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AUTHOR	Hadfield, Oakley D.; And Others
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ABSTRACT

Of the many factors that have been proposed as a rationale for poor mathematics conceptualization by American Indians, cultural factors remain the most popular when explanations are submitted. Additionally, the accepted fault for poor achievement is focused upon mathematics anxiety. A study of American Indian school mathematics achievement and mathematics anxiety was conducted at a middle school on the Navajo Indian Reservation in northern New Mexico/Arizona with a total sample of 353 students. The relationships of both achievement and anxiety to certain cognitive style predictor variables was also investigated through the use of the Comprehensive Test of Basic Skills Mathematics Subtest (CTBS, 1982), the Mathematics Anxiety Rating Scale for Adolescents (MARS-A), and the Learning Style Profile as designed by the National Association of Secondary School Principals Learning Style Task Force (NASSP-LSP). Results indicated that mathematics achievement was near the national norm in computational skills, but significantly lower in application skills. Also, mathematics anxiety was found to be excessively high for the entire sample population. Discussion focused upon the possibility that language deficiencies were the underlying cause for the discrepancies between computational and application skills. (29 references) (JJK)

MATHEMATICS ANXIETY IN THE NAVAJO RESERVATION SCHOOL

Oakley D. Hadfield

Jeanette V. Martin

Sharon L. Wooden

Department of Curriculum and Instruction

New Mexico State University

P.O. Box 30001, Dept. CUR

Las Cruces, New Mexico 88003-0001

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ABSTRACT

A study of mathematics achievement and mathematics anxiety was conducted in a middle school on the Navajo Indian Reservation. The relationships of both of these variables to certain cognitive style predictor variables was also investigated. Mathematics achievement was found to be near the national norm in computational skills, but significantly lower in applicational skills. Mathematics anxiety was found to be excessively high for the entire population. Multiple regression procedures found that cognitive style factors accounted for very little of the variance in any of the mathematics criterion variables except mathematics applicational skills. The possibility of language deficiencies as an underlying cause for descrepancies between computational and applicational skills is discussed.

MATHEMATICS ANXIETY IN THE NAVAJO RESERVATION SCHOOL

The current dropout rate for public school students in the U.S. is at an unacceptable level, particularly for minority groups (Barro & Kolstad, 1987). Of the many minority groups, American Indians have one of the most extensive dropout problems, with their rate of exit without graduation double that of the Hispanics, and four times that of the Anglos (Bradley, 1984; National Research Council [NRC], 1989, p. 20). In addition to the dropout problem itself, American Indian achievement is not up to par in many academic areas. Low mathematics achievement is one of the major areas of concern, because deficient preparation for jobs of the future is the ultimate result. This only perpetuates the economic and employment problems that already exist among the various Indian groups (Pottinger, 1985). Jobs of the future will require more mathematics, not less, and those who do not have sufficient mathematical training will be severely limited in career options (James & Kurtz, 1985; NRC, 1989, p. 21, Sells, 1973). American Indians are already the most underrepresented of all minorities in the technological areas (Lawrenz & McCreath, 1988), and such educational deficiencies only compound the problem.

On a recent Nevada minimum competency test for high school juniors, only 58% of the Native American students passed, compared to 84% of the Anglos (Trent & Gilman, 1985). A view of the national picture reveals that American Indians are 1.7 years behind the national norm in sixth grade mathematics achievement, and by their senior year in high school are a full three years behind. By the sixth grade, 46% require special help in mathematics (Fletcher, 1983). There needs to be an increasing effort to improve not only mathematics achievement on the American Indian

Reservation, but to boost the number of students participating in mathematics courses. Perhaps success with mathematics could build self confidence in the school setting, and then help in the reduction of dropout rates. Research indicates that self confidence and self image are strongly tied to school success (Purkey, 1978).

Of the many factors that have been asserted as reasons for poor mathematics achievement by American Indians, cultural factors tend to be among the most popular explanation. Indians are said to have a more wholistic, global view, which does not lend itself as well to analytical tasks. They like to start with a more complete picture, and fill in the details later, which is the opposite of the mathematical approach. Research indicates that they have a greater dependence upon right hemispheric functioning than Anglos (Wallis, 1983). They are also less competitive than those in the Anglo culture (Hynd, 1979), which is a disadvantage when mathematics is taught through independent practice and competition for correct answers and high test scores. The Indian's lack of time specificity also results in problems with completion of problems and tests within specified time allotments, and performing well simply for future benefits, grades, college majors, and job opportunities (Cundick, 1970; Fletcher, 1983).

