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ABSTRACT

The purpose of this study was to investigate the hypothesis that if selected instruction materials were more culturally-relevant, Native American students should be more motivated and better able to make connections between school learning and their own lives. This increased motivation and improved connections between school learning and their own lives would be reflected in more positive attitudes and increased achievement. The sample for this study was selected from the Bureau of Indian Affairs' (BIA) education system, which in 1987 was comprised of 103 BIA-operated schools and 64 schools operated by tribes and tribal organizations under contract with the BIA. The basic study encompassed grades 4 to 8 in a pretest posttest control group design with one independent variable, instruction (use of Indian-related teaching materials versus non-use of these materials), and two dependent variable, science achievement and attitude toward American Indians and science. Building on the basic design, tribal affiliation (Navajo versus non-Navajo) and sex of the students were included as modifier variables. Evidence reported in this study supports the claim that the use of culturally-relevant materials will have a positive effect on students. (20 references) (KR)

Indian-Related Materials in Elementary Science Instruction*

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Documents such as A Nation at Risk (National Commission on Excellence in Education, 1983), Educating Americans for the 21st Century (National Science Board Commission on Education in Mathematics, Science and Technology, 1983), and The Science Report Card (National Assessment of Educational Progress, 1988) regularly remind the nation of shortcomings in American education, especially among minority students. No group is more disadvantaged in this regard than America's first people, Native Americans, who suffer low standardized test scores and an inflated school dropout rate. The Bureau of Indian Affairs (1988) has reported that American Indian second graders scored at the 22nd percentile, and all other grade levels scored even lower on either the California Achievement Test or the California Test of Basic Skills. While test bias explains part of the poor performance (Harmon, 1990), certainly not all of the measured underachievement can be attributed to that source. Factors contributing to this lamentable situation include poverty (French, 1987; Snow, 1974), rural isolation (Bureau of Indian Affairs, 1988), low parental expectations and general lack of Indian involvement in schools (Native American Science Education Association, undated), the highest of any racial group's rate of handicaps due to Fetal Alcohol Syndrome and other causes (Bureau of Indian Affairs, 1988), low self esteem (Green, 1978), external locus of control (Lockheed & Gorman, 1978), different learning styles (Bradley, 1979; Kidwell, 1986), language barriers and cultural differences (Bureau of Indian Affairs, 1988; Atkinson, 1985), inadequate teachers and counselors (Bureau of Indian Affairs, 1988), and

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irrelevant curriculum and inappropriate learning materials (Pinxten, *et al.*, 1983; Fuchs & Havighurst, 1972).

Most of these factors are outside the direct control of teachers; but teachers are in a position to select many of the instructional materials used in their classes. It has been argued that if the selected instructional materials were more culturally-relevant, Native American students would be more motivated and better able to make connections between school learning and their own lives. This increased motivation and improved connections between school learning and their own lives would be reflected in more positive attitudes and increased achievement. The present study was designed to investigate that hypothesis.

Procedure

The sample for this study was selected from the Bureau of Indian Affairs' educational system, which in 1987 was comprised of 103 BIA-operated schools and 64 schools operated by tribes and tribal organizations under contract with the BIA. Because of the autonomous nature of the contract schools, the study was limited to schools directly operated by the BIA. A vigorous attempt was made to produce a representative random sample of the 103 BIA-operated schools; but as is outlined in stepwise fashion in Figure 1 on page 3, the final sample included nine schools from eight of the BIA's agencies. The figure shows the number of area offices or agencies and schools remaining after each step in the selection process. The students in the final sample were 60% Navajo, 17% Sioux, 9% Tohono 'o Odham (Papago), 7% Hopi, 2% each Kiowa and Cheyenne/Arapaho, and 1% each Yakima, Comanche, Wichita, Caddo, and Ponca.

The basic study encompassed grades four to eight in a pretest posttest control group design with one independent variable, instruction (use of Indian-related teaching materials versus non-use of these materials), and two dependent variables, science achievement and attitude toward American Indians and science. Teachers and, thus, their students were randomly assigned to the

experimental or control groups. Building on the basic design, tribal affiliation (Navajo versus non-Navajo) and sex of the students were included as modifier variables.

