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ABSTRACT

Efforts are being made to modify existing analytical teaching methods and curricula in mathematics to make them more holistic, to better match the learning styles of minority students. These changes have to be made by existing secondary and college mathematics faculty. Given the properties of field dependence-independence in human cognition, perception, and personality, it may be difficult for current mathematics teachers, who are likely to be highly field independent, to teach in a more field dependent manner and to create mathematics curricula that are less analytical. This study compared levels of field dependence-independence among four groups of (n=201) undergraduate students: mathematics majors, secondary mathematics education majors, other secondary education majors, and other majors. Subjects were given the Group Embedded Figures Test. Data analyses indicated group differences on the measure of field independence. No significant differences were found between the mathematics and secondary mathematics education majors; however, secondary mathematics education majors were more field independent than the group of other majors in secondary education, and mathematics majors were significantly more field independent than other majors and other secondary education majors. The implications of these group differences with regard to holistic teaching and curricula are discussed. Contains 25 references. (MKR)

Field Dependence-Independence and Holistic Instruction in Mathematics

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Abstract

The purpose of this study was to compare levels of field dependence-independence among four groups undergraduate students: mathematics majors, secondary mathematics education majors, other secondary education majors, and other majors. Subjects were given the Group Embedded Figures Test. Data analyses indicated group differences on the measure of field independence. No significant differences were found between the mathematics and secondary mathematics education majors; however, secondary mathematics education majors were more field independent than the group of other majors in secondary education, and mathematics majors scored significantly higher than other majors and other secondary education majors. The implications of these group differences with regard to holistic teaching and curricula are discussed.

Field Dependence-Independence and Holistic Instruction in Mathematics

Steen (1990) makes an extremely strong case for addressing the issues regarding minority and female participation in mathematics. He asserts that "by the year 2000, 40 per cent of the children in the public schools will be black or hispanic" (p. 130) and these students will require more mathematics to compete in the nation's job market. Minority students drop out of mathematics at disproportionately high rates and only a very few of the black students with the highest SAT mathematics scores choose to take mathematics in college.

To address this disparity in mathematics participation, Stiff (1990) urges an increase in the number of black mathematics teachers and substantial modifications in the teaching styles of mathematics teachers. Stiff argues that current mathematics classrooms are dominated by analytic teaching styles and classroom environments which are not compatible with black culture and learning styles; however, he acknowledges that there are many factors which contribute to black students' mathematics performance. He correctly suggests that schools must take postive actions to address issues related to minority student enrollment and success in mathematics. One suggestion is that teachers use more holistic methods of teaching and create classrooms which are less competitive. The National Council of Teachers of Mathematics (1989) Curriculum and Evaluation Standards clearly are intended

to address the issues of minority and female participation in mathematics.

The Professional Standards (NCTM, 1991) and the guidelines released by the Mathematical Association of America (MAA) (MAA, 1991) specify the enhanced qualifications needed by persons teaching mathematics. These guidelines suggest a prerequisite four years of high school mathematics for college intending students and then a college major in mathematics. Although the content, number of mathematics courses, and number of credit hours in mathematics is not specified, "given the nature of mathematics and the changes being recommended, teachers at all levels need substantive and comprehensive knowledge of the content and the discourse of mathematics" (pp. 139-140). Although the Professional Standards state that "the spirit and content of the coursework described above can be very different for traditional courses, every effort should be made to develop new courses that reflect these differences" (p. 139) and there should be an extensive focus on problem solving.

This problem must be addressed initially by those mathematics teachers currently in the field and those who are in the existing pipeline. One factor which prompted the present study is the recent efforts to recruit persons into mathematics teaching from a variety of fields. One means of securing teachers has been the nontraditional or alternative teacher certification programs which allow licensure to persons without degrees in mathematics education but often in mathematics or

engineering. Currently, 48 states offer varying routes to teacher licensure (Teacher Education Policy in the States, June, 1990).

The concept of field dependence-independence (FDI) is one facet of cognitive styles that has frequently been examined in research. Dembo (1981) defined FDI as "a measure of the extent to which individuals are able to overcome effects of distracting background elements (the field) when they attempt to differentiate the relevant aspects of a particular interaction" (p. 87). Persons who are able to overcome distractions are classified as field independent, or analytical. Those not able to overcome distractions are called field dependent, or global.

