and have less productive time for their children. Even though they have time due to their low-level education or none, there are less possibilities for them to support their children's learning (see APA, 2007; Bowden & Doughney, 2010).

Although many studies have been conducted related to SES, it is difficult to find the definite answers about which component of SES influences the achievement level the most, specifically in the fragile countries. In their review of relevant studies, Bradley and Corwyn (2002) concluded that, in some studies, *mother's education* played a more significant role whereas in some studies the *income* of the family had a higher impact on children's outcomes. They argue that a combination of two or more SES variables explains more variance than a single variable. In the Nepalese context, parents' education and economic factors may play an even more crucial role in mathematics achievement because the differences in SES between the families may be wide. In some families, both parents may be illiterate without much schooling, which, in many cases, leads to low economic level with agriculture as occupation while, in other families, both parents may have university degrees and may be able to offer relatively high economic standards to their children. From Metsämuuronen and Acharya (2013, p. 44) it is known that, at grade 8, parents' education alone explained the achievement score moderately (2.5–2.8 percent of the student variation; see Table 2).

1.3. Diversity and performance equality

Together with SES dimensions, other diversity factors such as geographical and cultural positions, or home language and gender may be related to the achievement level. In some cases, the diversity may explain the achievement inequality more than SES. Banks (2012) states that, in education, the challenge of diversity deepens when the society is stratified based on race, ethnicity, language, religion, disabilities and so on, which creates intellectual complexities among individuals (see details in Ahearn et al., 2002, p. 3).

It is challenging to determine the full magnitude of the impact of diversity in achievement. In the USA, for example, achievement discrepancy tends to be related to the racial and ethnic groupings (OCED, 2011). In contrast, in Finland and Iceland, as examples of the highest performers in the international PISA and TIMSS tests, the differences between schools in different geographical areas are notably small. However, from the language- and gender diversity viewpoint, even in Finland the differences in achievement are prominent. The difference between Finnish and Swedish speaking pupils is clear at the lower grades (Metsämuuronen, 2010); boys seems to score slightly higher than girls in mathematics on average (Metsämuuronen & Tuohilampi, 2014 for 9th graders and Ukkola & Metsämuuronen, 2019 for 1st graders), boys outnumber girls remarkably at the highest quartile and decile (around 75 percent boys vs. 25 percent girls; Metsämuuronen, 2013; 2017); the difference in the mother language performance is opposite: girls outperform boys in an obvious manner (e.g., OECD, 2019, p. 16).
In the Nepalese context, education has historically been a cultural capital for certain privileged caste/ethnic groups (e.g., Brahmins and Chhetris) which generally is reflected in their high level of achievements. Besides, geographical-, gender-, and cast variations are also apparent in students' performances (see Acharya, Shakya, & Metsämuuronen, 2013; NIRT, 2017). The impetus in creating coherence, fairness, and justice over the diversity to

minimize the cognitive conflict or obtain equity in terms of mathematics achievement is one of burning issues in fragile societies. EQUIP2 policy paper (2012) notes that the performance difference originates in socioeconomic inequalities in the longer run or it is the reverse.

1.4 Diversities in Nepalese Context

Nepal is socio-economically and -culturally highly diverse country with complex structures (see Acharya, Shakya, & Metsämuuronen, 2013; NIRT, 2017). There are altogether 125 caste/ethnic groups located in different geographical areas (CBS, 2012). Uniquely, most of them have their own spoken language (there are 123 languages in Nepal), which are different from the national language (Nepali). Traditionally, the economic system of the people is guided by the caste/ethnic system, which is still prominent in some specific groups. Again, those caste/ethnic- and language groups vary within each group, representing specific geographical areas.

A high proportion of Nepali population (25.2 percent) is below the poverty level. The Global Gender Gap Report ranked Nepal at 112th position in 2014 (WEF, 2014) and at 105th position in 2018 (WEF, 2018). The gender gap sub-index shows alarming situations, mainly in political empowerment (0.176–0.185), and economic participation (0.547–0.608). Although the index scores are comparatively high in educational attainment (0.889–0.926) and health and survival (0.972–0.966), due to poor index in political and economic areas, the country is situated in the bottom quartile of the list.

Among the total population, 32.9 percent, mainly females, are illiterate (CBS, 2019). Encouragingly, the trend of students' attainment in schools in the last decade indicates the growing popularity of education among all groups in the country. In 2019, 6.2 percent of children in basic-level school-going age were out of school, which was 10.6 percent in 2016 (CEHRD, 2020). It indicates a rapid change in the Nepalese society, and it is not only limited at the school level but is gradually also seen at all education levels.

Due to the higher illiteracy and poverty rates, awareness among parents about education and supporting their children's education is not yet up to the level. This means that, even though parents enroll their children in schools to get them educated, their performance or achievement level tends to be low. Some years back, the decreasing trends of annual School Leave Certificate (SLC) results (from 2020 onwards, Secondary Education Examination, SEE) in a decade also clearly indicated the hindered improvement in learning achievement, which was especially alarming in some specific social groups and geographical regions (Mathema & Bista, 2005). Similarly, the results of national assessment 2011 strongly support the reality that student performance is better when the parents have middle- or higher level of education and high economic status (Acharya, Metsämuuronen, & Koirala, 2013; Acharya, Metsämuuronen, & Adhikari, 2013; Shakya, Metsämuuronen, & Upadhyaya, 2013).

2. Research questions

Because COVID-19 has changed the educational realities, maybe permanently, the empirical section intends to offer historical perspectives and baseline results for the in-depth studies of the effects of COVID-19. So far, it is known that SES had an overall effect on achievement in Nepal. What is not known is how SES affects certain groups. This article studies the (in)consistency of SES over different groups before COVID-19. To be focused, only mathematics achievement is selected as the reference subject. The main, overall, research question is:

1) How did SES and other diversities affect the inequalities in mathematics achievement in Nepal before the COVID-19 pandemic?

This broad research question has connections with many diversity factors related to mathematics. Assessment studies conducted in various years revealed mathematics as one of the low-level subjects (CERID, 1999; EDSC, 1999; FBC & CHIRAG, 2008; EDSC, 2008; Metsämuuronen & Kafle, 2013, MoE, 2015). Historically, mathematics is known as a subject of boys, whereas girls are limited by non-technical subjects (Koirala & Acharya, 2005). However, the gender gap is reducing since the last decade at national as well as at regional and zonal levels (see details in MoE, 2015) though the results may fluctuate with the SES factors. Hence, a sub-question is formulated to seek the answers to SES effects on various diversity factors.

2) How did relevant diversity factors such as gender, geographical zone and region, location in urban or rural area, language, caste/ethnicity, and school type explain equalities and inequalities in relation to SES before the COVID-19 pandemic?

The questions are answered based on three large empirical national datasets concerning the learning outcomes in Nepal and related background questionnaires in grades 3, 5, and 8.

3. Methods

3.1 Sampling and datasets

Three nationally representative datasets of national assessment of student achievement of mathematics in Nepal are reanalyzed in this article: dataset of grade 3 and 5 (MoE, 2015) and dataset of grade 8 (Metsämuuronen & Kafle, 2013). Mathematics is one of the common subjects in all datasets and it is also a universal subject. Hence, it is selected to be assessed in this article with a purpose.

The basic unit for the sample-based national student assessment was the school, and schools were selected to represent the whole nation using the proportional stratified random sampling method (see Metsämuuronen & Acharya, 2013; MoE, 2015). The strata are: 1) Ecological zones (Mountain, Hill, Terai, and Capital Valley), 2) Developmental regions (Eastern, Central, Western, Mid-Western, Far-Western, and Valley), 3) Districts (75 altogether), 4) School type (Community and Private), and 5) School location (Rural and Urban) (see Figure 1a). After the sampling for the studies in the article, a new administrative division of provinces was formed by a new Constitution of Nepal: In the current situation, seven provinces have replaced the earlier system where Nepal was divided into 14 administrative zones which were grouped into five development regions (see Figure 1b).