		Area Offices or Agencies	Schools
Step 1.	The BIA schools are organized into 33 agencies and area offices responsible for 167 schools.	33	167
Step 2.	High schools (N=7) were not included.	33	160
Step 3.	Since only BIA schools were included, contract schools (N=64) were eliminated.	32	96
Step 4.	Schools in agencies having only one classroom per grade level were eliminated, since these agencies could not provide both an experimental and a control classroom. Ten agencies/area offices and their schools were eliminated for this reason.	22	60
Step 5.	A stratified random sample of these 60 schools was drawn so that the sample would reflect the relative student enrollment size in BIA schools.	15	42
Step 6.	Some agencies or schools declined to participate in the study.	10	17
Step 7.	Some schools did not return complete or useable data.	8	9

Figure 1. Stepwise Representation of Plan to Select Bureau of Indian Affairs Schools to Participate in the Study.

The investigation was carried out over a ten week period during which the teachers who used Indian-related materials were to teach science for 25 hours and related language arts for 25 hours. Teachers in the control group were to teach science, using the same instructional materials as the other group but without the Indian references, for 25 hours and their usual language arts for an additional 25 hours. Through logs kept by the teachers and telephone conversations between the teachers and project staff, it was found that the experimental teachers used the Indian-related materials an average of 33 hours. The control teachers used the materials less than 25 hours and in most cases, less than ten hours. Thus, a pitfall, i.e., comparing treatment versus no treatment, pointed out by McMillan and Schumacher (1984), was not entirely avoided.

Although the study was designed to investigate two levels of the independent variable, the teachers' logs and telephone conversations revealed that the study actually involved three instructional levels:

- Level Zero, the control group in which five teachers used the provided science materials less than ten hours during the ten week instructional period. Indian-related materials were not used in their science instruction.
- Level One, the experimental group in which four teachers used the Indian-related materials an average of 33 hours.
- Level Two, an exceptional control group that was not planned for but which emerged during the study. This group's teacher, who had been selected to be a part of the control group, had previously consistently used Indian-related materials, some of which overlapped with materials selected for use by the experimental teacher. However, this teacher did not use these materials during the course of the study. This teacher devoted 50 hours to teaching the science materials provided for the study.

More information about the subjects is displayed in Table 1, page 5.

The Indian-related materials used by the experimental group in Level One included 12 biographical profiles of American Indians ranging from a silversmith to a water quality technician to a weaver, who use science in their daily lives, and related science and language arts activities developed by teachers of Native Americans in the eight week NSF-supported teacher enhancement program, the MASTERS (Math And Science TEachers for Reservation Schools) Project. Along with these profiles and activities were included science activities from two NSF-supported curriculum development projects, COMETS (Career Oriented Modules to Explore Topics in Science), now a publication of the National Science Teachers Association (Smith, *et al.*, 1984), and Outdoor World Science (Killacky, 1988), which specifically relates science topics to the American Indian community. These materials were supplemented by 12 brief sketches from the AISES (American Indian Science and Engineering Society) publication, American Indian Scientists and Engineers (Card, 1986).

Table 1

Schools Participating in the Study by Treatment Level

Agency, School Name and Address	*Type of School	Grade Level	Number of Females	Number of Males
Level Zero: Control Classes (5 teachers; 5 classes)				
Navajo				
Eastern Navajo Agency, To' Hajiilee-He (Canyoncito), Laguna, NM	D	4th	8	5
Western Navajo Agency, Tuba City Boarding School, Tuba City, AZ	B	4th	12	10
Non-Navajo				
Hopi Agency, Polacca Day School, Polacca, AZ	D	6th	4	5
Papago Agency, San Simon School, Sells, AZ	D	6th	4	17
Pine Ridge Agency, American Horse School, Kyle, SD (5/6 combination)	D	5th 6th	6 4	5 5
Level One: Experimental Classes (4 teachers; 4 classes)				
Navajo				
Western Navajo Agency, Red Lake Day School, Tonela, AZ	D	6th	6	9
Ft. Defiance Agency, Greasewood/Toyei Consolidated, Ganado, AZ	B	7th 8th	8 5	4 6
Non-Navajo				
Anadarko Area Office, Riverside Indian School, Anadarko, OK (4/5 combination)	B**	4th 5th	4 4	4 4
Pine Ridge Agency, American Horse School, Kyle, SD	D	4th	11	6
Level Two: Exceptional Control Group (1 teacher; 5 classes)				
Navajo				
Shiprock Agency, Toadlena Boarding School Toadlena, NM	B	6th 7th 7th 8th 8th	8 3 2 5 5	9 5 3 4 3
ALL			99	104

* B = Boarding school. D = Day school.

