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ABSTRACT

Mathematics and science achievements have been assessed in the Third International Mathematics and Science Study (TIMSS) and its repetition (TIMSS-R). The released TIMSS and TIMSS-R reports are largely divided into subject domains. To merge the research outcomes, this study focused on an examination of the relationship between mathematics and science achievement. Moderate correlation coefficients have been found from the TIMSS and TIMSS-R. Different measurement scales were analyzed to articulate the correlation coefficients with student average scores in each subject. These empirical findings may help mathematics and science educators assess the need of curriculum integration advocated by several professional organizations in the United States and other nations. (Contains 1 table, 9 figures, and 38 references.) (Author/SLD)

Running head: Math/Science Relation

A Comparative Study of Relationship

Between Mathematics and Science Achievement at the 8th Grade

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Abstract

Mathematics and science achievements have been assessed in the Third International Mathematics and Science Study (TIMSS) and its repetition (TIMSS-R). Meanwhile, the released TIMSS and TIMSS-R reports are largely divided into subject domains. To merge the research outcomes, this study is focused on an examination of the relationship between mathematics and science achievements. Moderate correlation coefficients have been found from the TIMSS and TIMSS-R data analyses. Different measurement scales are analyzed to articulate the correlation coefficients with student average scores in each subject. These empirical findings may help mathematics and science educators assess the need of curriculum integration advocated by several professional organizations in the U.S. and other nations.

A Comparative Study of Relationship

Between Mathematics and Science Achievement at the 8th Grade

The global market competition has been one of the driving forces toward enhancement of educational accountability in many countries. As a result, more coherent guidelines have been developed over the last decade to strengthen curriculum standards in mathematics and science education. In the United States, professional organizations produced documents to advocate curriculum articulation between mathematics and science education (e.g., National Council for Teachers of Mathematics, 1998; National Research Council, 1996). Meanwhile, educators in the United Kingdom adopted interdisciplinary approaches in development of its national curriculum (Nixon, 1991). The Curriculum Council of Western Australia (1998) also recommended teaching methods across subject boundaries (Venville, Wallace, Rennie, & Malone, 1998). Implementation of these new initiatives around the world ranges from thematic units to an entirely combined curriculum (Lonning, DeFranco, & Weinland, 1998). According to Haigh and Rehfeld (1995), "most of these attempts have been based upon the assumption that integration increases student achievement in both mathematics and science" (p. 241).

In the late 1990s, large-scale databases have been released from the Third International Mathematics and Science Study (TIMSS) in 1995 and a repeat of the TIMSS project (TIMSS-R) in 1999. Widely cited as an international benchmark, the TIMSS and TIMSS-R projects incorporated both mathematics and science tests to assess student academic performance (e.g., Martin & Mullis, 1996; Mullis, et al., 2000). In this study, correlation coefficients between the mathematics and science scores are analyzed to assess the inter-subject relationship at the 8th grade using the TIMSS and TIMSS-R databases.

Despite the persistent push for curriculum articulation in several nations, empirical evidence is yet to be established to support curriculum integration. In terms of the content structure, the relationship between mathematics and science could be asymmetric. "Unlike the mathematics teacher who can choose to avoid science, the science teacher is not able to cover most topics without calling on mathematical concepts and skills" (Frykholm & Meyer, 2002, p. 504). Furthermore, the reliance on mathematics varies across different science fields. Physics is a subject heavily dependent on mathematical preparation. However, the demand is not as strong in biology, and "other sciences such as psychology might not yet be ready for the kind of mathematization that has taken place in physics" (Orton & Roper, 2000, p. 124).

On the other hand, whereas it was assumed that "integration would produce greater learning outcomes of both mathematics and science, … few empirical attempts have attempts have been made to test this assumption" (McBride & Silverman, 1991, p. 286). To date, the released TIMSS and TIMSS-R reports have been largely divided along with subject boundaries (e.g., Beaton et al., 1996a, b; Martin et al., 1998, 2001; Mullis, et al., 1998, 2001), and no correlation analyses have been conducted on student scores between mathematics and science. In this regard, this investigation not only helps assess the link between mathematics and science performance, but also enriches the comparative research literature by adding more empirical findings across the subject boundaries.

Review of the Literature

Lederman and Niess (1998) observed, "the current reforms have resulted in renewed interest in curriculum integration, especially between mathematics and science" (p. 281). Despite the development of national standards in the United States and other countries (e.g., NCTM 1998; Nixon, 1991; NRC, 1996; Venville et al., 1998), no interdisciplinary research has been conducted at the national or international levels to analytically address two fundamental topics: (1) a system-wide assessment of correlation between mathematics and science achievements; and (2) an examination of the linkage between a higher correlation and a higher average score in mathematics or science (see review articles by Czerniak, Weber, Sandmann, & Ahern, 1999; Hurley, 2001; Pang & Good, 2000).

Data Selection

In the United States, the National Assessment of Educational Progress (NAEP) has been one of the primary measures to assess the condition of education for more than three decades. The NAEP methodology, such as spiral sampling, data imputation, and plausible score construction, has been adapted in the international assessments (Gonzalez & Smith, 1997; Pashley & Phillips, 1993). However, in the NAEP data, mathematics and science scores were gathered from different student samples across the nation (Allen, Carlson, & Zelenak, 1999). Thus, no students took the science and mathematics tests concurrently, and no interdisciplinary analysis can be conducted using the NAEP database.