Garger and Guild (1984) claimed FDI has implications for education including its effect on behaviors in teaching, administering, and learning. Not only does the effect include how and what students learn, but also it impacts upon "the learning style demands made by teachers, curriculum materials, methods, and evaluation techniques" (p. 11). These researchers noted that field dependent teachers prefer interaction and discussion with students, whereas field independent teachers prefer impersonal teaching situations such as lectures. Other researchers (Coward, Davis, & Wichern, 1978; Saracho, 1978; Witkin, Moore, Goodenough, & Cox, 1977) have reported differences between field dependent and field independent teachers in the use of specific instructional techniques. Mahlios (1981a, 1981b) reported differences in teacher interactions with students and in

the type of questions asked by field dependent and independent teachers. In a study by Emmerich (cited in Witkin et al., 1977), it was found that field independent teachers used corrective feedback (that is, not only informing a student that a response was incorrect, but also telling the student why it was incorrect) more than did field dependent teachers. Thus, the construct of FDI may influence teaching styles and subsequently minority achievement and enrollment in mathematics.

Lusk and Wright (1981) tested 409 college students from various majors and reported males and students in the sciences or engineering were more field independent than their counterparts. Since mathematics certification extends beyond secondary mathematics education majors, there may be implications regarding the success of mathematics teachers with various undergraduate majors and their instructional behavior in the classroom.

Threadgill-Sowder, Sowder, Moyer, and Moyer (1985) summarized the effect of FDI on problem solving in mathem..ics by concluding that students scoring high on measures of field independence were generally better problem solvers than their field dependent peers. Dugger (1985) found that mathematical problem solving performance could be improved when Hispanic students were given instruction in how to compensate for differences in field dependence. The question of the relationship between FDI and problem solving may have implications not only for students in K-12 but also for the mathematics preparation of prospective secondary mathematics

teachers. College students may not be successful in mathematics or they may require alternative instructional techniques in areas such as problem solving.

According to Witkin and Goodenough (1981) field dependence-independence is "a perceptual-analytical ability that manifests itself pervasively throughout an individual's perceptual functioning" (p. 15) and it is a relatively stable construct which is not easily altered. Not only do field independence measures c relate with perceptual and cognitive variables, but also with personality variables (Frank, 1986) which may have great impact upon the teacher's behavior in the classroom.

The present study examines the construct, field dependence-independence, and group membership. The primary purpose of this study was to compare secondary mathematics education majors with their other college peers on a measure of field independence.

METHOD

Subjects

College students enrolled at a major land-grant university in the Southeast formed the subject pool for this study. Students classified as either sophomore, junior, or senior were considered as potential subjects. Subjects were sought from four groups: (1) secondary mathematics education majors; (2) mathematics majors; (3) other (non-mathematics) secondary education majors; (4) other college majors not included in the three groups above. Students in five junior-senior level mathematics classes, seven

professional education classes, and two beginning psychology classes were asked to participate in this study. The psychology classes were selected since these introductory courses enroll a wide variety of students from all schools.

All 54 students present in the mathematics classes agreed to participate. In the education classes, 116 of the 117 students present agreed to participate. Of the 64 students present in the two psychology classes, 51 agreed to participate. Thus, a total of 221 students participated in the study. From this total, data for 20 subjects were dropped since they either did not meet the sample criteria or did not complete the instruments. This resulted in 201 subjects, 85 males (42.3%) and 116 females (57.7%), with usable data for the subsequent analysis. A power analysis for ANOVA for a power of .80 and alpha of .05 indicated that the sample size of 201 was adequate.

For the purpose of clarity, secondary education majors are designated by membership in an approved 7th-12th grade teacher education program as described in the university's undergraduate catalog. Group 3, the other secondary education majors group, consisted of 26 English majors, 19 social studies majors, 6 science majors, and 20 majors in either business or health education. Group 4, the other majors group, consisted primarily of students in liberal arts or business.

Procedure

Because of the number of subjects and the varied majors needed, whole classes were sought for group administration of the

instruments used in this study. Five instructors teaching upper division mathematics classes were contacted and each gave permission for the researchers to administer the study's instruments during a regularly scheduled class meeting to those students who would agree to participate. These classes provided subjects for Group 2 and part of Group 1. Seven instructors of professional secondary education classes cooperated in this endeavor. Subjects for Group 1, Group 3, and a few subjects for Group 4 were obtained from these classes. The remainder of the subjects for Group 4 were obtained from the psychology classes.

Students in each class were informed about the nature of the study and were asked to participate. Those students who agreed to participate were given a demographic information cover sheet along with a measure of field independence.

Instruments and Measures

Group membership, the independent variable, is a nominal variable with four levels: 1 - secondary mathematics education majors, 2 - mathematics majors, 3 - other secondary education majors, 4 - other majors not in any of the above groups. Self-reported data on the subjects' sex, college-year standing, and college major were collected.