** Riverside Indian School is the only off-reservation boarding school in the sample.

The dependent variable of attitude toward American Indians and science was measured by a 40 item Attitude Toward Indians in Science Scale developed for this study. Students responded on a five point scale from strong disagreement to strong agreement to items such as "my tribe has no use for science or technology," "American Indian scientists can make important scientific discoveries," "I do not know about any American Indian scientists," and " I plan to take science courses in high school." Negatively worded items were scored in reverse, so test scores could range from 40 to 200 with higher scores indicating more positive attitudes.

In a pilot test of the instrument in Zuni, New Mexico, the Cronbach α was .80; and for all pretests collected for the present study, the Cronbach α was .65. Construct validity was established by a panel of experts, who included teacher educators involved in inservice programs in science and mathematics education for elementary teachers of American Indian students and/or faculty members of Haskell Indian Junior College. Their feedback was used to modify the items until there was agreement that the test measured student attitude toward Native Americans and science. Construct validity was also established through factor analysis. Predicted factors were found in a seven factor solution. Concurrent validity was shown by sending the names of the three students who scored highest and the three who scored lowest in each classroom to their teacher and asking that teacher whether those results were reflected in the students' behavior. They agreed that the students' behavior matched the test results. Finally, face validity was demonstrated by responses of teachers who used the instrument. After the Zuni pilot study, for example, that school's staff recommended adoption of the attitude instrument for annual use in the school.

The second dependent variable, science achievement, was measured by a 40 item Science Concept Questionnaire developed for this study to measure students' understanding of science concepts included in the Indian-related materials used in the study. Each item had four possible answers with one correct, so that scores could range from zero to 40 with a score of ten showing completely random responses. Reliability and validity were established by the same procedures used for the attitude instrument.

Results

In addition to the study's major purpose of investigating the effect of culturally-relevant materials, the present study was intended to describe the attitudes of American Indian elementary school students toward American Indians and science. Among the more interesting findings on the pretest for the 203 students was that 49% said they did not know about any American Indian scientists. On the other hand, 69% felt American Indian scientists can make important scientific discoveries and only 11% agreed that "my tribe has no use for science or technology." Over half (58%) of the students said they were good science students, 70% said "I have learned a lot about science in school," and 69% said that teachers made them interested in science. However, large percentages of the students also expressed negative attitudes. For example, 27% indicated that "science is not important to me," 28% marked "I'm not good in science," 25% asserted that "science is not a useful subject," 26% said that "science courses are boring," and 31% agreed that "science courses are harder for American Indian students than they are for non-Indian students." The pattern of posttest responses did not differ from the pretest results.

Turning to knowledge of science concepts, the American Indian elementary students in this study knew shockingly little about issues of major impact to Native Americans. For example, on the pretest barely 12% of the students correctly responded that alcohol is a depressant; and only 25% answered correctly on the posttest. Only 22% and 44% replied correctly on the pre- and posttests respectively to a question about diabetes. The question on aerobics was answered correctly by 16% of the students on the pretest and 29% of the students on the posttest.

A Pearson *r* correlation between attitude and achievement of .31 was calculated on pretest results and .24 on the posttests. There was a significantly positive, low level linear relationship between these two variables.

To examine the major problem of the investigation, pretest results were analyzed first, using MANOVA. No significant pretest differences among treatment groups were found with regard to attitude ($t = 1.78$ for level zero versus level one; $t = 1.34$ for level zero versus level two;

and t = -0.33 for level one versus level two). However, there was a significant pretest achievement difference among groups (t = 3.30, p<.05 for level zero versus level one; t = 2.95, p<.05 for level zero versus level two; and t = -0.14 for level one versus level two). See Table 2 for pretest attitude results and Table 3 for pretest achievement data. Posttest attitude and achievement data are shown in Tables 4 and 5.

Table 2

Attitude of Native American Elementary-Aged Students toward Native Americans and Science Prior to Treatment

Treatment Group and Tribe	Female			Male			Both		Together	
	N	Mean	SD	N	Mean	SD	N	Mean	N	Mean
Level Zero: Control										
Navajo	18	139.2	11.8	15	131.5	18.1	33	135.4	**85**	**134.8**
Non-Navajo	20	133.3	16.0	32	134.9	14.0	52	134.1		
Level One: Experimental										
Navajo	19	143.7	16.9	19	138.9	14.9	38	141.3	**71**	**137.3**
Non-Navajo	19	132.1	7.8	14	133.4	13.3	33	132.8		
Level Two: Exceptional Control										
Navajo	23	136.3	17.6	24	139.3	14.6	47	137.8	**47**	**137.8**
Non-Navajo	-	-	-	-	-	-	-	-		
All	100	137.0		105	135.4		203	136.3	**203**	**136.4**