In contrast, TIMSS and TIMSS-R projects included both mathematics and science tests at the 8th grade level. TIMSS researchers were quick at updating their measurement scales to maintain consistency on the student assessment. More specifically, the TIMSS-R scale was developed from a new three-parameter model to replace the original one-parameter model in TIMSS (Matin et al., 2001). Meanwhile, the TIMSS scores have been rescaled in TIMSS-R to enhance result comparability between these two projects (Martin, Gregory, & Stemler, 2000). In this study, the original and rescaled TIMSS scores are analyzed to compare impact of the scale adjustment on correlation coefficients between mathematics and science achievements. Furthermore, the TIMSS and TIMSS-R data are examined on the new scale to confirm consistency of the research findings between the two projects.

Statistical Computing

Depending on the data scaling, several options are available for describing linear correlations (SAS, 2001). Because student test scores are measured on an interval scale, Pearson correlation coefficient is an appropriate choice to assess the relation between mathematics and science achievements (Ott, 1993):

$$r = cov(x_1, x_2)/sqrt[var(x_1)*var(x_2)] \quad (1)$$

Formula (1) indicates dependency of a correlation coefficient on estimates of variances [i.e., $var(x_1)$, $var(x_2)$] and covariance [i.e., $cov(x_1, x_2)$]. For stratified cluster samples gathered in TIMSS/TIMSS-R, an assumption of simple random sampling may lead to underestimation of variability in statistical inference (Martin, Gregory, & Stemler, 2000; Martin & Kelly, 1997). Kish (1965) introduced a concept of design effect (deff) to describe the variance estimation:

deff=(variance from complex sampling)/(variance from simple random sampling)

To avoid the underestimation of statistical variability, special software packages other than SPSS are needed to account for the complex sampling structure (Cabrera, La Nasa, & Burkum, 2002). One of the widely used software packages for survey data analyses is an AM program developed by the American Institute of Research (AIR). AIR (2003) noted,

> AM is a statistical software package for analyzing data from complex samples, especially large-scale assessments such as the National Assessment of Educational Progress (NAEP) and the Third International Mathematics and Science Studies (TIMSS). (http://am.air.org, p. 1)

In the released database, TIMSS researchers computed a total of five plausible scores in each subject area to represent student achievement, and "one set of the imputed plausible scores can be considered as good as another" (Gonzalez & Smith, 1997, ch. 6, p. 3). The interchangeability of plausible scores suggests equivalency of the design effect among the plausible scores. Under an assumption of invariant deff values between mathematics and science scores, the AM software is employed to compute correlation coefficients from the TIMSS and TIMSS-R date sets.

Research Questions

By viewing the world as a giant education laboratory, the diversified education settings may have resulted in different correlation coefficients of student scores between mathematics and science. Research questions that guide this investigation are:

1. Do student mathematics and science achievements from TIMSS/TIMSS-R participating countries fit a linear relationship assumed by the Pearson correlation analyses?
2. Is the higher correlation linked to a higher average science performance in the international comparison?
3. What is the link between the score correlation and mathematics performance?
4. What are the consistent findings from the result triangulation across TIMSS and TIMSS-R projects?

Methods

The TIMSS data and program files were downloaded from a public website (http://www.timss.org). The average mathematics and science scores have been replicated to show an exact match with the existing results from TIMSS/TIMSS-R reports (Beaton et al., 1996a, b; Martin, et al., 2000; Mullis, et al., 2000). On basis of the scores at the country level, plots are created to examine the pattern of linearity on the score relationship (Question 1). Fisher's (1921) z transformation is conducted in each nation to compute an average correlation coefficient among plausible scores in mathematics and science. According to Corey, Dunlap, and Burke (1998), "When correlations come from a matrix, there is a consistent advantage associated with using [Fisher's] z'. Across sample size and numbers of correlations averaged, bias in average r(z)' is smaller than bias in average r" (p. 260).

To facilitate empirical comparisons of different education systems, correlation analyses are conducted at the country level to examine if higher correlation coefficients are linked to higher average scores in mathematics or science (Questions 2 & 3). Patterns of the data distribution are plotted at the country level to examine consistency of research findings between TIMSS and TIMSS-R databases on the old and new scales (Question 4). Results of the correlation analysis can be articulated with TIMSS/TIMSS-R scores to examine the link between the score correlation and student achievement in mathematics or science.

Results

Mathematics and science scores in all participating countries have been plotted on three scales: (1) TIMSS results on the TIMSS original scale; (2) TIMSS results on the new TIMSS-R three-parameter scale; and (3) TIMSS-R results on the new scale (see Figures 1-3). The average correlation coefficients from the Fisher's z transformation are listed in Table 1 for each nation. Because student scores represent an achieved curriculum in an education system (Linn, 2000; Zabulionis, 2001), the correlation coefficient indicates relationship of the achieved curricula between mathematics and science. The correlation coefficient has been plotted against academic performance in mathematics (Figures 4-6) and science (Figures 7-9). Correlation coefficients have been computed to describe relationships between the curriculum link (r) and student scores on both new and old scales (Table 2).