Another popular blame for poor mathematics achievement is mathematics anxiety. Mathematics anxiety is defined as discomfort to the point of affecting performance when dealing with any type of mathematical task. This could range from everyday calculations of measurements or percentages, to classroom testing situations. It is not necessarily related to intelligence, often affecting persons who are highly successful in other areas (Morris, 1981). Perhaps mathematics anxiety could be either more prevalent among Native Americans, or could affect mathematics achievement differently than among Anglo populations, where it has been shown repeatedly to be related to poor math achievement (Dew, Galassi, & Galassi, 1983; Frary & Ling, 1983).

Researchers must be very careful not to generalize the results of specific Native American tribes or reservation settings to the entire population of American Indians. There are certainly some characteristics in common among many of the tribes, but with over 400 tribes with their own unique cultures, there are more diversities than similarities (Keshena, 1980). The present study attempted to answer several research questions with regard to a specific grade level and school setting, within the Navajo Reservation, located in northern Arizona and New Mexico. Being the largest Indian Reservation in the U.S., it must be pointed out that there is also great diversity of settings and micro-cultures within the Navajo reservation itself.

There were three main purposes of this study. The first was to explore mathematics achievement in a single middle school on the Navajo Reservation, with regard to its computational and applicational aspects, and to then make comparisons to the national norms as a whole, by gender, and by grade level. The second purpose was to explore the mathematics anxiety level of the same population, and its possible relationship to mathematics achievement. The third goal was to explore possible relationships between several cognitive style scores of the Navajo students and their mathematics anxiety and achievement.

It was hypothesized that achievement would be significantly lower than the national norm in both the computational and applicational aspects of mathematics. Mathematics anxiety was not suspected to be significantly different than for Anglo groups, but was expected to be negatively related to mathematics achievement. Results were in contrast to expectations in some of these areas. In addition, cognitive style as a predictor variable of mathematics achievement and anxiety did not account for as much of the variance as expected, but results were statistically significant.

METHOD

Subjects and Procedures

The entire enrollment of a middle school located on the Navajo Indian Reservation was tested for mathematics achievement, mathematics anxiety, and cognitive style. The school was located within the boundaries of an Indian community in northern New Mexico. Ethnic representation in the school was 98% Navajo. Subjects who were not of Navajo lineage were excluded from the study, along with those who did not have scores available on all three instruments. This resulted in a total sample of 353.

Instruments

The Comprehensive Test of Basic Skills (CTBS) Mathematics Subtest is made up of concepts, computation, and application questions (CTBS, 1982). It is a widely accepted norm-referenced, objectives-based test in basic skills with well documented reliability and validity (CTBS Technical Report, 1984). The standardized scores for the computational and applications sections were both used, in order to provide the most delineated view of the achievement levels as possible.

The Mathematics Anxiety Rating Scale for Adolescents (MARS-A) is a 98 item Likert scale questionnaire designed specifically for adolescents to estimate their susceptibility to debilitating degrees of anxiety in numerical situations, including classroom, testing, and everyday functions such as balancing one's checkbook (Suinn, 1982). Total scores range form 98 to 490, with the higher scores representing the most mathematics anxiety. National norms for the middle school student range form 195 to 210. Content validity has been confirmed through factor analysis (Suinn & Edwards, 1982).

The National Association of Secondary School Principals Learning Style Task Force developed, tested, and refined the Learning Style Profile (NASSP-LSP) (Keefe & Monk, 1986) in a series of very thorough phases carried out over a four year period (Keefe, 1987). The instrument is designed as a first level diagnostic tool for classroom teachers to use in personalization of instruction to better match the learning styles strengths and weaknesses of their students through the use of individual student profile sheets. The instrument consists of 126 test items that make up 23 independent scales. These scales represent the four higher order factors of cognitive skills, perceptual responses, study preferences, and instructional preferences. The focus of this study included scales only from the cognitive skills area: analytical, spatial, discriminatory, categorization, sequential, and memory skills.