Table 3

Science Achievement of Native American Elementary-Aged Students Prior to Treatment

Treatment Group and Tribe	Female N	Female Mean	Female SD	Male N	Male Mean	Male SD	Both N	Both Mean	Together N	Together Mean
Level Zero: Control										
Navajo	18	11.0	2.4	15	11.4	2.8	33	11.2	**85**	**12.0**
Non-Navajo	20	13.7	3.3	32	11.8	3.1	52	12.9		
Level One: Experimental										
Navajo	19	16.4	5.8	19	14.3	4.5	38	15.4	**71**	**13.7**
Non-Navajo	19	10.8	2.6	14	12.9	3.9	33	11.7		
Level Two: Exceptional Control										
Navajo	23	14.7	5.3	24	13.4	4.5	47	14.0	**47**	**14.0**
Non-Navajo	-	-	-	-	-	-	-	-		
All	100	13.4		105	12.8		203	13.0	**203**	**13.0**

Table 4

Attitude of Native American Elementary-Aged Students toward Native Americans and Science After Treatment

Treatment Group and Tribe	Female N	Female Mean	Female Adj. Mean	Male N	Male Mean	Male Adj. Mean	Both N	Both Mean	Both Adj. Mean	Together N	Together Mean	Together Adj. Mean
Level Zero: Control												
Navajo	18	131.2	131.0	15	125.5	128.1	33	128.6	129.5	**85**	**130.9**	**131.9**
Non-Navajo	20	132.5	133.4	32	132.2	133.3	52	132.3	133.4			
Level One: Experimental												
Navajo	19	142.5	138.0	19	137.8	136.2	38	140.1	137.2	**71**	**139.6**	**139.0**
Non-Navajo	19	138.5	140.9	14	140.1	141.2	33	139.1	141.1			
Level Two: Except. Control												
Navajo	23	131.9	131.1	24	136.5	135.1	47	134.2	133.1	**48**	**134.2**	**133.1**
Non-Navajo	-	-	-	-	-	-	-	-	-			
All	99	135.3	134.9	104	134.4	134.8	203	135.0	134.9	**203**	**134.7**	**135.1**

Table 5

Science Achievement of Native American Elementary-Aged Students After Treatment

Treatment Group and Tribe	Female N	Female Mean	Female Adj. Mean	Male N	Male Mean	Male Adj. Mean	Both N	Both Mean	Both Adj. Mean	Together N	Together Mean	Together Adj. Mean
Level Zero: Control												
Navajo	18	11.7	12.3	15	11.6	12.4	33	11.6	12.4	**85**	**12.0**	**12.4**
Non-Navajo	20	12.9	12.7	32	11.8	12.3	52	12.4	12.5			
Level One: Experimental												
Navajo	19	19.5	18.0	19	18.5	18.0	38	19.1	18.0	**71**	**20.7**	**20.3**
Non-Navajo	19	22.8	23.7	14	22.5	22.6	33	22.6	23.0			
Level Two: Except. Control												
Navajo	23	24.0	23.3	24	26.5	26.3	47	25.3	24.8	**47**	**25.3**	**24.8**
Non-Navajo	-	-	-	-	-	-	-	-	-			
All	99	18.4	18.2	104	17.8	18.0	203	18.2	18.1	**203**	**18.1**	**18.2**

Since the Level Zero Control Group and the Level One Experimental Groups were the initial treatment groups of concern, a MANCOVA was performed with three independent variables, tribe, sex and treatment, using these two treatment levels and dropping the exceptional control group (Level Two) while using pretest scores as covariates. The results of this multivariate analysis are shown in Table 6 on page 11. The research hypothesis was supported. Students exposed to Indian-related materials had a more positive attitude and higher achievement than those who used similar materials without the culturally-relevant inclusions.

Table 6

Multivariate Analysis of Covariance with Three Independent Variables: Treatment, Tribe, and Sex, Comparing Only Experimental and No-Treatment Control Groups

Source of Variation	F
Three Way Interaction	
Treatment by Tribe by Sex	.0
Two Way Interactions	
Treatment by Tribe	4.4*
Tribe by Sex	.2
Treatment by Sex	.0
Main Effects	
Treatment	76.7*
Tribe	6.5*
Sex	.3

*$p<.05$

Next, because the exceptional control group (Level Two) had emerged during the course of the study, the posttest results for the same two dependent variables for all three treatment levels were analyzed, using MANCOVA with the pretest scores used as the covariates. The results are displayed in Table 7 on page 12. The most striking conclusion that can be drawn is that the experimental treatment seemed to be more effective in raising the achievement scores for non-Navajo students. These results are depicted in Figure 2 on page 12.