Discussions

Figures 1-3 indicate a linear pattern of the relationship between mathematics and science achievements among the TIMSS/TIMSS-R participating nations. Therefore, Pearson r is an appropriate method for describing relationship of the achieved curricula between mathematics and science. The correlation coefficients show a fair amount of variability, ranging from Kuwait's 0.39 on the TIMSS original scale (country id: 414) to 0.89 for South Africa's average scores rescaled in TIMSS-R (country id: 717) (Table 1). For countries with a performance score below 450 on the TIMSS scale, the range of correlation coefficients is larger than the results of top performing countries (Figures 4-9). In other words, the score correlations that are too strong or too weak are typically linked to poor performance in mathematics or science. This consistent pattern between TIMSS and TIMSS-R seems to support a moderate level of integration between mathematics and science (e.g., $0.44<r<0.63$ on the TIMSS original scale – see Figures 4 & 7). As a result, perhaps a more balanced position should be taken by school professionals to avoid an over emphasis or de-emphasis of integration between mathematics and science education.

In addition, without considering the rescaling of the TIMSS data, the correlation of student achievements appears to be positively associated with average national performance in mathematics and science (Table 2). However, Figures 4, 5, 7 and 8 show an unclear upward or downward pattern from the TIMSS data, which confirms the insignificant correlation on the original and new scales (Table 2). For the negative correlation from the rescaled TIMSS data (Table 2), Figures 5 and 8 indicate that South Africa's result could be an outlier with low performance scores and a high correlation coefficient between mathematics and science achievements ($r=0.89$). Had this observation been taken out, the correlation coefficients on the new scale would be 0.19 and 0.14, instead of –0.15 and -0.25, respectively (Table 2). Therefore, the negative correlation might reflect statistical artifact, and the TIMSS scale transformation did not clearly resulted in a significant correlation from the 1995 database.

On the other hand, the TIMSS-R results from 1999 show a significant correlation between Pearson r value and student achievement in mathematics and science (Table 2). It should be noted that only "Twenty-six countries took part in the TIMSS eighth-grade assessments in both 1995 and 1999" (Mullis, et al., 2000, p. 34). More than a dozen countries only participated in one of the international studies. Given the difference in participating nations, the correlation results could have been affected by the involvement of different countries between TIMSS and TIMSS-R.

Inspection of Table 1 further reveals a gap in the correlation results between the original one-parameter scale and the new three-parameter scale (i.e., r_95 < r_new95). On the same new scale, the TIMSS and TIMSS-R results show a stronger agreement between the correlation coefficients (r_new & r_99).

In part, this is because the three-parameter scale has taken the guessing effect into consideration (Hambleton, & Swaminathan, 1985). Hambleton (1988) noted, "with difficult multiple-choice tests, a researcher might anticipate considerable guessing on the part of examinees. Needed, therefore, would be a model that could handle this situation" (p. 154).

Because more than 90% TIMSS items are in a multiple-choice format (Lange, 1997), the result seems to support the effort of TIMSS researchers to rescale the TIMSS results, and thus, properly consider the potential impact from guessing (Martin et al., 2000; Mullis et al., 2000). For instance, the TIMSS instrument has the following mathematics item in a multiple-choice format:

O2. If the price of a can of beans is raised from 60 cents to 75 cents, what is the percent increase in the price?

A. 15%

B. 20%

C. 25%

D. 30%

Figuring out the *rate increase* is a basic mathematical skill required in many scientific experiments. With the four options in this question, the probability of obtaining a correct answer through random guessing is 25%. In the TIMSS data, only 28% 8th graders from all participating nations answered this question correctly! This result not only illustrates a need for correcting the guessing effect, but also urges educators to make a concerted effort to improve student performance in this joint area between mathematics and science. In summary, this empirical data analysis seems to suggest that the call for subject articulation is still a valid accountability issue following the long-lasting quest for educational improvement.

References

Allen, N. L., Carlson, J. E., & Zelenak, C. A. (1999). The NAEP 1996 technical report. Washington, DC: National Center for Education Statistics.

American Institute of Research [AIR] (2003). AM statistical software. [Online] Available at http://am.air.org [March 26, 2003].

Beaton, A., Martin, M., Mullis, I., Gonzalez, E., Smith, T., & Kelly, D. (1996a). Science achievement in the middle school years. Chestnut Hill, MA: Boston College.

Beaton, A., Mullis, I., Martin, M., Gonzalez, E., Kelly, D., & Smith, T. (1996b). Mathematics achievement in the middle school years. Chestnut Hill, MA: Boston College.

Cabrera, A. F., La Nasa, S. M., & Burkum, K. R. (2002). Pathways to college: What affects lowest-SES students' decisions to transfer to a four-year institution? [Online] Available at http://www.eriche.org/ASHEpapers02/Cabrera%20-%20Pathways%20to%20College.pdf.

Corey, D. M., Dunlap, W. P., & Burke, M. J. (1998). Observed and expected bias in average correlation with and without using Fisher's z transformation. Journal of General Psychology, 125, 245-261.

