A COMPARISON OF MATHEMATICS AND FIRST LANGUAGE SKILLS AS CONCURRENT PREDICTORS OF SECOND LANGUAGE SKILLS IN BOYS AND GIRLS: A TEST-BASED STUDY

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Abstract
Language skills and mathematical skills make use of the same sub-skills, and the same areas in the brain for their processing and a comparable psychological development. Mathematics skills are also reported to strongly correlate with language skills, and to depend on language skills for their processing. Therefore, there might be a robust possibility that these skills would be contemporary predictors of one another and a strong correlation could be expected among them. To investigate this hypothesis, scores of around 11 years 100boys and 100 girls in the subjects of English, Urdu, and mathematics were collected. They (boys and girls) belonged to the rural suburbs of a district in the South Punjab, Pakistan. They secured these scores in the grade 5 examinations conducted under Punjab Education Commission (PEC). The data was analyzed by applying a Pearson's correlation analysis, a hierarchical regression analysis, and later on, a factor analysis to find the relationship among the said skills. The statistical analyses revealed the presence of a strong correlation among second language (L2), first language (L1), and mathematical skills. Comparison with a previous study showed that this relationship was stronger in boys than girls.

Keywords: L1 skills; language teaching; mathematical skills and language; predictor of L2 skills; second language acquisition

1. INTRODUCTION

The connection among L1 and L2 skills and mathematics skills can be elucidated on both biological, and psychological grounds, as well as on the grounds of same/similar sub-skills taking part within these two skills, Children's initial mathematics skills progress in a collaborative/associative pattern with the non-mathematical elementary skills aiding as a base for the learning of later skills. Non-mathematical faculties, such as working memory and language skills are also related to the progress of mathematical skills at a more advanced level (Purpura & Ganley, 2014).

Furthermore, to read and to do math get administered in the regions of the brain that are more or less shared to both of these skills, and, at the same time, mathematical skills are dependent on verbal skills showing that the skills are mutually inter-related. When a person is mathematically literate it is supposed that s/he might have an ability to express quantitative material coherently in both verbal or visual form (Bohlmann & Pretorius, 2008). Kemp (1995) claims that mathematics skills need the ability to converse clearly and fluently and thinking judgmentally and logically which shows that learning of mathematics is greatly dependent on literacy skills. It depends significantly on language and reading (Bohlmann & Pretorius, 2008).

If we discuss about the mathematics discourse, it normally comprises of stuffs that have linguistic, cognitive and contextual aspects (Gibbs & Orton, 1994). The linguistic aspect includes both the receptive level (e.g. reading) as well as the productive level (e.g. writing, and discussing).

We have a range of studies discussing the role of language in mathematics (e.g. BartoliniBussi, 1998; Ellerton, Clarkson& Clements, 2000), and they all represent poorly developed language skills affecting the mathematical performance (Bohlmann& Pretorius, 2008). Generally, the mathematics register is abstract, conceptually heavy and straight forward (Prins, 1997). Mathematical symbols and illustrations (e.g. charts, tables, and graphs) raise the conceptual density. Mathematical discourse structures have more intricate and compact relations than usual discourse. Moreover, mathematics discourse is characterized by accuracy, demanding deep attention to details. Mathematics texts are ordered and cumulative too, e.g. to understand each statement is essential for to understand successive statements. Ignoring or misinterpreting any of the steps has severe results for the comprehension at large.

The language problem is a complex issue; it is even more evident now that only if the students reach an adequate level of expertise in the use of natural language only then they could perform mathematical activities in a satisfactory way (Boero, Douek & Ferrari, 2002).In other words mathematical notions are required to be learnt in the context of mathematics, it does not matter whether the learning happens through reading and/or other practices of natural language (Sfard, Nesher, Streefland, Cobb & Mason, 1998). It may not be possible without well-developed reading and language skills that the learners could not be able to "develop mathematical thinking skills such as generalizing, explaining, describing, observing, inferring, specializing, creating, justifying, representing, refuting and predicting" (Department of Education, 2002, p. 63). Reasoning skill, for example, depends on an intimacy of logical relationships in language, and reading skills support the ability to develop meaning from written stuff. Learners require to access information and comprehend the context as well as the content before applying any of the mathematical skills they have acquired (Bohlmann & Pretorius, 2008).

Mathematics related problems of children who are English language learners seem to have relationship to the language requirements of mathematics tasks. In comparison to this, children with specific language impairment seem to have trouble with mathematics tasks due to their "linguistic as well as non-linguistic processing constraints" (Alt, Arizmendi & Beal, 2014). Most of the research we find to presentany such relationship comes from the research on the language deficits (e.g. dyslexia) and mathematics deficits (e.g. dyscalculia) which revealed the underlying processes working in both.

The participation of dorsal stream in reading can be confirmed from the results of certain studies (e.g. Haxbyet.al., 1991; Venneri et al., 2003). Convincing evidence comes from studies using techniques of neuroimaging and neuropsychology. The evidence shows that separate neural systems are engaged in processing the information which is relevant to the visual configurations of objects and information relevant to their spatial positions (e.g. Haxby et.al.,1991), the same visuo-spatial skills could also be involved in mathematical skill problems (Venneri et al., 2003).