Table 7

Multivariate Analysis of Covariance with Three Independent Variables: Treatment, Tribe, and Sex

Source of Variation	F
Three Way Interaction	
Treatment by Tribe by Sex	.0
Two Way Interactions	
Treatment by Tribe	3.6*
Tribe by Sex	.2
Treatment by Sex	.2
Main Effects	
Treatment	33.5*
Tribe	7.5*
Sex	.1

*p<.05

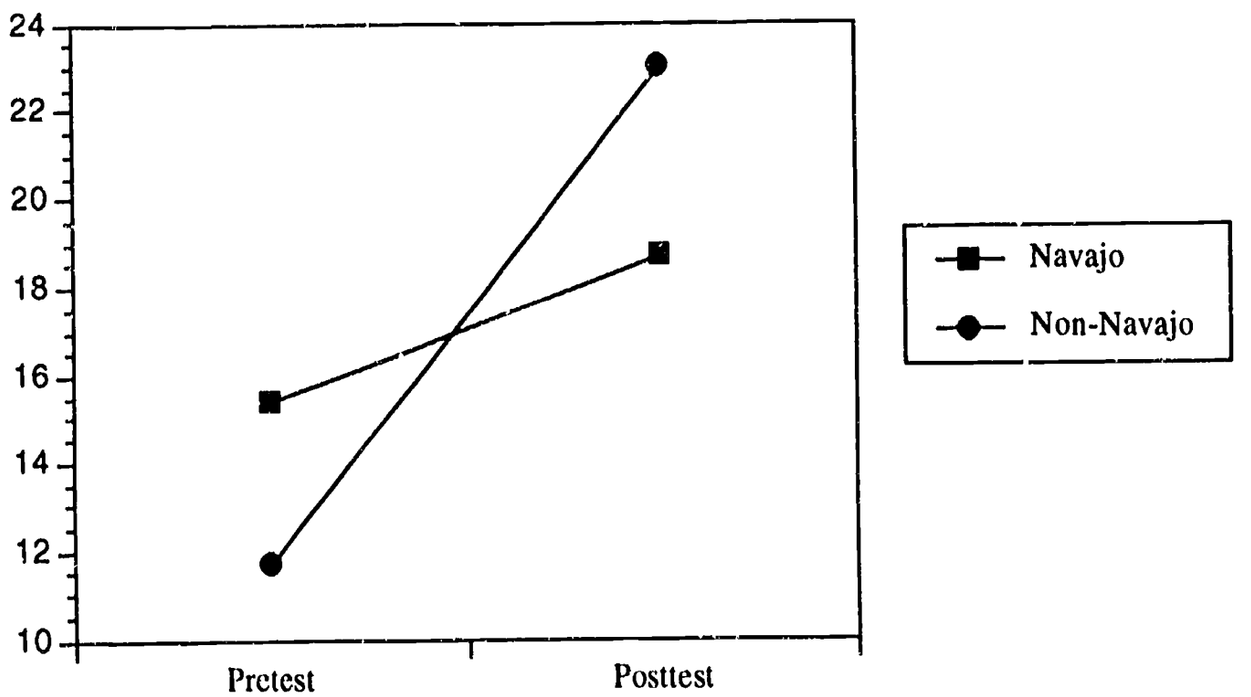

Figure 2. Effect of Experimental Treatment on Achievement of Navajo and non-Navajo Students.

Finally, since treatment was the main independent variable of concern, it was helpful in interpreting the data to perform an additional MANCOVA with treatment as the only independent variable. Attitude and achievement data for this analysis are shown in Tables 8 and 9 respectively. MANCOVA results are displayed in Table 10 on page 14.