Curriculum Council of Western Australia (1998). Curriculum framework consultation draft. Perth, Western Australia: Author.

Czerniak, C., Weber, W., Sandmann, A., & Ahern, J. (1999). A literature review of science and mathematics integration. School Science and Mathematics, 99 (8), 421-430.

Fisher, R. A. (1921). On the 'probable error' of a coefficient of correlation deduced from a small sample. Metron, 1, 1-32.

Frykholm, J. A., & Meyer, M. R. (2002, May). Integrated instruction: Is it science? Is it mathematics? Mathematics Teaching in the Middle School, 502-508.

Gonzalez, E. J., & Smith, T. A. (1997). Users guide for the TIMSS international database. Chestnut Hill, MA: TIMSS International Study Center.

Haigh, W. & Rehfeld, D. (1995). Integration of secondary mathematics and science methods courses: A model. School Science and Mathematics, 95 (5), 240-244

Hambleton, R. K. (1988). Principles and selected applications of item response theory. In R. L. Linn (Ed), Educational measurement (3rd ed.). London: Collier Macmillan.

Hambleton, R. K., & Swaminathan, H. (1985). Item response theory: Principles and applications. Boston, MA: Kluwer.

Hurley, M. (2001). Reviewing integrated science and mathematics: The search for evidence and definitions from new perspectives. School Science and Mathematics, 101 (5), 259-268.

Kish, L. (1965). Survey sampling. New York: John Wiley & Sons.

Lederman, N. G. & Niess, M. L. (1998). 5 apples + 4 oranges = ? School Science and Mathematics, 98 (6), 281-284.

Linn, R. (2000). The measurement of student achievement in international studies. Paper prepared for the Board for International Comparative Studies in Education (available at http://www4.nas.edu/DBASSE/BICSE.nsf/ files/Linn.pdf/)

Lonning, R., DeFranco, T., & Weinland, T. (1998). Development of theme-based, interdisciplinary, integrated curriculum: A theoretical model. School Science and Mathematics, 98 (6), 312-318.

Martin, M. O., Gregory, K. D., & Stemler, S. E. (2000). TIMSS 1999: Technical report. Chestnut Hill, MA: TIMSS International Study Center.

Martin, M. O., & Kelly, D. L. (1997). Technical report volume II: Implementation and analysis. Chestnut Hill, MA: TIMSS International Study Center.

Martin, M. O., Mullis, I. V. S., Beaton, A. E., Gonzalez, E. J., Smith, T. A., & Kelly, D. L. (1998). Science achievement in Missouri and Oregon in an international context: 1997 TIMSS benchmarking. Chestnut Hill, MA: TIMSS International Study Center.

Martin, M. O., Mullis, I., Gonzalez, E., O'Connor, Chrostowski, S., Gregory, K., Smith, T., & Garden, R. (2000) TIMSS 1999: International science report. . Chestnut Hill, MA: Boston College.

Martin, M. O., Mullis, I., Gonzalez, E., O'Connor, Chrostowski, S., Gregory, K., Smith, T., & Garden, R. (2001). Science benchmarking report TIMSS 1999 – Eighth grade. Chestnut Hill, MA: Boston College.

McBride, J. W., & Silverman, F. L. (1991). Integrating elementary/middle school science and mathematics. School Science and Mathematics, 91 (7), 285-292.

Mullis, I. V. S., Martin, M. O., Beaton, A. E., Gonzalez, E. J., Kelly, D. L., & Smith, T. A. (1998). Mathematics achievement in Missouri and Oregon in an international context: 1997 TIMSS benchmarking. Chestnut Hill, MA: TIMSS International Study Center.

Mullis, I. V. S., Martin, M. O., Gonzalez, E. J., Gregory, K. D., Garden, R. A., O'Connor, K. M., Chrostowski, S. J., Smith, T. A. (2000). TIMSS 1999: International mathematics report. Chestnut Hill, MA: TIMSS International Study Center.

Mullis, I., Martin, M. O., Gonzalez, E., O'Connor, Chrostowski, S., Gregory, K., Garden, R., & Smith, T. (2001). Mathematics benchmarking report TIMSS 1999 Eighth grade. Chestnut Hill, MA: Boston College.

National Council of Teachers of Mathematics (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: The Author.

National Council of Teachers of Mathematics (1998). Principles and standards of school mathematics (draft). Reston, VA: The Author.

Nixon, J. (1991). Reclaiming coherence: Cross-curriculum provision and the national curriculum. Journal of Curriculum Studies, 23 (2), 187-192.

Orton, T., & Roper, T. (2000). Science and mathematics: A relationship in need of counseling? Studies in Science Education, 35, 123-154.

Ott, R. (1993). An introduction to statistical methods and data analysis (4th ed.). Belmont, CA: Duxbury.

Pang, J. & Good, R. (2000). A review of the integration of science and mathematics: implications for further research. School Science and Mathematics, 100 (2), 73-82.

Pashley, P. & Phillips, G. (1993). Toward world-class standards: A research study linking international and national assessments. Arlington, VA: National Science Foundation.

SAS (2001). SAS/STAT user's guide. Gary, NC: Author.