Figure 1a: Main strata used in the samples at the time of sampling

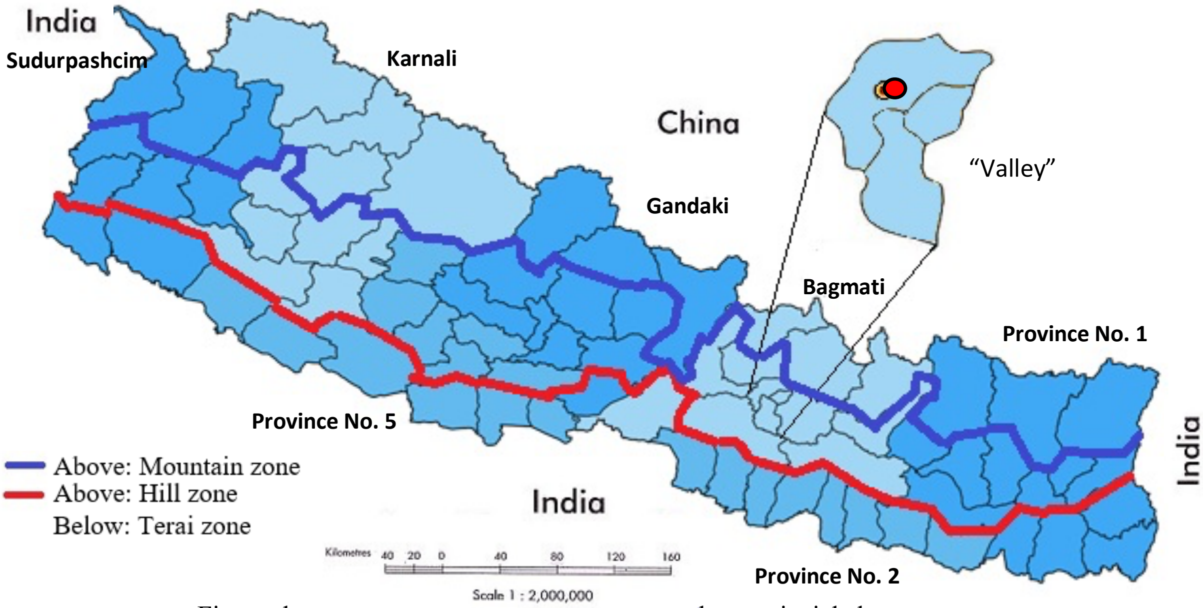

Figure 1b: Main administrative divisions after the provincial changes 2015

The schools were selected proportionately from randomly selected 25 districts out of the 75 for grade 8 and 28 districts for grades 3 and 5. The grade 3 mathematics dataset covered 841 schools and 19,252 students. In grade 5, there were 557 schools and 13,714 students and, in grade 8, 421 schools and 16,033 students. Three districts from the Kathmandu Valley were selected in all samples. The reason is that the Capital area consists many schools and it is the most diverse area from the viewpoint of caste/ethnic, language, environment, economic activities, population, and development opportunities. Gender-wise distribution of the sample is reported in Table 1.

Table 1: Gender-wise distribution of the datasets

	Grade 3			Grade 5			Grade 8		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Girls	8,071	59	25.5	6,302	53	23.1	8,043	41	21.0
Boys	8,300	59	25.2	6,570	54	22.5	7,963	45	21.4
Total	16,371	59	25.3	12,872	54	22.8	16,006	43	21.3

3.2 Background variables and SES Dimensions

The datasets provide information about the diversity including geography, gender, language, religion, culture, caste/ethnicity, occupation, home possessions, home accessories, achievement, and parents' literacy level and occupation. There are altogether seven variables related to parents' education, income, and economy, which are combined to measure the SES (Table 2). These indicators are the same as used in PISA and TIMSS background questionnaires (e.g., OECD, 2017).

The SES variables were originally measured by using different scales (from nominal to ordinal scales). Because of incomparable scales (from 0–1 to 0–12), all variables were first re-scaled to 0/1 variables to give them an equal weight (see Table 2). In this process, the variables were first analyzed with the respect of educational outcomes. Decision Tree Analysis (DTA), the data mining tool in SPSS software, and ANOVA, the basic tool for analyzing the differences between group means, were used to find the best classification of each variable regarding the statistical differences in learning outcomes. Second, 11 to 12 variables comprising the home possessions and three variables comprising the home accessories were summed up and dichotomized on the basis of DTA and ANOVA.

Third, all seven variables for SES were dichotomized based on DTA and ANOVA. Hence, all variables—regardless of their original scale—are scaled as 0 or 1. Finally, seven indicators are summed up as the final SES indicator.

Table 2: Indicators of SES in the dataset of grade 8 (Metsämuuronen & Acharya, 2013, p. 44)

Variable	cut-off[1]	effect on total score[2] (percent points)
Father's education	less than SLC-passed = 0, other = 1	+6%, $\eta^2 = 0.025$
Mother's education	less than SLC-passed = 0, other = 1	+7%, $\eta^2 = 0.028$
Father's occupation	Agriculture = 0, other =1	+6%, $\eta^2 = 0.023$
Mother's occupation	Agriculture = 0, other =1	+6%, $\eta^2 = 0.017$
Home possessions	5 or less out of 12 possessions = 0, 6 or more = 1	+5%, $\eta^2 = 0.016$
Home accessories		
Mobile phone	2, 3 = 1, other = 0	+6%, $\eta^2 = 0.025$
Television	1–3 = 1, other = 0	+7%, $\eta^2 = 0.032$
Computer	1–3 = 1, other = 0	+8%, $\eta^2 = 0.028$
Car	1–3 = 1, other = 0	+3%, $\eta^2 = 0.003$
Bathroom	2, 3 = 1, other = 0	+3%, $\eta^2 = 0.006$
all together	0 out of 5 = 0, other = 1	+6%, $\eta^2 = 0.019$
Attending to private school	no = 0, yes = 1	+19%, $\eta^2 = 0.142$
Total SES		+25%, $\eta^2 = 0.106$

1) based on Decision tree analysis (DTA)
2) based on one-way ANOVA

3.3 Achievement tests

Mathematics achievement was measured by using a set of tests with three versions in each grade. Experienced teachers from the respective grades prepared items, which were pretested and selected for the final test. The final test versions were compiled by using the following six principles: (1) Content's dependence on the curriculum (construct validity), (2) Content's coverage to be as wide as possible (content validity), (3) Proper structure of cognitive levels of the cognitive domain (ecological validity), (4) High test discrimination (reliability), (5) Proper difficulty level, and (6) the Comparability of the results with the international results like TIMSS and PISA. All the tests showed up to be very discriminative; reliability of the total score is higher than $\alpha = 0.90$ in all three grades (Metsämuuronen, & Kafle, 2013; MoE, 2015).

In each grade, the three versions of tests were equated to the same scale using IRT modeling (see the mechanics in Metsämuuronen & Acharya, 2013; MoE, 2015). Because IRT modeling requires a linking procedure between different test versions, a good number of common items were selected carefully to link the version with each other. Some items were borrowed from the international TIMSS database. IRT was used for item calibration, finding the latent ability (Theta, θ), as well as comparing and equating the three versions with the TIMSS database. SPSS software was used for the classical item analysis and One Parametric Logistic Model software (OPLM, Verhelst, Glas, Verstralen, 1995) was used for the IRT modeling.

The parameters of the international items were fixed during item calibration so that all test items were calibrated in the international TIMSS scale: grade 3 and 5 datasets were calibrated into TIMSS grade 4 scale and grade 8 dataset into TIMSS grade 8 scale. The original output is the latent ability (θ), which is a standardized normal score ranging usually from –4 to +4. These values in each test version were later transformed to equated scores which were further converted into the percentage of maximum score so that the score of 100 means that the student made a perfect score and 0 means that no items were successfully answered. From now onwards, "marks" or "average" or "mean score" refers to the percentage of the maximum marks ranging from 0 to 100. The notation of 50 percent refers to 50 percent correct of the equated maximum score. The scores are not equated over the grades and, hence, the scores in different grades are not strictly comparable.

3.4 Used Methods

Basic methods are used for the analysis, mainly ANOVA- and ANCOVA type of modeling and Pearson correlation. Two indicators of the explaining power of single factors of models are used: eta squared, or partial eta squared (η^2), and Cohen's *f* (Cohen, 1988). The first tells strictly how many percent of the total variance in the dataset can be explained with the factor under study. Then, η^2 = 0.030 means that the factor explains 3 percent of the total variance (= 0.03 × 100 percent). Cohen's f is a commonly used indicator of effect size where the values near zero refer to trivial or non-existent differences between the groups, values around 0.1 refer to a small effect size, values around 0.2–0.3 to medium effect size, and values higher than 0.4 to high effect size referring to remarkably wide differences between the groups (see Cohen, 1988, pp. 285–287). When the traditional significance (*p* value) indicates whether the difference would be seen in the population, effect size tells how remarkable this difference could be.