Available norms on the NASSP were drawn from a large number of studies. Internal consistency (alpha) and test-retest reliability (10-day) data range from .37 to .82 with an average of about .61 (Thomson, 1986). Concurrent validity studies yielded positive correlations of the appropriate subscales of the LSP with the Witkin Group Embedded Figures Test (Witkin, Oltman, Raskin, & Karp, 1971), the Edmund Learning Style Identification Exercise (Reinert, 1980), and the Dunn, Dunn, and Price Learning Styles Inventory (Dunn, Dunn, & Price, 1974).

Data Analysis

Scores for mathematics computational achievement, mathematics applicational achievement, and mathematics anxiety were all tabulated for means and standard deviations by gender and by grade level. Results were then compared to national norms. Also, a series of one-way analyses of variance was performed by grade level with mathematics computation, mathematics applications, and mathematics anxiety as the dependent variables. Similar analyses by gender were planned, but became unnecessary. To seek relationships between the three dependent variables, Pearson product-moment correlation coefficients were then determined.

To determine which cognitive style subscale scores would be most valuable in predicting mathematics computational achievement, mathematics applicational achievement, or mathematics anxiety, three forward multiple regression procedures were performed, using the six cognitive style factors as predictor variables . All three regressions were performed on the total sample, as well as by gender and grade level. An alpha level of $p < .05$ was selected for all statistical procedures.

RESULTS

Table 1 reveals the results for the three dependent variables of mathematics computational achievement, mathematics applicational achievement, and mathematics anxiety. Mean mathematics computational score for the entire sample was above the national norm (M = 54.00, SD = 25.17), while the corresponding mean for mathematics applications was below the national norm (M = 41.86, SD = 22.18). This averages to a total national percentile score of 47.93, which is not seriously below the mean for the entire country. The higher scores in mathematics computation shows that mathematics as such is no serious problem for this particular Native American group. It is the lower scores in mathematics applications that is the cause for more alarm. This points to a conclusion that either the students are not being well prepared in the applications areas, or that a language deficit prevents them from being able to effectively interpret word problems. There were no apparent differences between male and female groups for either of the two mathematics achievement factors, so analyses of variance were not performed.

Table 1
Means for Dependent Variables of Mathematics Computation, Mathematics Application, and Mathematics Anxiety Scores

Dependent Variable	Total Sample (*N*=353)	Males (*n*=148)	Females (*n*=205)	6th (*n*=114)	7th (*n*=109)	8th (*n*=130)
Computation						
m	54.00	52.21	55.30	58.32	58.94	46.08
s	25.17	25.34	25.03	24.60	21.66	26.56
Application						
m	41.86	42.89	41.11	40.31	44.74	40.79
s	22.18	21.13	22.93	20.80	20.76	24.34
Anxiety						
m	245.09	245.67	244.67	245.09	255.96	235.98
s	62.75	60.53	64.44	54.35	70.70	61.55

In exploring possible differences by grade level in mathematics achievement, a one-way analysis of variance revealed no significant differences in the three grade level mathematics applications means ($F = 1.35$, $df = 2/350$, $p = .2957$), but did find the eighth grade mathematics computational mean to be significantly lower than the sixth and seventh grade means ($F = 10.77$, $df = 2/350$, $p = .0001$). This causes concern that eighth grade mathematics instruction may bring about a retrogression rather than an advance in student skills. This could be either due to poor instruction, or a sudden loss of interest on the students' part. Perhaps their arrival at the age for peer acceptance as a priority is somewhat related. The instructional team at the school plans to look carefully at this result.

A significant finding in the area of mathematic anxiety was that the mean MARS-A value of the total sample (M = 246.22, SD = 62.31) was considerably higher than the 195-210 predicted by national norms (Suinn & Edwards, 1982). The one-way analysis of variance showed no significant differences by grade level ($F = 3.04$, $df = 2/350$, $p = .0490$), and means by gender were so similar that a comparison test was unnecessary. It was more a picture of excessively high anxiety scores across the board. A recent study for a comparable group within 100 miles of this study, in a town of similar size, but with predominantly Anglo students, yielded a much lower mean MARS-A score (M=201.08, SD=57.41, N=481) for high school students (Hadfield & Maddux, 1988). This indicates an apparently disturbing gap between ethnic groups. There is, therefore, a crucial need for change in the reservation classroom in order to lessen anxiety toward mathematics and to increase student confidence, particularly in mathematics applications. This could in turn increase participation in mathematics courses.