Venville, G., Wallace, J., Rennie, L., & Malone, J. (1998). The integration of science, mathematics, and technology in a discipline-based culture. School Science and Mathematics, 98 (6), 294-302.

Zabulionis, A. (2001, September 14). Mathematics and science achievement of various nations. Education Policy Analysis Archives, 9 (33). Retrieved [date] from http://epaa.asu.edu/epaa/v9n33/ [July 26, 2002].

Table 1

Correlation coefficients between mathematics and science scores

country_id	r_95	r_new95	r_99
36	0.61066	0.72561	0.73445
40	0.60400	0.74650	.
56	0.53763	0.72533	.
57	0.56130	0.72329	.
100	.	.	0.70826
124	0.50309	0.60844	0.65022
152	.	.	0.67055
158	.	.	0.79888
170	0.46660	0.70264	.
196	0.60592	0.72942	0.71988
200	0.55550	0.71477	.
201	0.59682	0.72885	.
203	.	.	0.68582
208	0.54204	0.67358	.
246	.	.	0.63206
250	0.44642	0.59251	.
280	0.60900	0.76270	.
300	0.57560	0.71952	.
344	0.55414	0.72474	0.69972
348	0.58429	0.70712	0.71063
352	0.52166	0.69369	.
360	.	.	0.69388
364	0.43267	0.62444	0.66955
372	0.59635	0.73103	.
376	0.60736	0.71732	0.77825
380	.	.	0.76616
392	0.55408	0.68190	0.72506
400	.	.	0.75202
410	0.57265	0.72091	0.73592
414	0.38991	0.55434	.
428	0.50811	0.64808	0.67064
440	0.54685	0.65489	0.73885
458	.	.	0.72142
498	.	.	0.68617
504	.	.	0.43424

Table 1 (continued)

Correlation coefficients between mathematics and science scores

country_id	r_95	r_new95	r_99
528	0.56049	0.75407	0.69678
554	0.58807	0.72179	0.76637
578	0.54790	0.66924	.
608	0.62747	0.79023	0.66908
620	0.45528	0.64280	.
642	0.60999	0.71681	0.70437
643	0.56386	0.67507	0.71900
702	0.49319	0.68224	0.78195
703	.	.	0.73010
705	.	.	0.70417
710	.	.	0.67490
717	0.54361	0.89345	.
724	0.48891	0.64371	.
752	0.54953	0.69207	.
756	0.55418	0.73575	.
764	0.51430	0.61442	0.71423
788	.	.	0.54241
792	.	.	0.65385
807	.	.	0.71579
826	0.60866	0.72191	.
827	0.58280	0.71281	.
840	0.61213	0.74919	0.77763
890	0.55386	0.70312	.
926	.	.	0.76603
956	.	.	0.67450

Notes: (1) The country ID follows specification of the TIMSS codebook.
(2) For those countries did not participate both TIMSS and TIMSS-R, the sign "." is the default for missing observations
(3) r_95 : Correlation coefficients from the original TIMSS scale;
r_new: TIMSS correlation coefficients on the new TIMSS-R scale;
r_99 : Correlation coefficients from the TIMSS-R database.

Table 2

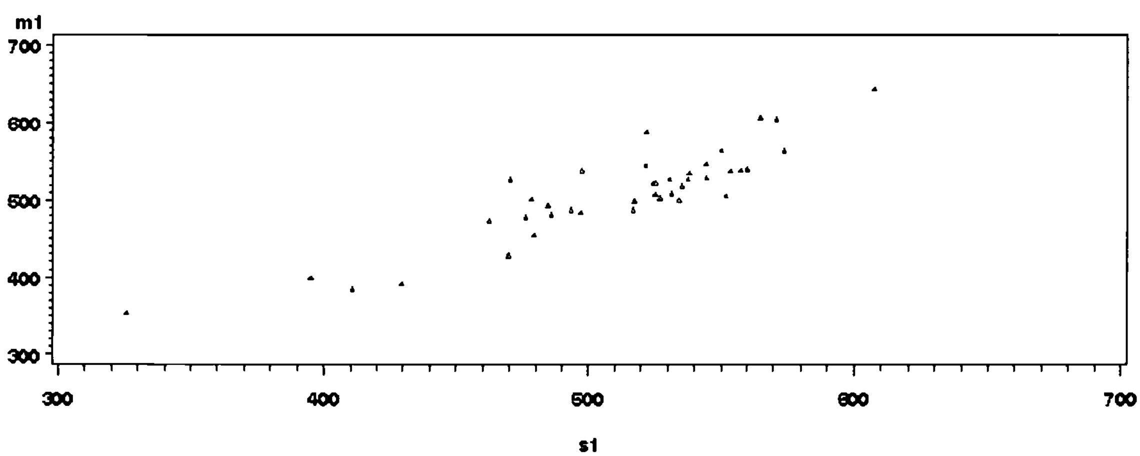
Correlation between student performance and the indicator of math-science link

	r_95	r_new95	r_99
Mathematics achievement	0.24960	-0.15469	0.46436 ***
Science achievement	0.25681	-0.25216	0.51684 ***

Notes: (1) The math-science link in the achieved curriculum is described by the correlation between mathematics and science achievements.
(2) *** indicate that the correlation is significant at 0.05 level.
(3) r_95 : Correlation coefficients from the original TIMSS scale;
r_new: TIMSS correlation coefficients on the new TIMSS-R scale;
r_99 : Correlation coefficients from the TIMSS-R database.