Another studywas conducted by Vinckenbosch, Robichon and Eliez (2004) on the individuals with dyslexia who observed a significant decreaen the density of the gray matter inside both the middle and the inferior temporal gyri. They also reported the presence of a positive co-relation between the performance on the tasks of rhyme judgement and the density of gray matter in the middle temporal gyri and the middle inferior frontal gyri bilaterally. Gray matter and white matter anomaly is also reported to be seen in both dyslexia and developmental dyscalculia (Rykhlevskaia et al., 2009;Vinckenbosch, Robichon & Eliez, 2004).

Working memory is another ability which is relevant to both language and mathematics. It has the capability to predict about the achievements of children in reading, as well as in mathematics but to a lesser degree. Though, the contribution of working memory is common in both ability domains (Gathercole, Alloway, Willis & Adams, 2005). Working memory aids as a resource to the learner for letting a child integrate with the contemporary inputs with the information that s/he retrieves from long-term memory. It can help predict the severity of impairments in both reading and mathematics (Swanson & Beebe-Frankenberger, 2004; Swanson & Saez, 2003).

We have a range of research (e.g. Alt, Arizmendi & Beal, 2014; Bohlmann& Pretorius, 2008) studying the interdependent predictive connection between reading and mathematics. Purpura, Hume, Sims and Lonigan (2011) confirmed that a child's academic achievement at the start of his/her academic career is intensely related to his/her success attained in studies at a later stage (Butler, Marsh, Sheppard& Sheppard, 1985; Krajewski & Schneider, 2009).Reading and

mathematics have a core position in the early achievement of a child in his/her studies, which are important not only for the child in his/her capacity but also in his/her acquisition of knowledge inside other areas (Anders, 1986; Brown & Murray, 2005; Snow, Burns& Griffin, 1998). In addition to it, mathematics and reading assist in each other's progress. These areas show signs of mutual dependence right from very early age (McClelland et al., 2007; Welsh, Nix, Blair, Bierman & Nelson, 2010) and also have long term effect on each other (Duncan et al., 2007; Juel, 1988).

1.1. OBJECTIVE OF THE STUDY

The present study aims to explore if a relationship exists among L2,L1 and mathematics skills in boys of grade 5.And if the relationship exists what is the strength of that relationship.

1.2 HYPOTHESIS

As we know that language and mathematical skills depend on the same sub-skills, same areas in brain for their work, and a similar psychological development (Purpura & Ganley, 2014), therefore these skills could be concurrent predictors of one another. Thus, we predict a strong relationship in boys also. Furthermore, a strong relationship, among the skills, is already observed in girls in a recent study (see Farukh, Ali & Ahmad, 2020).

2. METHODOLOGY

Being quantitative in nature, this study aimed to confirm the hypothesis (see 1.2) with the help of the statistical results based on test scores. The test was conducted by PEC in 2018 in Punjab (Pakistan). PEC is an autonomous body of Punjab Government School Education Department which examines the 5th and 8th grade students in Punjab. This study used the test results of grade 5 students for the subjects of English, mathematics and Urdu.

Data from 200 students (100 females and 100 males) aged around 11 years was collected. They were studying at public sector schools located in the rural area of the South Punjab and were from similar social background (i.e. lower). Majority of the students used Punjabi as their L1. However, some of them (students) used Saraiki as their L1. They also knew how to use Urdu which was the national and second L1 of the subjects of this study.

2.1 DESCRIPTION OF TESTS

2.1.1 ENGLISH TEST

English test comprised of both objective, and subjective parts of 100 marks in total, out of which, 50 marks were specified for objective and the remaining 50 marks were specified for the subjective part. Objective part comprised of 25 MCQs (multiple choice questions) where one correct answer carried two marks, and were designed to test students' skill/knowledge about parts of speech, reading comprehension, rhyming words, and tenses. The subjective part, on the other hand, comprised of five long questions of 10 marks each that (questions) were designed to test students' skills in comprehension of a paragraph, fill in the blanks, letter writing, paragraph writing, story writing, and use of words into sentences.

2.1.2 MATHEMATICS TEST

Mathematics test was also divided into objective, and subjective parts of 50 marks each (100 marks in total) where objective part contained 25 MCQs (each question carried 2 marks). The MCQs were asked to test the students' knowledge about different mathematical categories (i.e. addition, average of numbers and graphs, daily-use algorithmic statements, division, geometry, highest and least common factors, multiplication, and subtraction). Whereas, subjective part contained five long questions which were intended to check students' knowledge about algorithms (i.e. +, -, ×, and ÷), geometry (i.e. area/drawing square etc.), highest and lowest common factors, ratio/proportion, and statistics/graphs. Every long question carried 10 marks for correct answer.

2.1.3 URDU TEST

Like English, and mathematics tests, the test of Urdu was also divided in objective and subjective parts where objective part contained 25 MCQs and subjective part included five long questions. MCQs were developed from application writing, comprehension, essay writing, explanation of poetry in simple sentences, letter writing, story writing, and Urdu parts of speech. Both of the parts (i.e. objective and subjective) carried 50 marks each (100 marks in total). 2 hours and 45 minutes' time was given to solve the test.