4. Results

4.1 Population disparity based on distributions of achievement

The distributions of the mathematics test score show remarkable *Population disparity* (see the criteria of this kind of disparity in Metsämuuronen 2019) in Nepal before COVID-19 pandemic. Although the raw scores from different grades are not comparable, the *patterns* in the distributions indicate the prevailing learning inequalities. In each grade, there are two to three distinct populations (low-, medium- and high performers; Figure 2) instead of only one normally distributed population as we see, for example, in Finland (see graphs in e.g., Ukkola & Metsämuuronen, 2019 p. 37 for grade 1; Ukkola & Metsämuuronen, 2021 for grade 3; Metsämuuronen, 2013, p. 45 for grades 3, 6, and 9; Metsämuuronen, 2017, p. 62 for grade 12).

In grade 3 we observe a long tail at the left-hand side; this means that pupils enter the system with quite wide differences so that most of the students are quite good in mathematical operations in relation to the expectations explicated in the national curriculum. In grade 5, the distribution is a widened normal distribution, showing that there are at least two populations that are somewhat close to each other. At grade 8, again, we observe a long tail in the right-hand side; this indicates that the educational system produces wide differences in the student population. The last point indicates a potential inequality generated by the system. These datasets show the serious gaps in the achievement levels, which is more prominent in the 8th grade.

From the average national score viewpoint, the mathematics achievement is found in a downward pattern, from lower to upper grades, that is, 59 percent (SD 25.3), 53 percent (SD 22.8), and 43 percent (SD 21.3) of the equated correct answers in grades 3, 5, and 8, respectively. Although the scores are not fully comparable, the trend in the means reflects the fact that the item writers, reflecting the demands of the curriculum, expected more from the students in higher grades but the students were not able to fulfill these expectations to the same extent as did the pupils at lower grades.

4.2 Inequalities based on school type and SES

In what follows, the inequalities that exist in achievement with different variables of diversity such as gender, caste, language, and geographical locations are discussed. The disparity in the performances is seen at the school- and the student level. In this section, the school level disparity is discussed while the student level disparity is in focus in Section 4.3.

The achievement disparity in Nepal can be seen easily when we aggregate the achievement and SES scores at the school level, illustrated by the school type: community and private schools (see Metsämuuronen & Ilic, 2018 for the description of pedagogical differences between these schools). By using the term suggested by Metsämuuronen (2019), we observe an obvious *School type disparity* in Nepal.

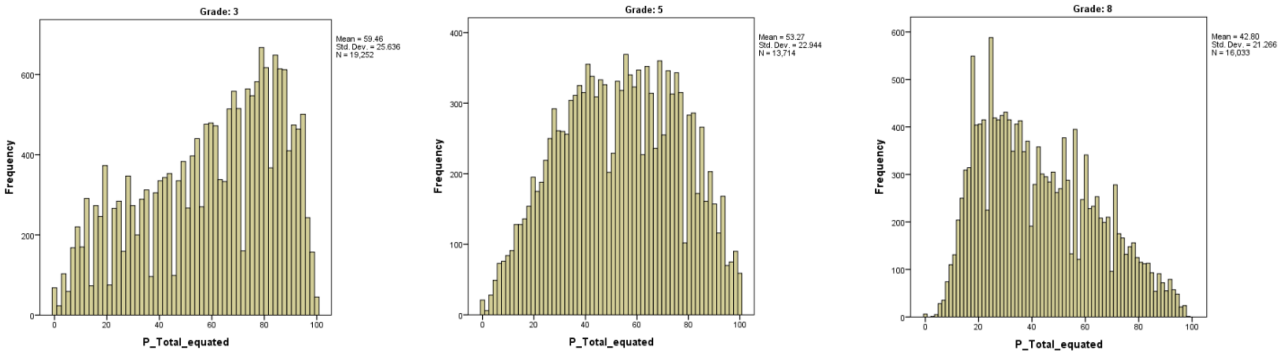

Figure 2: Population distributions of grades 3, 5 and 8 in Mathematics tests in Nepal; pre-COVID-19 pandemic

Establishing a private school is a good business and their number is growing in Nepal. In 2013, out of all basic level schools at grades 1–8, 16 percent were private schools, where nearly 15 percent students were enrolled, and 84 percent were community schools (DOE, 2013). In 2017, 18 percent schools were private, and 17 percent of the students enrolled in these institutions (MoEST, 2018). Figure 3 illustrates that students in the private schools (denoted by a triangle), located in the upper right-hand quarter of the graph, mostly get high scores and their average SES is high. On the contrary, most of the students in community schools have a low SES, and, notably, the range of the average achievement score in the school is extremely wide ranging from 5 percent to above 95 percent. This situation is similar in all three grades under study.

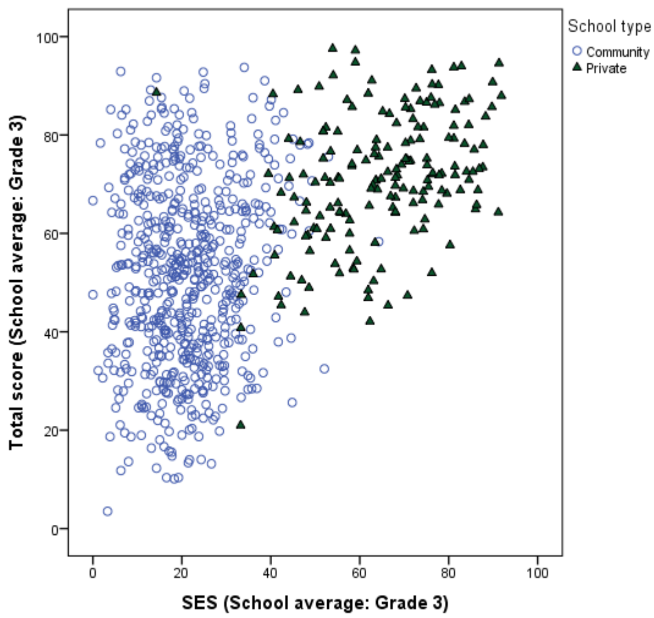

Figure 3: School achievement in mathematics based on SES and types of schools

It should be noted that, in Nepal, the high level of achievement in private schools can be explained almost fully by their selection of students: lower-achieving students are not enrolled in private schools. Obviously, the private schools are also expensive and hence the unprivileged families cannot afford their fees. However, it is notable that some community schools with students from a low average SES are at the same achievement level as the highly privileged private schools. This draws attention to the pedagogical processes: what was done differently in these

highly achieving community schools with less resources where the outcomes are at the same level as in the private schools with much more resources (see the discussion and answers in Metsämuuronen & Ilic, 2018).
The achievement gap between community and private is the highest in grade 8 (24 percent units), followed by grade 3 (20 percent units) and 5 (17 percent units) (see Figure 4).

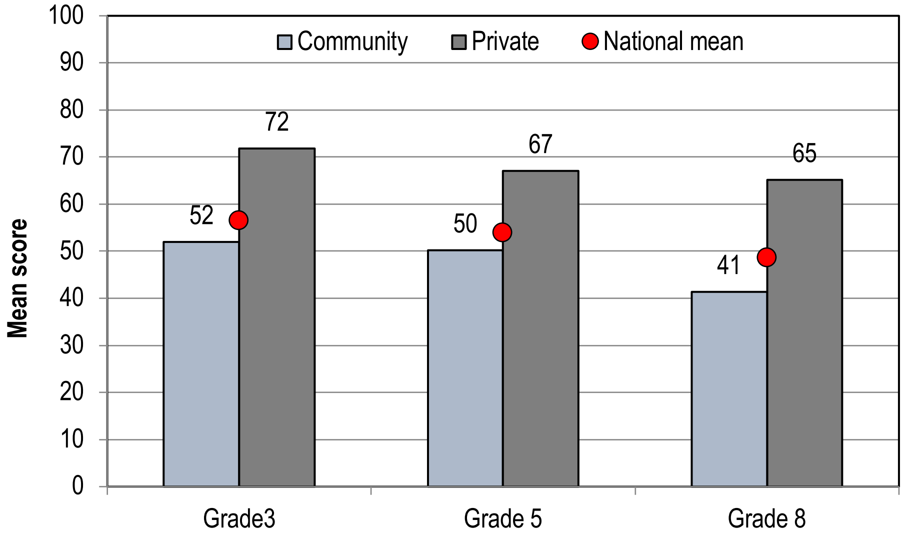

Figure 4: Mean scores in the community and private schools

The diversity tends to exacerbate the inequalities in achievement when it is associated with the SES of students. This is seen clearly when we focus on the average scores of the schools. Among the schools with the highest average achievement level (the highest quartile), 47, 41, and 70 percent of the schools for grades 3, 5, and 8, respectively, were private ones. On the contrary, of the schools with the lowest quartile, only 1–3 percent are private ones. We note the obvious discrepancy at the grade 8 schools: practically all (70 percent) of the best performing schools are private ones.