Figure 1: Plot of science and mathmatics scores

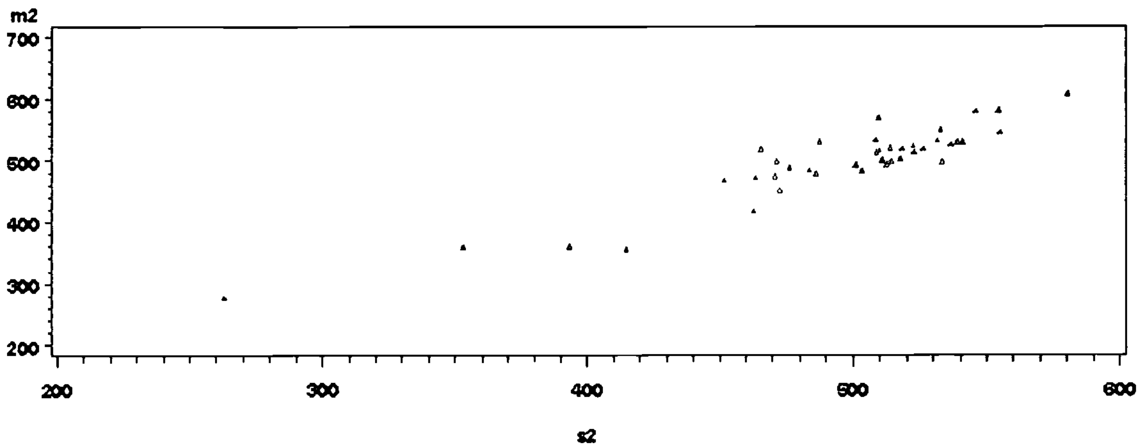
TIMSS Results on the Original Scale



m1: average mathematics score; s1: average science score.

Figure 2: Plot of science and mathmatics scores

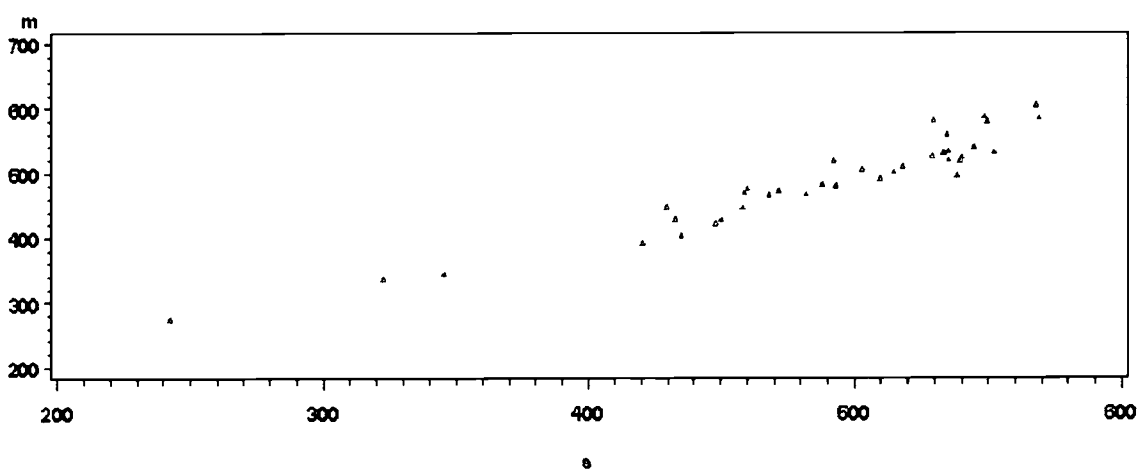
TIMSS Results on the TIMSS—R Scale



m2: average mathematics score; s2: average science score.

Figure 3: Plot of mathmatics and science scores

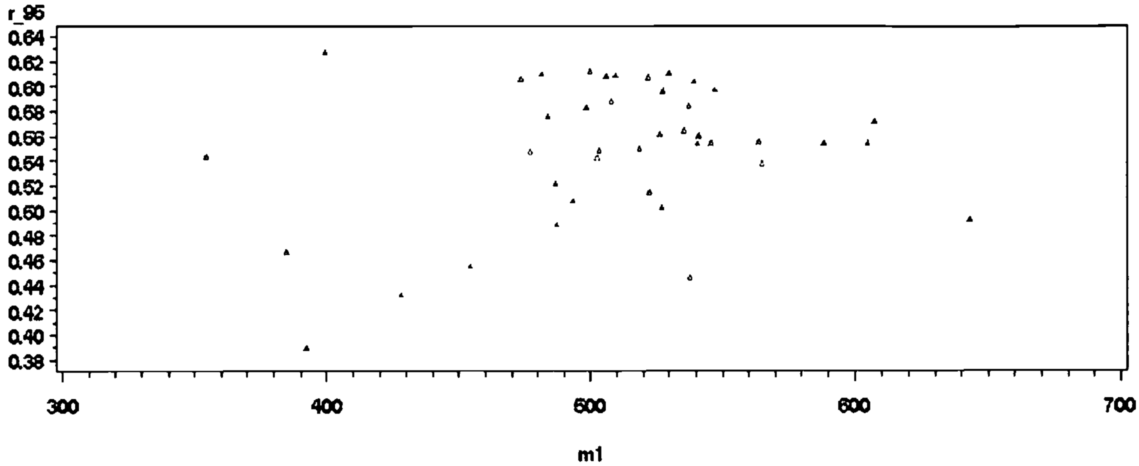
TIMSS—R Results



m: average mathematics score; s: average science score.