The relationship of this high level of mathematics anxiety to the two mathematics achievement variables was not as strong as suspected. The correlation coefficient of $r = -.151$ ($p = .0045$) indicated that mathematics anxiety was not overwhelmingly strong as a predictor of poor mathematics computational skills. The same appears true of mathematics applicational skills, with a correlation coefficient of $r = .205$ ($p = .0001$). The most likely conclusion here is, once again, that poor language skills, or some other less evident factor, is more prohibitive of mathematics achievement than is mathematics anxiety. Especially in light of the results above that revealed mathematics applicational skills as considerably lower than mathematics computational skills.

Table 2 reveals the results of the multiple regression procedures, with 23.21% of the variance in mathematics applicational scores accounted for by the cognitive predictor variables. Spatial visualization was by far the best predictor, which is in agreement with a vast amount of previous research that relates such skills to overall mathematics achievement. By contrast, the cognitive predictor variables accounted for very little of the variance in either mathematics computational scores (r^2 = .0796) or mathematics anxiety (r^2 = .0580). For mathematics computational scores, spatial visualization and memory skills were the only significant predictors. For mathematics anxiety scores, sequential, spatial visualization, and discriminatory abilities were the only significant predictors.

Table 2
Partial Variances (R^2) of LSP Cognitive Subscale Factors as Predictors of Mathematics Applicational Achievement

Independent Variables	Total Sample (*N*=353)	Males (*n*=148)	Females (*n*=205)	6th (*n*=114)	7th (*n*=109)	8th (*n*=130)
Analytical	.0237**	.0055	.0304**	.0327*	.0028	.0268*
Spatial	.1753***	.1254***	.2145***	.1726***	.1248***	.2138***
Discriminatory	.0000	.0015	.0051	.0006	.0060	.0077
Categorical	0169**	.0170	.0179*	.0012	.0252	.0746***
Sequential	.0092	.0441**	.0020	.0114	.0112	.0145
Memory	.0069	.0166	.0013	.0213	.0100	.0005
Total R^2	.2321***	.2101***	.2694***	.2397***	.1801***	.3380***

* $p < .05$ ** $p < .01$ *** $p < .001$

DISCUSSION

An overall view of the results of the various investigations in this study gives the impression that mathematics anxiety is a concern for the Navajo middle school student. It is a concern not only because of its meager relationship to achievement, but more primarily because such high levels as found here can act as a deterrent to participation in mathematics courses. This in turn decreases the number of students who will be well prepared for the careers of the future. Unbiased texts, occupational counseling, and cultural sensitivity on the part of school personnel could perhaps be part of the solution.

Secondly, the mathematics achievement profile of this particular school reveals a significantly different profile for the two separate areas of computational and applicational skills. The computational results were on a par with the national norms, which is a promising result. However, their lack of predictability by cognitive skills lends one to believe that the students are simply good at repeating steps. The applicational profile, being significantly lower, suggests a marked need for improvement in student critical thinking skills, but there is no evidence that this does not hinge primarily on a lack of the necessary language skills for reading and interpreting the test items. The predictability of applicational skill scores by the cognitive skills variables perhaps indicated that the applicational subscales of the instrument did require considerably more cognitive processes than did the computational section, and that this accounts for about one-fourth of the variance. This leaves three-fourths of the variance to be explained elsewhere, and language deficiency is the most likely source. Connelly (1985) suggests that reliance on nonverbal communication by the Native American is a serious deficit in academic performance. Further studies seeking relationships between language skills and mathematics applicational achievement are warranted.

REFERENCES

Barro, S.M. & Kolstad, A. (1987). *Who drops out of high school? Findings from high school and beyond. Contractor report.* Washington, D.C.: U.S. Government Printing Office 20402. (ERIC Document Reproduction Service No. ED 284 134)

Bradley, C. (1984). Influences on the learning and participation of minorities in mathematics. *Journal for Research in Mathematics Education, 15* (2), 96-106.

Comprehensive Test of Basic Skills. (1982). Monterey, Ca.: CTB/McGraw-Hill.