4.3 Diversity, SES, and disparity

Analysis based on students provides more detailed results about the existing situations as they represent diverse SES backgrounds. Hence, from now on, the analysis concentrates on students' achievement score as the dependent variable, students' diverse backgrounds as the independent variable and SES indicator as the explanatory factor.

4.3.1. SES and achievement

Like the school mean, the students' performance also shows an almost linear connection between SES and achievement in all three grades (Figure 5). The correlation is highest in the dataset for grade 3 (r = 0.35) and somewhat lower at the other grades (r = 0.27 and 0.29 in grades 5 and 8, respectively). The performance gap between the highest and the lowest SES groups is notable (29, 22, and 25 percentage points). Notably, the thresholds of the SES are found when students have met more than three out of the seven indicators of SES. Beyond this threshold, students performed above the national average in their respective grades.

SES alone explains 8–12 percent of the variation in the student dataset depending the grade: 12.4 percent in grade 3 (f = 0.33), 8.0 percent in grade 5 (f = 0.27), and 8.7 percent in grade 8 (f = 0.28), showing at least a medium effect size; 12 percent is a notable explaining power in the educational settings. In what follows, SES is included in models to explain the differences between other diversity groups.

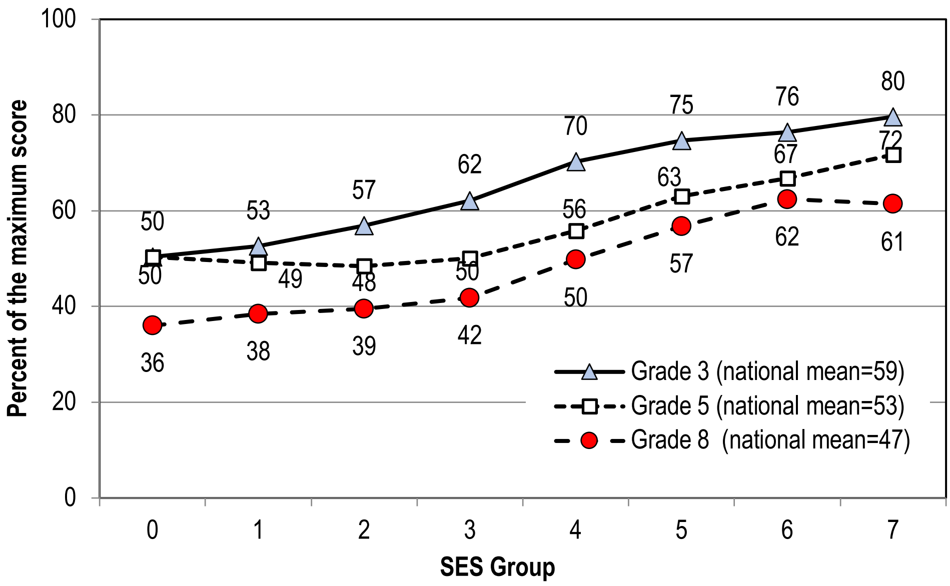

Figure 5: Student achievement and SES in different grades

4.3.2. Gender and SES: toward gender parity in mathematics

There is no statistically significant difference between boys and girls when it comes to the achievement level in mathematics (59 percent in both groups) at grade 3 (Table 3). The same phenomenon is seen also in Finland (Ukkola & Metsämuuronen, 2021). A mild gender disparity is seen in upper grades favoring boys (a difference of one point in grade 5 and three points in grade 8). This seems to indicate a slight gender-biased social scenario of Nepal seen prominently with the increment of students' grade so as in achievement levels. When categorizing the achievements into quartiles, the disparity is wider in grades 5 and 8. In grade 5, around 53 percent girls and 47 percent boys are in the lowest quartile and the reverse in the highest quartile, that is, 48 percent girls and 52 percent boys. The situation is more widened in grade 8: 56 percent girls and 44 percent boys in the lowest quartile and 44 percent girls and 56 percent boys are in the highest quartile.

Table 3: Gender wise achievement in upper and lower quartile groups

Sex	Quartile	Grade 3			Grade 5			Grade 8		
		N	Mean	SD	N	Mean	SD	N	Mean	SD
Girl	lowest	1,455	18	7.8	1,359	21	7.6	3,412	22	6.5
	highest	3,143	84	7.0	1,441	84	7.4	723	82	6.3
	Total	8,071	59	25.5	6,302	53	23.1	8,043	41	21.0
Boy	lowest	1,474	18	8.1	1,197	21	7.6	2,733	22	6.2
	highest	3,080	84	7.0	1,564	84	7.3	938	83	6.5
	Total	8,300	59	25.2	6,570	54	22.5	7,963	45	21.4
Total	lowest	2,929	18	8.0	2,556	21	7.6	6,145	22	6.4
	highest	6,223	84	7.0	3,005	84	7.3	1,661	82	6.4
	Total	16,371	59	25.3	12,872	54	22.8	16,006	43	21.3

Table 4: ANCOVA table of SES and Gender explaining achievement

Tests of Between-Subjects Effects
Dependent Variable: Total score in Math

Grade	Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Cohen's f
3	Corrected Model	1299567.271a	2	649783.6	1156.51	<0.001	0.124	
	Intercept	18999607	1	18999607	33816.1	<0.001	0.674	
	SES	1299368	1	1299368	2312.66	<0.001	0.124	0.33
	Gender	38.354	1	38.354	0.068	0.794	0.000	0.00
	Error	9196366	16368	561.85				
	Total	67736904	16371					
	Corr.d Total	10495933	16370					
5	Corrected Model	544382.049b	2	272191	569.128	<0.001	0.081	
	Intercept	9718102	1	9718102	20319.7	<0.001	0.612	
	SES	534759.6	1	534759.6	1118.14	<0.001	0.08	0.27
	Gender	7883.703	1	7883.703	16.484	<0.001	0.001	0.03
	Error	6154727	12869	478.26				
	Total	43672134	12872					
	Corr.d Total	6699109	12871					
8	Corrected Model	685298.136c	2	342649.1	836.728	<0.001	0.095	
	Intercept	4929786	1	4929786	12038.2	<0.001	0.429	
	SES	623910	1	623910	1523.55	<0.001	0.087	0.28
	Gender	45873.05	1	45873.05	112.019	<0.001	0.007	0.08
	Error	6553403	16003	409.511				
	Total	36579133	16006					
	Corr.d Total	7238701	16005					

a R Squared = .124 (Adjusted R Squared = .124)
b R Squared = .081 (Adjusted R Squared = .081)
c R Squared = .095 (Adjusted R Squared = .095)

The gender disparity seems to fade when we add SES to the model. When SES is taken as a covariate, the gender difference exists at the higher grades ($p < 0.001$) but is not notable in any of the grades (Table 4). This means that SES explains the difference and gender does not add much to our knowledge ($\eta^2 < 0.007$). Notably, the effect of SES at grade 3 is high ($\eta^2 = 0.124$, Cohen's $f = 0.33$).

The gender parity indicates a positive signal towards equity. It seems that "mathematics as boys' subject" is not anymore true in the Nepalese context. It would be interesting to see how the COVID-19 pandemic affects this phenomenon.

4.3.3. Social hierarchy, SES, and achievement

The traditional caste system is still deeply embedded in Nepalese society, creating unintended inequalities. Many lower caste and marginalized groups suffer in an obvious or un-obvious manner, which also impacts students' performance. Historically, the advantageous caste groups (Brahmins and Chhetris) were those who were maximally educated—Brahmins to be the teachers and Chhetris to be the nobles and warriors. In contrast, for many years, literacy was forbidden for the marginalized groups known as *Dalits* ("untouchables") and rare also within *alpasankhyak* ("minorities"). Also, many indigenous tribes (*Adivasi janajatis*) did not relate their traditions by using literal education while some other ethnic groups such as *Newars* were devoted to keep higher standards in studies. Hence, it is no wonder why the higher castes and certain ethnic groups have traditionally dominated education, administration, and economical activities in Nepal. Gurung (2005) evaluated the situation at the beginning of 1990's: the major three cast/ethnic groups (Brahmin and Chhetris, and Newars) combined together shared 89.2 percent civil service employment in the Government of Nepal in 1991. At that time, 73.8 percent of the students in the higher education came from the higher castes, 22.0 percent janajatis and 2.9 percent Dalit. When it comes to adult literacy rate, Brahmin and Chhetris, and Newars were noted to be advanced groups also on 2017 (NIRT, 2017, p. 19). Although formal education has been open since 1950s, the debates of educating all groups of children was discussed seriously with the introduction of the international program Education for All (EFA) in 1990 on (see UNESCO, 1994; 2011).