Figure 4: Plot of correlation coefficients and math scores

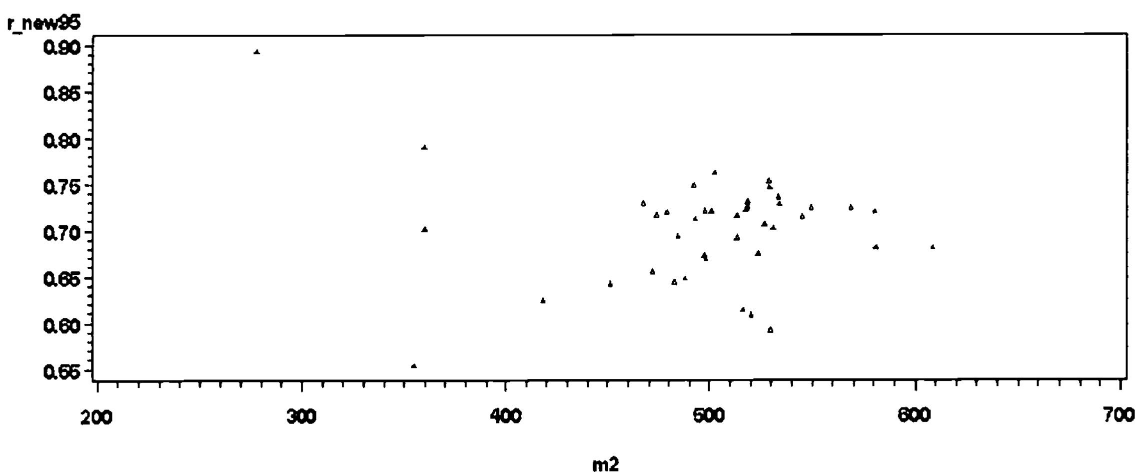
TIMSS Results on the Original Scale



r_95: correlation coefficient; m1: average mathematics score.

Figure 5: Plot of correlation coefficients and math scores

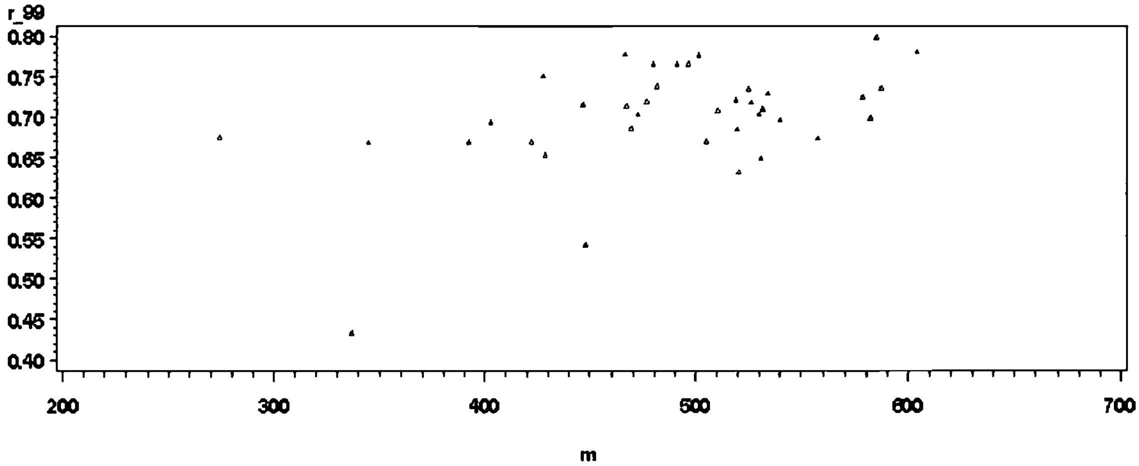
TIMSS Results on the TIMSS-R Scale



r_new95: correlation coefficient; m2: average mathematics score.