Field dependence-independence was measured by means of the Group Embedded Figures Test (GEFT) developed by Oltman, Raskin, and Witkin (1971). The GEFT assessed the subject's ability to locate a simple figure embedded in a more complex design. Responses are graded right or wrong and a total score from 0 to

18 is possible . Increasing magnitudes reflect increasing degrees of field independence. The manual for the GEFT (Witkin, Oltman, Raskin, & Karp, 1971) reported a reliability estimate of .82 obtained by using Spearman-Brown prophecy formula. Using the Spearman-Brown prophecy formula, the data for this present study yielded a reliability estimate of .83.

RESULTS

Descriptive findings for the five groups determined by choice of college major are presented in Table 1 and reveal that, as a group, the group of Mathematics majors scored higher on the GEFT (more in the field independence direction) than any of the other four groups. The Secondary Mathematics Education group scored second highest.

Insert Table 1 here.

The ANOVA for the dependent variable, field dependence-independence, using Group as the independent variable is presented in Table 2. Since this analysis of variance was significant, the Tukey test was applied to determine between which pairs of group means a statistically significant difference existed. The .05 level of significance was used as the criterion probability. The results of the Tukey test revealed the following: (1) Secondary Mathematics Education majors were significantly more field independent than were the Other Secondary Education majors; (2) Mathematics majors were

significantly more field independent than both the Other Secondary Education majors and the group of Other college majors; (3) Secondary Mathematics Education majors and Mathematics majors did not score significantly different on the measure of field independence.

Insert Table 2 here.

DISCUSSION

Consistent with the findings of Lusk and Wright (1981), the data analyses found significant differences due to the independent variable, Group. Witkin and Goodenough (1981) and Witkin et al. (1977) have previously reported differences on the GEFT for various occupational groups. They reported that persons trained in education generally tend to be people-oriented, a trait associated with field dependent persons. On the other hand, persons choosing careers related to the mathematical sciences tend to favor impersonal domains, a characteristic associated with field independent persons. The Secondary Mathematics Education majors group of this study did not differ statistically from the Mathematics majors group but did differ from the Other Secondary Education majors.

Given the more field independent characteristics of mathematics majors, preservice secondary mathematics education majors, other science and engineering majors, and teacher certification practices today, Stiff's assertion (1990) that secondary mathematics instruction is analytical is supported.

It is reasonable to assume that most collegiate teachers of mathematics were undergraduate majors in mathematics, mathematics education, one of the other sciences, or engineering. Mathematics instruction at the collegiate level of mathematics is probably even more analytical in approach than is secondary mathematics, and one may question if it is probable that collegiate mathematics instruction will become less analytical.

Assume that secondary and collegiate mathematics teachers and programs want to become more holistic. If the assertions that field dependence-independence is pervasive in a person's behavior and not easily altered (Witkin & Goodenough, 1981) and is a characteristic of personality (Frank, 1986), mathematics teachers would have to act in a manner inconsistent with their own personality and perceptual and cognitive functioning. A significant question for further research is to ascertain the degree which highly field independent teachers can teach in a holistic manner.

The suggestion that mathematics teachers and programs become more holistic assumes field dependent learners would function better if there was a cognitive style match between teaching and learning styles. Early studies by DiStephano (1970) and James in 1973 (cited in Bertini, 1986) found that students described teachers positvely and teachers described students as more intelligent, logical, and successful when students and teachers were cognitively matched. Packer and Bain (1978) found that students gave more positive ratings to field dependent teachers;

however, the relationship between cognitively matched teachers and students and students' mathematics achievement was unclear. Matching 10th grade geometry students with teachers on levels of field dependence failed to yield significant results (Brennan, 1984) although the results were in that direction. One study by Saracho and Dayton (1980) found negative results from matching on cognitive styles and student achievement.

CONCLUSION

In an effort to address the undeniable need to increase minority participation in mathematics, efforts are being made to modify existing analytical teaching methods and curricula in mathematics to make them more holistic to better match the learning styles of minority students. For the immediate future, these changes, if they are to be attempted, have to be made by existing secondary and college mathematics faculty. Evidence exists to suggest that field dependent students respond more favorably to field dependent teachers; however, the relationship between increased student achievement in mathematics and cognitively matching students and teachers is less clear. Given the properties of field dependence-independence in human cognition, perception, and personality, it may be difficult for current mathematics teachers who are likely to be highly field independent to teach in a more field dependent manner and create mathematics curricula which are less analytical.

An increase in minority participation in mathematics is critical. Even though the evidence to support cognitive matching

and improvement in students' mathematics achievement is less than convincing, there is evidence to support improved teacher-student relationships may result in increased minority student enrollment in mathematics courses and long term improvement in minority achievement in mathematics. Mathematics educators should attempt to modify the curriculum and teaching styles as suggested and to evaluate the outcomes. Mathematics educators should continue to seek other means of addressing minority participation.