Table 8

Attitude of Native American Elementary-Aged Students toward Native Americans and Science Before and After Treatment

Treatment Group		Before Treatment		After Treatment		
	N	Mean	SD	Mean	SD	Adj. Mean
Level Zero: Control	85	134.8	14.9	130.9	15.1	132.1
Level One: Experimental	71	137.3	14.2	139.6	17.0	139.2
Level Two: Exceptional Control	47	137.8	16.0	134.2	16.1	133.4
ALL	203	136.4	14.9	134.7	16.0	134.9

Table 9

Achievement of Native American Elementary-Aged Students Before and After Treatment

Treatment Group		Before Treatment		After Treatment		
	N	Mean	SD	Mean	SD	Adj. Mean
Level Zero: Control	85	12.0	3.1	12.0	3.6	12.4
Level One: Experimental	71	13.6	4.8	20.7	4.9	20.6
Level Two: Exceptional Control	47	14.0	4.9	25.3	9.1	25.0
ALL	203	13.0	4.1	18.1	5.3	18.2

Table 10

Multivariate Analysis of Covariance with Treatment as the Only Independent Variable

Source of Variation	F
Multivariate	37.6*
Univariate	
Achievement	83.0*
Attitude	4.8*

*p<.05

Post-hoc ONEWAY analyses revealed that at the beginning of the experiment there were no significant differences between the three treatment groups with respect to attitude. There were, however, significant differences with respect to pretest achievement scores. The no treatment control group (Level Zero) had significantly lower achievement pretest scores than either of the other two groups.

There also were significant differences among all three treatment groups on posttest achievement scores, even though the pretest scores served as the covariates. Posttest achievement scores for the exceptional control group were highest followed by the experimental group. The no treatment control group had the lowest posttest achievement scores. These results are presented in Figure 3 on page 15.

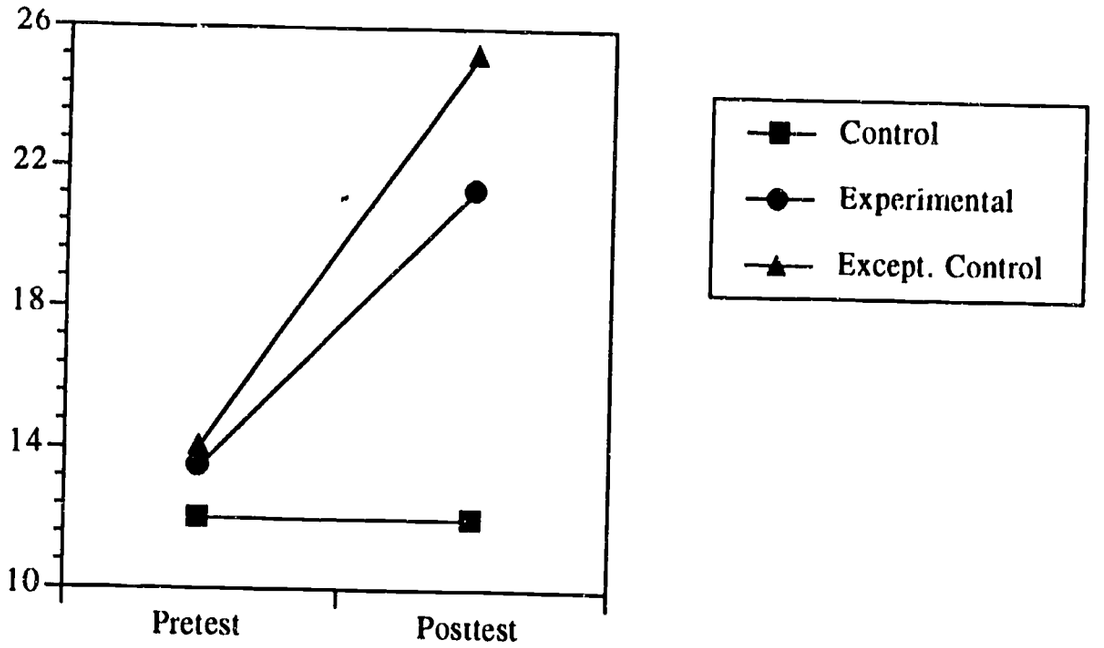

Figure 3. Effect of Treatment on Student Science Achievement.