Figure 6: Plot of correlation coefficients and math scores

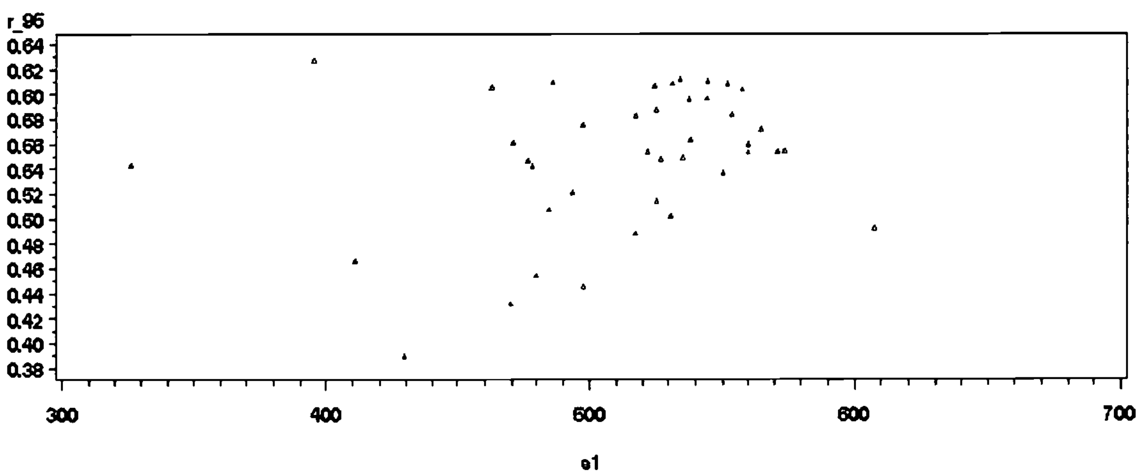
TIMSS—R Results



r_99: correlation coefficient; m: average mathematics score.

Figure 7: Plot of correlation coefficients and science scores

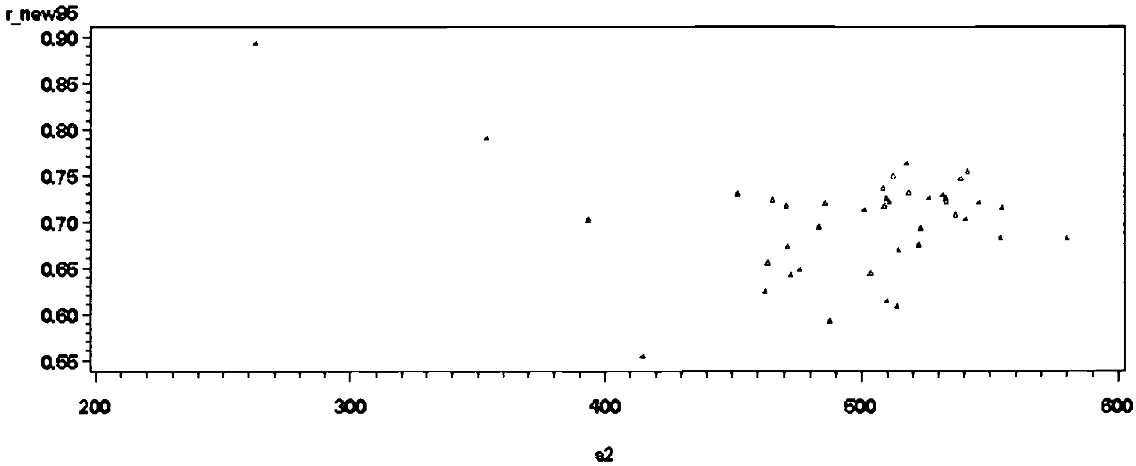
TIMSS Results on the Original Scale



r_95: correlation coefficient; s1: average science score.

Figure 8: Plot of correlation coefficients and science scores

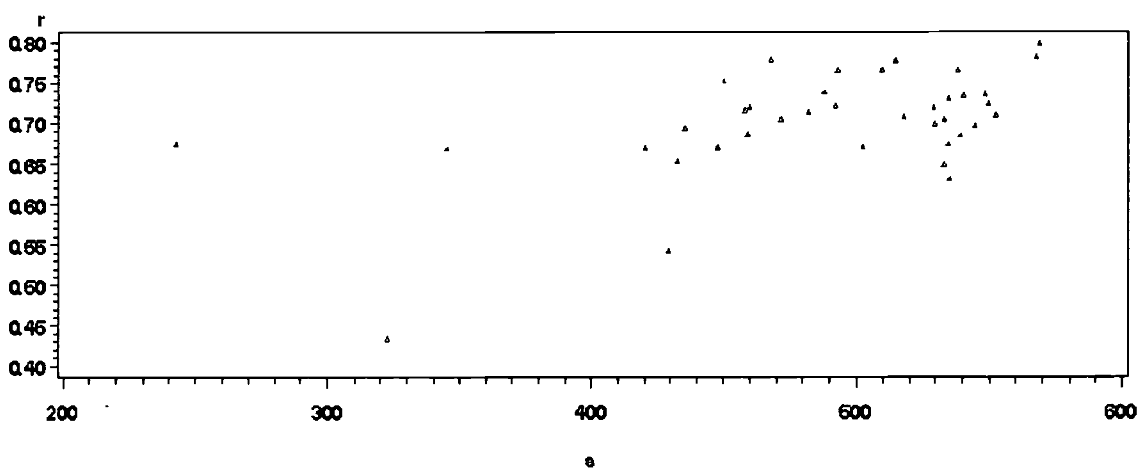
TIMSS Results on the TIMSS–R Scale



r_new95: correlation coefficient; s2: average science score.

Figure 9: Plot of correlation coefficients and science scores

TIMSS–R Results



r_99: correlation coefficient; s: average science score.

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