In the datasets used in this study, the privileged casts (Brahmin/Chhetri) have the highest achievement score in grades 3 (66 percent) and 5 (57 percent) and comparatively high also in grade 8 (45 percent) while Dalits have the lowest scores in all grades (55, 50, and 37 percent, respectively; see Table 5). The differences are mild though (7–9 percentage points) in comparison with the SES groups. An interesting fact is that students from Madheshi background, that is, people of Indian ancestry residing in the Terai zone near the Indian border, outperformed mildly (49 percent) the Brahmins and Chhetris (45 percent) in grade 8. The high performance of the Madhesi students may be explained as a kind of "Jokk-Mokk effect" (for the phenomenon, see Metsämuuronen & Ilic, 2018) where some unexpected group in the rural areas performs better than others to ensure their study places in the cities—or, in this case, maybe in India which would be a natural direction for Madhesi students.

The achievement gap between students in the highest and the lowest quartiles indicates obvious inequalities between the castes/ethnicities, especially in grade 3 (Table 6). Students from the Brahmin/Chhetri background enroll in school with good knowledge of mathematics in comparison with other castes and ethnic groups. In grade 3, 48 percent of Brahmin/Chhetri students belong to the highest quartile and 11 percent to the lowest quartile while, if the students would be randomly distributed in the quartiles, we expect to see 25 percent of the students in both groups. Also, in grade 5, the distribution of Brahmins/Chhetris is notably towards the highest quartile (27 percent) than in the lowest quartile (14 percent). In all assessed grades, the proportion of Dalits students is comparatively high in the lowest quartile, especially in grade 8 (i.e., 49 percent of Dalits in the lowest quartile and only 4 percent in the highest quartile). A good sign from the equity viewpoint is that, in grade 3, students from the Dalit background are distributed somewhat evenly in the lowest and the highest quartiles (21 and 30 percent, respectively). This may indicate that when these students get older, if these proportions continue at this level in the higher grades too, they may see a totally different world than their parents.

Table 5: Achievement by caste/ethnicity in the lowest and highest quartiles

Caste/		Grade 3			Grade 5			Grade 8		
ethnicity	Quartile	%	Mean	SD	%	Mean	SD	%	Mean	SD
Brahmin/	lowest	11	19.7	7.4	14	22.4	7.4	34	22.0	6.3
Chhetri	highest	**48**	84.8	7.1	**27**	83.8	7.3	**12**	82.5	6.6
	Total	100	65.7	23.1	100	57.0	21.7	100	45.0	21.6
Janajati	lowest	15	18.9	7.7	21	22.0	7.1	42	21.8	6.4
	highest	40	84.3	6.9	20	83.5	7.5	9	82.3	6.1
	Total	100	61.1	24.3	100	51.8	22.2	100	41.1	20.9
Dalit	lowest	**21**	18.5	7.5	**25**	22.2	7.2	**49**	21.5	6.3
	highest	**30**	82.9	6.7	20	82.7	7.4	4	82.2	6.7
	Total	100	54.6	24.6	100	50.2	22.4	100	36.8	18.6
Madhesi	lowest	19	19.2	7.7	**25**	20.1	8.3	27	22.6	6.5
	highest	**33**	84.5	7.2	21	84.4	7.5	18	82.9	6.4
	Total	100	57.5	25.0	100	50.9	24.3	100	49.1	22.2
Other	lowest	**25**	17.7	8.3	**24**	19.0	8.2	43	22.2	6.4
	highest	30	83.6	6.9	25	83.5	7.1	5	79.8	4.8
	Total	100	53.6	26.2	100	52.5	24.7	100	40.2	19.4

Table 6: Gender and caste-wise achievement in different grades

Caste	Grade 3			Grade 5			Grade 8		
	Girl	Boy	Difference	Girl	Boy	Difference	Girl	Boy	Difference
Brahmin/Chhetri	65	66	-1	56	59	-2	43	47	-5
Janajati	62	61	2	52	52	0	40	43	-3
Dalit	55	55	0	49	51	-2	35	39	-4
Madhesi	56	60	-3	48	54	-6	48	50	-2
Other	54	55	-1	53	53	-1	41	40	1
Total	61	61	0	53	55	-2	41	45	-4

Caste/ethnicity is linked with gender to a certain extent (Table 6). Except for the groups of Dalit students in grade 3 and janajati students in grade 5, the gender gap is found ranging 1–6 percentage points. Among the groups, the highest gender gap is noted in Madheshi students favoring boys in grade 3 and 5 (three and six percentage points, respectively). Even in the high castes Brahmin/Chhetri, the gap between boys and girls is five percentage point in grade 8.

With knowledge of the SES of the students, the interpretations get somewhat complicated. When students have a high SES (5–7 out of the seven indicators of SES are met), they achieve, on average, more than 70 percent of the maximum score in grade 3, more than 60 percent in grade 5, and more than 64 percent in grade 8 regardless the cast (except Dalit, 42 percent). The GML ANCOVA model with SES as a covariate the interaction of sex and caste shows statistically significant difference at $p < 0.001$ between the casts in all three grades (Table 7). However, the effect size of caste/ethnicity is small (Cohen's $f = 0.12$, 0.10, and 0.15 in grades 3, 5, and 8, respectively) and the factor explains only around 1 percent of the student variation in grades 3 and 5 and 2 percent in grade 8 ($\eta^2 = 0.013$, 0.010, and 0.023). SES explains the difference more than caste does in all grades with a medium effect size of SES on the achievement (grade 3: $\eta^2 = 0.097$ and $f = 0.328$; grade 5: $\eta^2 = 0.075$ and $f = 0.285$; grade 8: $\eta^2 = 0.081$ and $f = 0.297$). Hence, if we know the SES of a family, the cast/ethnicity does not seem to be an important factor in explaining the differences in mathematics achievement.

All in all, the analysis shows that students' SES is a more prominent factor of achievement inequality than caste and gender. However, the difference in achievement between the privileged castes (Brahmin/Chhetri) and low caste (Dalit) is still notable. This result may require more effective interventions for students from the marginalized groups. The positive signal is that the distribution of Dalit students at grade 3 shows equality in being evenly distributed in the lowest and the highest quartile instead of being mainly located in the lowest quartile as seen in higher grades. It would be interesting to see what the effect of COVID-19 epidemic of this matter is.

Table 7: ANCOVA table of SES (Covariate) and Caste/ethnicity×Gender (fixed variable) explaining the achievement

Tests of Between-Subjects Effects
Dependent Variable: Total score in Math

Grade	Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Cohen's *f*
3	Corr.d Model	1092745.643a	10	109274.6	208.791	<0.001	0.123	
	Intercept	15039092	1	15039092	28735.23	<0.001	0.659	
	Gender*Caste	102918.2	9	11435.36	21.85	<0.001	0.013	0.11
	SES	836960.5	1	836960.5	1599.182	<0.001	0.097	0.33
	Error	7772011	14850	523.368				
	Total	64411533	14861					
	Corrected Total	8864757	14860					
5	Corr.d Model	584465.967b	10	58446.6	125.058	<0.001	0.09	
	Intercept	7864158	1	7864158	16826.93	<0.001	0.572	
	Gender*Caste	57436.81	9	6381.868	13.655	<0.001	0.01	0.10
	SES	473124.4	1	473124.4	1012.343	<0.001	0.075	0.28
	Error	5875127	12571	467.356				
	Total	43037235	12582					
	Corrected Total	6459593	12581					
8	Corr.d Model	790615.187c	10	79061.52	196.111	<0.001	0.109	
	Intercept	2515272	1	2515272	6239.081	<0.001	0.281	
	Gender*Caste	151360.2	9	16817.8	41.716	<0.001	0.023	0.15
	SES	565568.5	1	565568.5	1402.881	<0.001	0.081	0.30
	Error	6435448	15963	403.148				
	Total	36529206	15974					
	Corrected Total	7226064	15973					

a R Squared = .123 (Adjusted R Squared = .123)
b R Squared = .090 (Adjusted R Squared = .090)
c R Squared = .109 (Adjusted R Squared = .109)

4.3.4. Language, SES, and Achievement

Out of all community schools for grades 1–8 in Nepal, 84 percent have Nepali as their instruction language (DoE, 2013) while most, if not all, private schools use English as their medium of instructions (see Metsämuuronen & Ilic, 2018). Socially, language is associated with ethnicity in Nepal. However, at present, the domination of Nepali language is growing in other language groups as well. Out of the 123 categorized languages of Nepal, in the dataset, 12 major languages were classified in the background questionnaires. In what follows, language is discussed from two viewpoints: first, by comparing Nepali speakers to other language groups (non-Nepali) and, second, by examining single language groups.