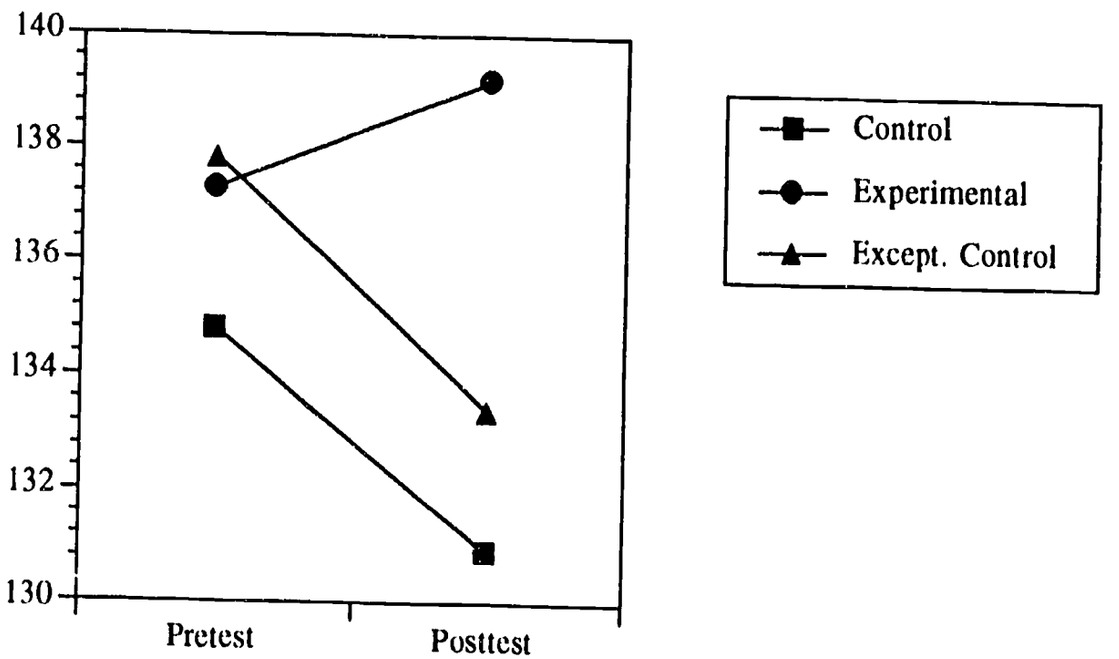

Figure 4. Effect of Treatment on Student Attitude.

Posttest attitude scores of the three treatment groups also were significantly different. That is, the experimental group had significantly higher posttest attitude scores than either of the control groups. The two control groups were not significantly different with respect to attitude as indicated in Figure 4 on page 15. With regard to the practical significance of these differences, there was an effect size of 0.48 when comparing the experimental (Level One) and control (Level Zero) groups. The experimental group scored approximately one-half standard deviation above the control group.

Discussion

Multiple factors affect the underachievement of American Indian students in science and their attitude toward Native Americans and science. Many of these factors are outside the teachers' direct control, but the selection of instructional materials certainly is largely within the purview of teachers in their own classrooms. Since sympathetic (and not so sympathetic) critics of Indian education have called for increased use of culturally-relevant materials and since it is the policy of many schools serving this population to attempt to use more culturally-relevant instructional materials, the present study was carried out to test the claims that such materials would improve instructional outcomes for this population.

Evidence reported in this study supports the claim that the use of culturally-relevant materials will have a positive effect on students. However, several cautions must be raised. the sample used in this study was not randomly selected, even though extensive efforts were made to analyze such a sample. In the end, although the teachers selected for the study were chos through a stratified random sampling procedure, the teachers who actually participated n considered to be volunteers. Moreover, the Bureau of Indian Affairs schools serve only approximately ten percent of Indian students, so the generalizability of this study's findings is thereby limited.

A second source of concern regarding our findings revolves around the mixed results for tribe and for the exceptional control group that emerged during the study. Had we limited our analysis to the two intended treatment groups -- experimental and control -- our results would have been simpler and more easily interpreted. However, concerns for more fully understanding the variables being studied compelled us to include the exceptional control group in our investigation. Inclusion of that latter group leads to the conclusion, in brief, that the students were achieving at a higher level -- as was the case with the experimental group -- because of their teacher's increased attention to the science topics being tested. Moreover, this group's not using culturally-relevant instructional materials had a negative effect on their attitude.

Notwithstanding these cautions, we propose the following conclusions. First, Indian-related materials do have a positive effect on the attitude of American Indian elementary school students. The policy of increasing use of culturally-relevant students for this population ought to be supported. However, the effect of culturally-relevant materials on achievement is not so clear. Given the increased achievement of the students whose teachers devoted more attention to the science topics being tested, regardless of whether or not the materials were culturally-relevant, it would appear that time on task, rather than cultural relevancy is the more important variable affecting achievement. However, since results from this study indicate that there is a significant and positive relationship between attitude and science achievement, then use of culturally-relevant materials may have a more positive effect on achievement than what was indicated in this study.

Second, there are significant differences in attitude and achievement among students from different tribes in Level One, the experimental classes. While the multivariate effect is significant and therefore some linear combination of the variables, treatment and tribe, affects achievement and attitude, only the univariate effect on achievement is significant. There were no differences due to sex. While both Navajo and non-Navajo students' achievement scores increased, non-Navajo students' achievement score increased significantly more than did Navajo students' achievement scores. There were no significant differences among tribes with regard to attitude scores.