Comprehensive Test of Basic Skills Technical Manual. (1984). Monterey, Ca.: CTB/McGraw-Hill.

Connelly, J. (1985). Receptive and expressive vocabularies of young Indian children. *Journal of American Indian Education, 25* (1), 33-37.

Cundick, B. (1970). Measures of intelligence of southwest Indian students. *The Journal of Social Psychology, 81* (1), 151-156.

Dew, K.H., Galassi, J.P., & Galassi, M.D. (1983). Mathematics anxiety: Some basic issues. *Journal of Counseling Psychology, 30* (3), 443-446.

Dunn, R., Dunn, K., & Price, G.E. (1974). *Learning Styles Inventory.* Lawrence, Kans.: Price Systems, Inc.

Fletcher, J.D. (1983). What problems do American Indians have with mathematics? Orem, Ut: WICAT, Inc. (ERIC Document Reproduction Service No. ED 247 052)

Frary, R.B. & Ling, J.L. (1983). A factor-analytic study of mathematics anxiety. *Educational and Psychological Measurement, 43* (1), 985-993.

Hadfield, O.D., & Maddux, C.D. (1988). Cognitive style and mathematics anxiety among high school students. *Psychology in the Schools, 25* (1), 75-83.

Hynd, G. & Garcia, W. (1979). Intellectual assessment of the Native American student. *School Psychology Digest, 8* (1), 446-454.

James, R.K. & Kurtz, V.R. (1985). *Science and mathematics educati n for the year 2000 and beyond.* Bowling Green, OH: School Science and Mathematics Association.

Keefe, J.W. (1987). *The purpose and significance of the NASSP Learning Style Profile.* Reston, Va.: National Association of Secondary School Principals. (ERIC Document Reproduction Service No. ED 283 828)

Keefe, J.W. & Monk, J.S. (1986). *NASSP Learning Style Profile.* Reston, Va.: National Association of Secondary School Principals.

Keshena, R. (1980). Relevancy of tribal interests and tribal diversity in determining the educational needs of American Indians. In *Conference on Educational and Occupational Needs of American Indian Women* (pp. 231-250). Washington, D.C.: National Institute of Education, Program on Teaching and Learning.

Lawrenz, F. & McCreath, H. (1988). Native American school environment: Focus on science and mathematics education. *School Science and Mathematics, 88* (8), 676-682.

Morris, J. (1981). Math anxiety: Teaching to avoid it. *Mathematics Teacher, 74* (6), 413-417.

National Research Council. (1989). *Everybody counts: A report to the nation on the future of mathematics education* (ISBN 0-309-03977-0). Washington, D.C.: National Academy of Science.

Pottinger, R. (1985). Indian reservation labor markets: A Navajo assessment and challenge. *American Indian Culture and Research Journal, 9* (3), 1-20.

Purkey, W. (1978). *Inviting school success: A self-concept approach to teaching and learning.* Belmont, CA: Wadsworth.

Reinert, H. (1980). *Edmunds Learning Style Identification Exercise.* Edmunds, Wash.: Edmunds School District No. 15.

Sells, L. (1973). High school mathematics as the critical filter in the job market. In *Proceedings of the Conference on Minority Education*. Berkeley, Ca.: University of California.

Suinn, R.M. (1982). *The Mathematics Anxiety Rating Scale for Adolescents.* Ft. Collins, Co.: Rocky Mountain Behavioral Science Institute.

Suinn, R.M. & Edwards, R. (1982). The measurement of math anxiety: The Mathematics Anxiety Rating Scale for Adolescents - MARS-A.*The Journal of Clinical Psychology, 38* (1), 576-580.

Thomson, S.D. (1986). *Strategies for improving achievement within diversity.* Paper presented at the International Intervisitation Programme in Educational Administration, Hawaii and New Zealand. (ERIC Document Reproduction Service No. ED 273 040)

Trent, J.H. & Gilman, R.A. (1985). Math achievement of Native Americans in Nevada. *Journal of American Indian Education, 24* (1), 39-45.

Wallis, P. (1983). Holistic learning: A must with American Indian students. *Momentum, 14* (1), 40-42.

Witkin, H.A., Oltman, P.K., Raskin, E., & Karp, S.A. (1971). *Group Embedded Figures Test*. Palo Alto, Ca.: Consulting Psychologists Press, Inc.