When speakers are divided into two groups—Nepali speakers and non-Nepali speakers—Nepali speakers' achievement level is somewhat higher than non-Nepali speakers' though the gap is small in grade 8 (around two percentage points) and slightly higher in lower grades (around four percentage points). The obvious reason for the discrepancy at the lowest level may be the domination of mother language: students with non-Nepali background may face difficulties in their learning in lower grades because of low proficiency in the instruction language. GML ANOVA shows achievement difference between Nepali and non-Nepali language groups to be statistically significant with $p < 0.001$ in grades 3 and 5 and $p = 0.002$ in grade 8. But the effect size and variation explained of language groups is small in all grades ($\eta^2 = 0.007$ and $f = 0.084$ in grade 3 and 5; $\eta^2 = 0.001$, $f = 0.032$).

SES somewhat complicates the matter. In high SES families, the difference in the achievement score between Nepali-and non-Nepali students in grade 8 is very small if not non-existent (Nepali speakers, 57–63 percent and non-Nepali speakers, 62 percent). However, when SES is low, non-Nepali speakers' achievement is four percentage points higher than that of the Nepali speakers (39 percent and 35 percent). Likewise, in grade 5, when the Nepali speakers are from a low SES, the achievement score is found to be lower than that of the non-Nepali speakers (i.e., 49 percent and 52 percent). In grade 3, Nepali speakers slightly supersede (52 percent) the non-Nepali speakers (49 percent) in the group of low SES.

When it comes to individual languages, in grade 3, certain language groups seem to be ahead of the others though the difference is difficult to explain. In any case, speakers of Magar (79 percent), Tamang (73 percent), Maithili (71 percent), and Nepali (61 percent) achieved the highest scores. Except for Tamang speakers, girls are ahead of boys in high achiever groups, especially the Maithili girls are six percentage points better than boys. The high gender gap of eight percentage points is found also for Gurung speakers, favoring boys (girls, 52 percent and boys, 60 percent). In grade 5, speakers of Magar (65 percent), Tamang (62 percent), Rai (61 percent), Nepali (55 percent), and Urdu (54 percent) are above the national average. Of these, in Magar and Rai language groups, boys mildly outperform girls. All in all, the variation in achievement depending on gender is notably high in grade 5, varying from no gender difference to the difference of 17 percentage points (Gurungs). In grade 8, the highest achievement levels are observed in the language groups of Sherpa (54 percent), Newar (52 percent), Gurung, and Tharu (45 percent). Out of total 12 language groups, boys are ahead by 2–4 percentage points in eight language groups (Nepali, Magar, Tharu, Tamang, Urdu, Rai, Gurung, and "Other") and, only in the groups of Newar and Sherpa, girls are ahead of boys by 4–6 percentage points. Hence, there seems to be some cultural restrictions in some language groups for girls to reach the level of boys in mathematics.

GML ANOVA indicates that the achievement level due to home language is statistically significant ($p < 0.000$) in all three grades (Table 8). In grade 3, the home language explains 3 percent of the student variation showing a medium level of effect size ($\eta^2 = 0.029, f = 0.20$). Likewise, in grade 5, the home language explains around two percent of variation, showing a medium effect size ($\eta^2 = 0.024, f = 0.20$). In parallel, in grade 8, two percent of the student variation can be explained by language, showing a small effect size ($\eta^2 = 0.018, f = 0.10$). It seems the home language may affect mathematics learning to some extent in the lower grades but in the upper grades, the language is a less influential factor. This could be explained by the medium of instruction in schools: the language is not an issue for those who speak Nepali fluently, but the achievement at beginning of the school may be affected by the home language, but this effect wanes within the school years.

It seems that gender does not explain the achievement level ($p > 0.280$) when we have more powerful factors in the model such as home language and SES (Table 8). However, there seems to be a mild interaction effect of language and gender in the lower grades ($p < 0.043$), that is, boys and girls with different language backgrounds, behave differently when it comes to learning mathematics. The effect size of this interaction factor is small—if not non-existent—in all grades ($f < 0.10$). Language seems to have a unique effect ($f > 0.12$)—specifically in grade 3 ($f = 0,12$). SES, when controlled, appear to explain the differences the best ($f > 0.26$)—specifically in grade 3 ($f = 0.31$).

The mixed results of the effect of home language indicates a complexity in the phenomenon. It is difficult to claim categorically that speakers of some language groups would perform systematically lower or higher than others. However, it is safe to say that disparity exists when language groups are categorized only into two (Nepali and non-Nepali). However, it seems that when the SES of the family is high, the home language background has less effect on the mathematical achievement in school. Like with gender and caste, SES explains inequalities in language more clearly than the language itself. Nevertheless, there seems to be language-wise differences in mathematics achievement that cannot be explained by gender or SES. Because language reflects the cultural and ethnic background of the students, this indicates cultural and ethnic disparity in education in Nepal. In the studies to come of the effects of COVID-19, the language issue would be important to include to the analysis: did the pandemic affect equally to different language groups.

Table 8. ANCOVA table of SES (Covariate) and Language and Gender (fixed variable) explaining achievement

Tests of Between-Subjects Effects
Dependent Variable: Total score in Math

Grade	Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Cohen's f
3	Corr.d Model	1609394.410a	24	67058.1	123.3	<0.001	0.153	
	Intercept	598571.089	1	598571	1101	<0.001	0.063	
	SES	1070107.47	1	1070107	1968	<0.001	0.107	0.31
	Language	294833.778	11	26803.1	49.3	<0.001	0.032	0.18
	Gender	71.022	1	71.022	0.131	0.718	0	0.00
	Lang.*Gender	10980.981	11	998.271	1.836	0.043	0.001	0.03
	Error	8886538.57	16346	543.652				
	Total	67736903.7	16371					
	Corrected Total	10495933	16370					
5	Corr.d Model	649410.537b	24	27058.8	57.46	<0.001	0.097	
	Intercept	1522052.57	1	1522053	3232	<0.001	0.201	
	SES	459992.334	1	459992	976.8	<0.001	0.071	0.26
	Language	92494.034	11	8408.55	17.86	<0.001	0.015	0.12
	Gender	89.912	1	89.912	0.191	0.662	0	0.00
	Lang.*Gender	10534.515	11	957.683	2.034	0.022	0.002	0.04
	Error	6049698.77	12847	470.904				
	Total	43672133.8	12872					
	Corrected Total	6699109.31	12871					
8	Corr.d Model	781015.326c	23	33957.2	84.04	<0.001	0.108	
	Intercept	173699.363	1	173699	429.9	<0.001	0.026	
	SES	588999.943	1	589000	1458	<0.001	0.084	0.28
	Language	90872.731	11	8261.16	20.45	<0.001	0.014	0.12
	Gender	464.353	1	464.353	1.149	0.284	0	0.00
	Lang.*Gender	3262.021	10	326.202	0.807	0.622	0.001	0.03
	Error	6457686.17	15982	404.06				
	Total	36579133	16006					
	Corrected Total	7238701.5	16005					

a R Squared = .153 (Adjusted R Squared = .152)
b R Squared = .097 (Adjusted R Squared = .095)
c R Squared = .108 (Adjusted R Squared = .107)

4.3.5. Geographical diversity and achievement

Geographically, Nepal can be divided into ecological and locational strata (see Figures 1a and 1b above). There are three ecological zones (Mountain, Hill, and Terai) and two locations (rural and urban). At the time of sampling, there were also five development regions (Eastern, Central, Western, Mid-Western, and Far-Western; see Figure 1a). Capital Valley consisting of three districts from Hilly zone Kathmandu, Lalitpur and Bhaktapur has unique characteristics, so it is considered as a different stratum within the ecological regions. Distinctively, caste and language groups are historically recognized depending on the specific ecological zones of Nepal like Sherpa and Rai in Mountain zone; Gurung, Brahmin/Chhetri, and Newar in Hill zone; and Madheshi, Brahmin, and Newar in Terai zone. Hence, the ecologic division is most important from the perspective of Nepalese social structure. Besides, the location of the student (rural or urban) can also indicate inequalities in achievement. We may also keep in mind Aasland's and Haug's (2011) result that people's perception of their own social situation in Nepal seems to be more to do with geography and objective social class (SES) than with caste, ethnicity, or religion.