Why does the use of culturally-relevant materials differentially affect students from different tribes? There are many possible explanations for these results. Undoubtedly, every teacher participating in this study used the materials in different ways. Upon additional examination of the data, including qualitative data gained from daily logs and telephone conversations with participating teachers, the following generalizations became apparent.

1. Prior to the treatment, Navajo students in the experimental group had higher science achievement (mean = 15.4) than non-Navajo students in the experimental group (mean = 11.7).

2. Navajo students were enrolled in higher grades (seventh and eighth) than non-Navajo students (fourth and fifth).

3. Following treatment, there was no change in attitude for Navajo students but a positive change in attitude for non-Navajo students. Both groups showed gains in achievement following treatment, although achievement gains were much higher for non-Navajo students than Navajo students. Why did non-Navajo students show such tremendous achievement gains? Figure 5 depicts some differences in the school situations for Navajo and non-Navajo students participating in this study. Perhaps these factors can help account for some of the differences in achievement.

The Navajo students' teachers were both first year teachers at their respective schools. However, both had worked previously with Indian students in other schools. Neither of the teachers were from the same tribe as their students. One of the non-Indian teachers was African-American; and the other teacher was Tewa (i.e., from a nearby but distinctly different tribe). Because neither of the Navajo students' teachers shared the same tribal heritage as their students, communication between teachers and students may have been strained. The African-American teacher commented on numerous occasions both in the log and during telephone conversations that her students were reluctant or unwilling to share their tribal beliefs in class. Further, nearly all of the Navajo students were speaking English as a Second Language. Yet the curriculum materials, like virtually all materials used with BIA students, were written only in English. Finally, the African-American teacher had a medical emergency during the treatment period; and because of an

extended absence, the experimental materials were used for six instead of ten weeks. The Tewa teacher got a late start with the materials and used them for eight instead of ten weeks.

In contrast to the Navajo teachers, one of the non-Navajo students' teachers had taught at the school for three years, while the other teacher had taught at the same school for 13 years. The non-Navajo students' teachers were both Indian teachers working with students from their own tribes. In one case, a teacher at an off-reservation boarding school was Choctaw as were some of her students. In the other case, the teacher and students all were Sioux. Further, culturally relevant materials were used extensively in both non-Navajo classrooms. However, from the teachers' logs it was difficult to gauge exactly how many hours were spent with the experimental materials. That they were used extensively were obvious, though. Neither of the non-Navajo students' teachers commented about communication difficulties; and less than ten percent of the non-Navajo students spoke English as a Second Language.

Factor	Navajo	Non-Navajo
1. Teacher Time at Present School in Years.	1 1	3 13
2. Teacher's Tribal Affiliation.	None (Black) Tewa	Sioux (with Sioux students) Choctaw (with students of various tribes)
3. Percent of ESL Students.	90-100	0-10
4. Percent of Profiles.	25	75

Figure 5. Factors that may Account for Differences in Achievement Gains among Students from Different Tribes.

In addition to variations in student and teacher characteristics, contents of the culturally-relevant curriculum materials possibly rendered them different for students from various tribes. Four of the basic 12 profiles in the materials featured Navajos, one was Sioux, and none were Choctaw. From the accompanying AISES profiles (Card, 1986) there were two Navajo, one Choctaw, and no Sioux among the 12 profiles. Perhaps, profiles of individuals who share a

common tribal heritage with Indian students who are reading the profiles are more effective than generic Indian profiles.

The preceding information suggests that there were many differences between the Navajo and non-Navajo students -- for example, match of the curriculum materials with the students' ethnic heritage, teacher's ethnic heritage relative to the students, students' native language, and so forth -- that go well beyond the differences in tribal heritage of the two groups. Perhaps at issue is not an inherently "tribal" factor but rather a multitude of other factors and interactions of factors that have resulted in significant tribal differences with respect to the use of a culturally-relevant curriculum.

As work continues with Native American students, it will be important to isolate independent factors and gauge their importance in order to make science a significant everyday event for all children. Based on the overwhelming response of teachers of American Indian school children to attend the MASTERS Project in which the development of culturally-relevant materials and their appropriate use in the classroom are primary foci, teachers at least see value in using these materials to improve their students' science achievement and attitude toward science and American Indians in science. This inferred positive effect of the use of culturally-relevant materials is supported by the results of this study.

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