2.1.4 COLLECTION OF RESULTS

The test results (for this study) were collected from the school offices with prior permission from the head teachers at boys' and girls' schools located in the rural areas of the South Punjab (Pakistan) in the form of marks sheets issued by PEC. The identity of the students, teachers, and schools is hidden for ethical consideration. The marks of English, mathematics, and Urdu tests were separately arranged in a table to process in SPSS.

2.1.5 ANALYSIS PROCEDURE

The data were analyzed by running Pearson's correlation analysis to determine the skewness of the three variables (i.e. English, mathematics, and Urdu).

2.1.6 STATISTICAL ANALYSES

Before starting the analyses the skewness of the data was determined (for the variables) which was calculated to be-.44 for English scores, -.4 for Urdu scores, and .19 for mathematics scores. All of these skewness values were normal, therefore no rectification was required. A Pearson's correlation analysis (Table 1) was performed before starting a hierarchical regression analysis (Table 2).

Table 1. Summary of Inter-Correlations for Scores on all Variables

Variables	1	2	3
English		.72**	.75**
Urdu			.68**
Mathematics			

*Correlation is significant at the 0.05 level (two-tailed).
**Correlation is significant at the 0.01 level (two-tailed).

Table 1 show that all the 3 variables are highly correlated with one another. In the hierarchical regression analysis, the variables were entered one by one, and the contribution of every variable was calculated by controlling the effect of the other variable. English language skill was a dependent variable whereas Urdu literacy skills and math skills were entered in two steps as independent variables. Urdu literacy skills were entered in the first step, whereas math scores were entered in the second step, after controlling for the effect of Urdu language score effect.

Table 2. Hierarchical Regression Analysis Exploring Predictors of English Proficiency in Boys

Step	Variables	R2/ΔR2	Beta
1	**Urdu**	.52***	.72***
2	**Mathematics**	.65***	.48***

*p<.05.**p<.01.***p<.001. Beta=standardized coefficients beta.

The regression analysis revealed significant beta values indicating that both L1 (Urdu), and mathematics skills were concurrent predictors of English skills. To further discover the connection among the variables, a principal component analysis was conducted using varimax rotation. Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) = 0.74, Barlett's test of sphericity $\chi 2$ (3) = 160.38, $p < .001$. All the variables were then let to load on factors without specifying the number of factors. The variables loaded on one factor with high values of factor loadings.

Table 3.Summary of Factor Loadings with Varimax Rotation of the English, Urdu, and Mathematics Scores

Item	Component
English	**.92**
Urdu	**.89**
Mathematics	**.90**

Extraction Method: Principal Component Analysis.

a. 1 components extracted. Note: Factor loadings >.40 are in boldface.

Loading of all variables on one factor with the values above **.4** shows high association among the variables.

3. COMPARISON

A comparison of Table 1of the current study with the results of Farukh et al. (2020) shows a higher value of correlation among the variables in boys. A similar comparison of Table 2 in both boys and girls represents high beta, and R square change values in boys. Similarly, a comparison of the factor analyses in both studies shows all higher values particularly the factor loadings (which show a very high association among the skills) in boys of the same age and background on the same tests.

4. DISCUSSION

According to the hypothesis of the study a strong relationship is observed among L1 skills, mathematics skills, and L2 skills in boys of grade 5. The results show that all of these skills can predict one another's concurrent performance i.e. if a child is good at language skills s/he would be good at mathematics too and vice versa. Similarly, if a child is good in L1 skills, his performance in L2 would also be good (Farukh, Irfan & Zafar, 2018).The loading of all three variables on the same factor also shows that all variables are strongly associated. Another interesting thing in the study is that this strong relationship in boys is even stronger than it was reported in girls. Which shows that in boys' performance in anyone of the skills can predict the performance in the other skill with more certainty than in girls. This strong predictive relationship between L2 skills, L1 skills, and mathematics supports the old studies claiming that reading (a language skill) and mathematics help in each other's development, and indicate this inter-relatedness from very early age (McClelland et al., 2007; Nelson, 2010).

The findings support the existing research showing a high degree of correlation in youth as well as during elementary school (Fuchs et al., 2006; Lee, Ng & Ng, 2009; Purpura & Ganley, 2014). Moreover, both mathematics, and reading skills in childhood can be predictors of each other as they are at middle and high school levels (Hooper et al, 2010). This study has a limitation that the children were not controlled for their IQ level. This limitation could be dealt with in further studies by administering a test for IQ prior to the selection of samples.

6. CONCLUSION

Language and mathematics skills are highly associated in boys than even in girls, and its pedagogical implication is that if a child achieves good scores in L1 and/or mathematics skills, s/he would achieve good scores in L2. If the same child is not performing well in L2 then there are more chances of a problem with the teaching methodology than the child's skills. This suggests a change in teaching methodology/syllabus rather than to blame the child's language skills.

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