GLM ANOVA and the related Tukey's post hoc test shows that Capital Valley at the Hill zone is ahead of all other regions in grade 3 and 5 (Table 9) regarding mathematics achievement. In grade 3, the widest gap is observed between students from the Capital Valley and Terai zone (22 mean points), which is followed by Hill (21) and Mountain (16) zones. Students from the Hill zone areas are five points lower than the Mountain areas. Students from the Terai zone are at the lowest in the strata although there is no statistical difference between the means of the students from the Terai and Hill zones in grade 3.

In grade 5, the gap is notably high between students from the Capital Valley and from the Hill zone as well as from the Capital Valley and the Terai zone, which is 19 points on average for each zone. Likewise, the difference between students from the Capital Valley and Mountain zones is 13 points. The difference is not statistically significant between Hill and Terai zones. After Capital Valley zone, students from the Mountain zone perform six points better than students from the Hill and Terai zones. In grade 5, students from the Hill zone are the lowest achievers out of all four ecological zones.

In grade 8, students from the Terai zone are ahead of other zones (except Valley). This was seen also in Madhesi students' high performance over the advantageous castes discussed above. The highest difference between Terai and Hill zones is notably 16 points, which is followed by the differences between the Terai and Mountain zones (14) and Terai zone and Capital Valley (11). Again, students from the Hill zone have the lowest achievement score.

Table 9: Multiple comparisons of Ecological zones

Multiple Comparisons Tukey HSD
Dependent Variable: Total score in Math

(I) Ecological zone	(J) Ecological zone	Grade 3 Mean Difference (I-J)	Grade 3 Sig.	Grade 5 Mean Difference (I-J)	Grade 5 Sig.	Grade 8 Mean Difference (I-J)	Grade 8 Sig.
Mountain	Hill	5.03*	< 0.001	6.52*	< 0.001	2.84*	< 0.001
	Terai	5.89*	< 0.001	6.29*	< 0.001	-13.62*	< 0.001
	Valley	-15.71*	< 0.001	-12.67*	< 0.001	-2.93*	< 0.001
Hill	Mountain	-5.03*	< 0.001	-6.52*	< 0.001	-2.84*	< 0.001
	Terai	0.86	0.216	-0.24	0.956	-16.47*	< 0.001
	Valley	-20.74*	< 0.001	-19.1960*	< 0.001	-5.77*	< 0.001
Terai	Mountain	-5.89*	< 0.001	-6.29*	< 0.001	13.62*	< 0.001
	Hill	-0.86	0.216	0.24	0.956	16.47*	< 0.001
	Valley	-21.5958*	< 0.001	-18.96*	< 0.001	10.69*	< 0.001
Valley	Mountain	15.71*	< 0.001	12.6718*	< 0.001	2.9297*	< 0.001
	Hill	20.74*	< 0.001	19.20*	< 0.001	5.7727*	< 0.001
	Terai	21.60*	< 0.001	18.96*	< 0.001	-10.6934*	< 0.001

Based on observed means.
* The mean difference is significant at the .05 level.

All in all, the inequalities between the geographical zones are noticeable in all grades. Nevertheless, in grades 3 and 5, students from the Capital Valley outperform the students form other zones whereas in grade 8, students from Terai outperform other zones. The reason is the surprisingly high performance of Madhesi students locating in Terai zone. From the equity perspective, zonal differences reflect wide inequalities of learning opportunities in different ecological areas in Nepal, which may create two-levelled human resources in the country. In the studies to come, it would be interesting to see whether COVID-19 pandemic have teared more difference between the Capital Valley and the rest country.

4.3.6. Geographical diversity and achievement; Disparities between rural and urban areas

Above, the effect of the school location was handled from the school average viewpoint. Here the student dataset is focused. The terms “rural” and “urban” themselves hint at the disparities. In the context of Nepal, location is one of the important factors because, at the time of collecting the information, 83 percent of people lived in the rural areas (52 percent female and 48 percent male; CBS, 2013). From the perspectives of infrastructure development and human resource development, the technical inequalities are very wide.

The achievement difference between rural and urban is wider in the lower grades (14–15 percentage points) than in grade 8 (eight percentage points) (Table 10).

Table 10: Location-wise achievement of grade 3, 5 and 8

		Grade 3			Grade 5			Grade 8		
Location		N	Mean	SD	N	Mean	SD	N	Mean	SD
Rural	Female	6277	56	25.6	4563	49.2	22.2	6033	39	20.1
	Male	6653	57	25.6	4696	51.4	22.2	5845	43	20.7
Urban	Female	1771	71	21.4	1239	65.0	21.6	2010	47	22.4
	Male	1749	70	20.5	1300	64.8	20.6	2118	50	22.5
Total	Female	8048	59	25.5	5802	52.5	23.0	8043	41	21.0
	Male	8402	59	25.2	5996	54.3	22.5	7963	45	21.4

In the datasets, there is no gender difference in grade 3 as discussed above. GLM ANCOVA with main effects of location and gender shows statistically no difference in grade 3 ($p > 0.05$) although the difference is statistically significant in grade 5 and 8 with a negligible effect size (see Table 11). The ANCOVA model explains more variation of SES than other fixed factors (location and gender), that is, a medium effect size in grade 3 ($\eta^2 = 0.05, f = 0.20$), small in grade 1 ($\eta^2 = 0.02, f = 0.12$), and moderately high in grade 8 ($\eta^2 = 0.07, f = 0.30$).

The datasets show that both girls and boys are equally competitive in the beginning of their education (in grade 3). However, in upper grade girls perform slightly lower than boys. Statically, inequality is explained more by SES than location and gender. Based on the results by Shrestha and colleagues (2021) it is expected the COVID-19 pandemic have had exacerbated impact in education in the rural areas with low infrastructure and less use of internet than in the urban areas.

4.3.7. School type disparity and School location disparity

In the dataset, most of the community schools are situated in the rural areas (87–88 percent of the rural schools) and most of the private schools in urban areas (66–68 percent of the urban schools). It indicates unequal distribution of the education system in the country, especially when private schools usually represent high scores and SES in Nepal. The learning outcomes are significantly lower in the rural area, but the phenomenon is not clear (Table 12). Both in community and private schools for grade 8, the achievement level is somewhat higher in the rural community schools than in the urban areas if the Capital city area is included in the analysis. However, outside the Capital city areas, students from the urban areas perform, in general, higher than the students from rural areas.

Table 11: ANCOVA table of SES (covariate) and Location and Gender as (fixed variable) explaining achievement

Tests of Between-Subjects Effects
Dependent Variable: Total score in Math

	Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Cohen's *f*
3	Corrected Model	591985.053a	4	147996.3	246.62	< 0.001	0.07	
	Intercept	6220941.641	1	6220942	10366.52	< 0.001	0.44	
	SES	399888.772	1	399888.8	666.371	< 0.001	0.05	0.22
	School_location	1877.171	1	1877.171	3.128	0.08	0.00	0.00
	Gender	1149.614	1	1149.614	1.916	0.17	0.00	0.00
	Location*Gender	89.693	1	89.693	0.149	0.70	0.00	0.00
	Error	7963919.175	13271	600.099				
	Total	49597971.68	13276					
	Corrected Total	8555904.228	13275					
5	Corrected Model	202115.350b	4	50528.84	106.347	< 0.001	0.04	
	Intercept	3722891.304	1	3722891	7835.502	< 0.001	0.45	
	SES	70497.233	1	70497.23	148.374	< 0.001	0.02	0.12
	School_location	26636.956	1	26636.96	56.062	< 0.001	0.01	0.08
	Gender	4495.96	1	4495.96	9.463	< 0.001	0.00	0.03
	Location*Gender	320.104	1	320.104	0.674	0.41	0.00	0.00
	Error	4640606.504	9767	475.131				
	Total	29509357.7	9772					
	Corrected Total	4842721.854	9771					
8	Corrected Model	664709.253c	4	166177.3	452.27	< 0.001	0.16	
	Intercept	2316746.343	1	2316746	6305.288	< 0.001	0.39	
	SES	251741.23	1	251741.2	685.142	< 0.001	0.07	0.27
	School_location	98069.101	1	98069.1	266.906	< 0.001	0.03	0.17
	Gender	10737.72	1	10737.72	29.224	< 0.001	0.00	0.05
	Location*Gender	2171.925	1	2171.925	5.911	0.02	0.00	0.03
	Error	3585006.071	9757	367.429				
	Total	21371649.47	9762					
	Corrected Total	4249715.325	9761					

a R Squared = .069 (Adjusted R Squared = .069)
b R Squared = .042 (Adjusted R Squared = .041)
c R Squared = .156 (Adjusted R Squared = .156)