REFERENCES

Bertini, M. (1986). Some implications of field independence for education. In M. Bertini, L. Pizzamiglio, & S. Wagner (Eds.), Field dependence in psychological theory, research, and application (pp. 93-106). Hillsdale, NJ: Lawrence Erlbaum Associates.

Brennen, P. K. (1984). An analysis of the relationships among hemispheric preference and analytical/global cognitive style, two elements of learning style, method of instruction, gender, and mathematics achievement of tenth grade geometry students. Dissertation Abstracts International, 45, 3721A.

Dugger, C. R. (1985). A study of the effectiveness of field-dependent/field independent instruction on the mathematical problem solving ability of Hispanic students. Dissertation Abstracts International, 45, 2388A.

Coward, R. T., Davis, J. K., & Wichern, R. L. (1978). Cognitive style and perception of the ideal teacher. Contemporary Educational Psychology, 3, 232-238.

Dembo, M. H. (1981). Teaching for learning: Applying educational psychology in the classroom (2nd ed.). Glenview, Illinois: Scott Foresman and Company.

DiStephano, J. J. (1970). Interpersonal perceptions of field independent and field dependent teachers and students. Dissertation Abstracts International, 31, 463A.

Frank, B. M. (1986). Cognitive styles and teacher education: Field dependence and areas of specialization among teacher education majors. Journal of Educational Research, 80, 19-22.

Garger, S., & Guild, P. (1984). Learning styles: The crucial differences. Curriculum Review, 23, 9-12.

Lusk, E. J., & Wright, H. (1981). Differences in sex and curricula on learning the Group Embedded Figures Test. Perceptual and Motor Skills, 53, 8-10.

Mahlios, M. C. (1981a). Effects of teacher-student cognitive style on patterns of dyadic classroom interaction. Journal of Experimental Education, 3, 147-157.

Mahlios, M. C. (1981b). Instructional design and cognitive styles of teachers in elementary schools. Perceptual and Motor Skills, 52, 335-338.

Mathematical Association of America (1991). A call for change: Recommendations for the mathematical preparation of teachers, Washington, C.C.: MAA

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

National Council of Teachers of Mathematics (1991). Professional standards for teaching mathematics. Reston, VA: The Council.

Oltman, P., Raskin, E., & Witkin, H. A. (1971). Group embedded figures test. Palo Alto, California: Consulting Psychologists Press.

Packer, J., & Bain, J. (1978). Cognitive styles and student-teacher compatibility. Journal of Educational Psychology, 10, 864-871.

Saracho, O. N. (1978). The relationship of the match of teachers'-students' cognitive style to the teachers' perception of students' competence. Dissertation Abstracts International, 39, 2738A. (University Microfilms No. 78-21, 237)

Saracho, O. N., & Dayton, C. M. (1980). Relationship of teachers' cognitive styles to pupils' academic achievement gains. Journal of Educational Research, 72, 544-549.

Steen, L. A. (1990). Mathematics for all Americans. In. T. J. Cooney (Ed.), Teaching and learning mathematics in the 1990s (pp. 130-134). Reston, VA: National Council of Teachers of Mathematics.

Stiff, L. V. (1990). African-American students and the promise of the Curriculum and Evaluation Standards. In. T. J. Cooney (Ed.), Teaching and learning mathematics in the 1990s (pp. 152-158). Reston, VA: National Council of Teachers of Mathematics.

Teacher Education Policy in the States: A 50-state survey of legislative and administrative actions, June, 1990. Washington, DC: U. S. Department of Education.

Threadgill-Sowder, J., Sowder, L., Moyer, J. C., & Moyer, M. B. (1985). Cognitive variables and performances on mathematical story problems. The Journal of Experimental

Education, 54, 56-62.

Witkin, H. A., & Goodenough, D. R. (1981). Cognitive styles: Field dependence and field independence. New York: International Universities Press, Inc.

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. (1977). Field-dependent and field-independent cognitive styles and their educational implications. Review of Educational Research, 47, 1-64.

Witkin, H. A., Oltman, P. K., Raskin, E., & Karp, S. A. (1971). A manual for the embedded figures test. Palo Alto, California: Consulting Psychologists Press.

Table 1

Means and Standard Deviations by Groups for Dependent Variable

Group	n	Mean	sd
Math Educ.	50	12.92	4.42
Mathematics	41	14.54	3.55
Other Sec. Ed.	62	10.73	4.00
Other Majors	48	11.90	4.74

Table 2

ANOVA: Field Dependence-Independence by Group

Source	df	Sum Squares	Mean Squares	F
Between groups	3	385.635	128.545	7.250*
Within groups	197	3492.693	17.729	
Total	200	3878.328		

*p < .001