Table 12: Mean score of the students from rural and urban school

School type	Location	Mean with Capital city			Mean without Capital city		
		Grade 3	Grade 5	Grade 8	Grade 3	Grade 5	Grade 8
Community schools	Rural	51	50	**42**	54	49	39
	Urban	**60**	**54**	38	53	**55**	37
Private schools	Rural	71	61	**68**	71	62	65
	Urban	72	**72**	64	71	**70**	62
Total	Rural	53	51	45	55	50	41
	Urban	**68**	**66**	**55**	**65**	**65**	**48**
Community	difference	9	4	4	1	6	2
Institutional	difference	1	11	4	0	8	4

Previous assessments in Nepal (EDSC, 2008; FBC & CHIRAG, 2008) have indicated diverse location-wise achievement although those measurements were not based on the type of school; the achievement difference between rural and urban was not more than two percentage points. Nevertheless, the analysis in FBC and CHIRAG (2008) showed that urban school students at grade 5 were at a higher level than students from the rural schools whereas the analysis in EDSC (2008) showed that students from the rural schools outperformed the students from the urban schools.

The wide gap between the community and private schools in grade 3 is a detrimental one from the equity viewpoint. It indicates an unequal pedagogical delivery system in two different locations in community schools. In the urban areas, community schools can compete with private schools; they seem to be able to introduce better strategies in pedagogical processes in comparison with both private schools in general and community schools in the rural areas. This can be inferred from the fact that results in these highly performing community schools are at the same level as where the institutional schools (with much higher SES) are (see Figure 3 above).

5. Conclusions and discussion

The main research question in the article was how SES and other diversities affected the inequalities in mathematics achievement in Nepal just before the COVID-19 pandemic. A more focused question was how the selected diversity factors (gender, geographical zone and region, location in urban or rural area, language, caste/ethnicity, and school type) did explain equalities and inequalities in relation to SES. The results may be used later as a baseline in assessing the effect of COVID-19 on educational equality in Nepal.

Seven outcomes of the analysis are worth highlighting. First, in each grade, even in the normal situation, *population disparity* in Nepal is obvious, that is, instead of one national, normally distributed population, there are at least two to three distinct populations with deviations outcomes in mathematics. This indicates that the educational system is not able to smoothen the wide differences in the student population caused by a wide variety of factors causing inequality in education. Underlying this basic disparity, we found several factors that explain the basic disparity. Some of these factors were studied in the article.

Second, an obvious matter affecting the discrepancy in the population in pre-COVID realm was the SES or—maybe more appropriate in Nepal—economic, social, and cultural status (ESCS). The performance gap in mathematics between the highest and lowest SES groups was notable: 29, 22, and 25 percentage points in grades 3, 5, and 8, respectively. Knowing that the standard deviation of mean score in different grades are 25, 23, and 21 percentage points, the students from the lowest SES group are around one standard deviation behind those who come from the highest SES group. This difference is remarkable. In grade 3, SES alone explained over 12 percent of the variation in the student dataset and 8–9 percent in the higher grades. Twelve percent is a notable explaining power in educational settings. Hence, it seems that the educational system is not able to smoothen the disparities caused by the low education or economic standard of the parents even in the pre-COVID realm. Instead, we can detect several possible disparities in Nepal: *Parents' education disparity*, *Parents' occupation disparity*, *Home possessions-and accessories disparity* and, as whole, *Socioeconomic status disparity* (see the rationales for these in Metsämuuronen, 2019).

Third, the wide gap between community and institutional schools in grade 3 is a malign one from the equality viewpoint. This indicates a strict *School type disparity* with unequal pedagogical systems within the country. Mainly, the difference between the community and private schools is caused by rigorous selection of the students in Nepal; because the highest performing students are actively selected from the community schools to the private schools, it is difficult to show that any specific pedagogical reason would explain the differences in achievement. We also see notable *School location disparity*: in urban areas, community schools could compete with private schools; they seem to be able to introduce better strategies in pedagogical processes than the private schools (see also the discussion in Metsämuuronen & Ilic, 2018 regarding English proficiency). This can be inferred from the fact that the results in these highly performing community schools at the same level as where the institutional schools are (with much higher SES) are.

Fourth, a positive result is that we cannot detect *Gender disparity* related to achievement in mathematics in Nepal in the pre-COVID realm. There are mild differences between boys and girls when it comes to the achievement in mathematics, but the effect is reduced to almost non-existent when we add SES to the models. Specifically, there is no difference between boys and girls in grade 3 and minor differences exist at the higher grades. This indicates a positive signal towards equity. Mathematics as boys' subject is not true in the Nepalese context; it may be interesting to see what the effect of COVID-19 on this phenomenon would be.

Fifth, there were real differences in the achievement between privileged castes (Brahmin/Chhetri) and low castes (Dalit) although the magnitude is mild (7–9 percentage points, depending on the grade) in comparison with the effect of SES. Hence, there still was *Ethnicity Parity* in Nepal although ANCOVA shows that SES is a more prominent factor in explaining the inequality in achievement than caste and gender. Hence, if we know the SES of the family, caste/ethnicity does not seem an important factor in explaining the differences in mathematics achievement; this is in line with Aaslands' and Haug's (2011) results based on a household survey. A positive signal is that the distribution of Dalit students at grade 3 shows equality in being evenly distributed in the lowest and highest quartile instead of being mainly located in the lowest quartile as seen in the higher grades.

Sixth, mixed results of the effect of home language indicate complexity in the phenomenon. It is difficult to claim categorically that some language groups perform systematically lower or higher than others. However, it is safe to say that mild *Home language disparity* exists when language is categorized into two distinct groups (Nepali and non-Nepali). The gap between Nepali and other language speakers was small in grade 8 (around 2 percentage point) and slightly higher in lower grades (around 4 percentage point). Like with gender and caste, SES explains inequalities in language more clearly than the language itself. Nevertheless, there seems to be language-wise differences in mathematics achievement that cannot be explained by gender or SES. Because language reflects cultural and ethnic background of the students, this indicates a mild *Cultural and Ethnic disparity* in education in Nepal in the pre-COVID realm.

Finally, seventh, the inequalities between the geographical zones are noticeable in all grades; we observe a clear *Geographical disparity* in Nepal in the pre-COVID realm. The main difference is seen between the Capital Valley zone in comparison with the other zones in grade 3 and 5. The widest difference was in grade 3: students from the Capital Valley outperformed the students from Terai by 22 percentage points, Hill by 21 percentage points and Mountain by 16 percentage points. The reason for the higher scores in the Capital Valley may be understandable: most of the intellectual and economical resources, that is, highly educated families with decent or high incomes, can be found in the Capital city in Nepal. Students of grade 8 differ from the other grades; those from the Terai outperformed students from other zones. From the equity perspective, the zonal differences reflect wide inequalities of learning opportunities in different ecological areas in Nepal in the pre-COVID realm.

All in all, even before the COVID-19 pandemic, there were wide differences between the students in all grades studied in the article. It is no wonder why the national distribution showed several populations; there *are* several populations that perform differently when it comes to achievement in mathematics. The fact that the economic, social, and cultural status varied widely between the families, alone, causes the deviance in achievement between different populations. Also, the intensity of the intellectual and economic resources to the Capital city creates a wide difference between the geographical areas in Nepal. The results are not totally new—those who work at the national level of student assessment in Nepal know the challenges. Anyhow, it is notable how much SES affects the gender issues, caste/ethnicity issues and language issues. We cannot change that without making unethical decisions. Two obvious questions in the post-COVID realm are, first, how the pandemic have affected the already existing disparities between the different groups in Nepal and, second, what could the individuals, teachers, schools, and governments do to smoothen these discrepancies and to prevent widening of the gap between the advantageous and disadvantageous groups.

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