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Solving Math Problems—What is the Performance of Deaf College Students?

By Ronald R. Kelly and Keith Mousley

Introduction

In Lang's (1996) historical perspective on bridging teaching and research, he cites the words of a young deaf teacher, Laura C. Sheridan, who presented "Thoughts from My School-Room" to the Eleventh Convention of the American Instructors of the Deaf in Berkeley, California, July 15-22, 1886 (Sheridan, 1887). Sheridan's plea to the convention members was that they focus on the real difficulties of the school-room and noted "…that aspiring teachers have felt a disappointment after attending a convention at hearing so little plain talk upon the practical questions that have knotted and snarled their school-room work."

Action research is a viable classroom oriented approach for educational research to address teachers' concerns and the "practical questions that have knotted and snarled their school-room work." As defined by Oja and Smulyan (1989):

> *Action research projects have three general aims: staff development, improved school practice and the modification and elaboration of theories of teaching and learning…. Improved practice results from practitioner participation in the investigation of actions or issues of immediate importance.* (p.1)

We have conducted a number of applied class-room studies to better understand the problem solving abilities of deaf college students and to improve their abilities for solving math problems. The goal is to improve instruction and educational practice with respect to problem solving. Strategies previously examined have included

• giving a signed explanation to a peer observer after which they would write their understanding of the problem and solution
• visualizing the problem solving process prior to starting to solve a problem, and
• teacher modeling of the analytical process for a sample problem.

The results and discussion of these strategies have been published elsewhere (Mousley & Kelly, 1998).

Continuing in this series of classroom studies on problem solving, the authors have examined the ability of deaf and hearing college students' to transfer and apply their math computation and problem-solving skills, demonstrated with graphically presented problems, to similar problems presented as word problems. This article presents the preliminary and partial findings of this study that are being prepared for publication elsewhere.

Problem solving involves the identification and application of previous experience, knowledge, and skills that result in solutions to problems (Biehler & Snowman, 1997). A successful problem solver must be able to recognize similarities between a current problem and previous problem experiences, as well as to identify the relevant information presented within the problem necessary to develop a correct solution. Transfer of learning refers to those times when students are able to independently apply previously learned knowledge and problem-solving skills to similar but different situations.

Research

Four classes of deaf college students enrolled in NTID math classes (n = 37) and one comparison group of

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Susan Fischer, in collaboration with Lorraine Delhorne and Charlotte Reed, colleagues at MIT, have had their paper, "Effects of rate of presentation on the reception of ASL" published in the June issue of *Journal of Speech, Language, and Hearing Research*. Based on data collected at NTID, this paper argues that there is an upper limit for speed of processing language regardless of the modality in which it is communicated (speech vs. sign). For more information, contact Fischer at *SDFNCR@RIT.EDU*.

Vince Samar, **Ila Parasnis** and **Jerry Berent** presented a paper, "Deaf poor readers' VEPs reveal magnocellular system deficits," in June, 1999, at the 11th Annual Convention of the American Psychological Society in Denver, CO. Their study provides the first objective neurophysiological evidence that developmental dyslexia may occur in the deaf population. For more information, contact Samar at *VJSNCR@RIT.EDU*.

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Jeffrey Porter has been appointed Interim Director for the Center for Research, Teaching and Learning (CRTL) at NTID, effective September 15, 1999. Porter began his career at NTID in 1980. He has a Ph.D. in Educational Psychology from Washington University at St. Louis. Recently, he was a Fulbright Fellow in the UK/USA Academic Administrator Program at the University of York in England. Porter is a graduate of the Management Development in Higher Education program at Harvard University. He is a tenured associate professor in Psychology at NTID, and, before his appointment as Interim Director for CRTL, was director of the NTID Learning Center.

Action Research and the Individual Learner

There is a lot of discussion these days, from keynote presentations at national conferences to discussions among colleagues strolling down the hall, about the need for undergraduate education to re-affirm and re-vitalize its simple, profound purpose: the support of student learning.

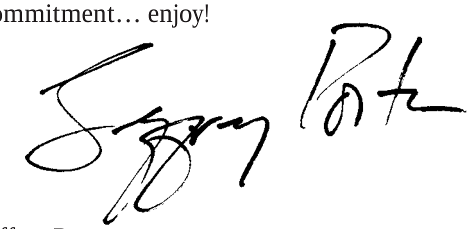
The two articles featured in this edition nicely highlight two inter-related themes at center stage in this discussion: the reality of individual differences among diverse learners and the role of action research in coping with this reality. Rothman-Marshall looks at individual differences among students in terms of the Myers-Briggs typology, amd Kelly and Mousley apply research tools to illuminate the complexities of problem-solving within classroom settings. The juxtaposition of these two pieces is wonderful happenstance (or shrewd editorial judgment!); ultimately, action research represents a powerful means toward the goal of supporting successful learning by individual students.

Clearly, for any given learning task in any particular instructional context, tremendous variation exists among the involved learners, variation only crudely and partially captured by demographic categories and learning style taxonomies. In the day-to-day practice of teaching and learning, conceptual frameworks establishing discrete categories of students or kinds of learning styles are swamped by actual variation among unique learners. The comforting fiction of the average student fades quickly against the reality of the individual student. Undergraduate teachers cannot aim for the "middle" of the class when the "middle" doesn't exist.

The challenge for teachers in supporting the academic success of individual students is seeing beyond demographic indicators and learning style profiles. It is seeing each student as a unique learner. It is divining, through artistry, plain old trial and error, ongoing partnerships and dialogue with students, insights passed along by colleagues, and the incorporation of pertinent research findings, those individual learning characteristics having the most significance for developing supportive instructional strategies. It is becoming your own action researcher, collecting information from students to use as formative feedback in assessing and improving instructional practice. Finally, it is viewing learner diversity in the face of established goals and standards not as a problem, but as a source of pedagogical innovation and educational enrichment.

Supporting the academic success of individual students is a daunting challenge for teachers. Yet it can be an enriching, even generative, one; particularly when you wrestle with it through an approach that can be termed "teacher as reflective practitioner."

As for research supported through CRTL, we will continue our commitment to ensure that it focuses on and illuminates the "action" between teacher and learner, has pay-off in helping student learning become as productive as possible, and recognizes, rather than blurs, the reality of the individual learner. The articles you encounter in this issue reflect that commitment… enjoy!



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NTID Research Bulletin
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Ron Kelly teaches graduate courses in the NTID Master of Science in Secondary Education of Students who are Deaf or Hard of Hearing Program, as well as The Psychology of Teaching and Learning graduate course in Rochester Institute of Technology's College of Liberal Arts – Behavioral Science Division. His research interests include cognitive processing, problem solving, and captioning. For more information, he can be contacted by e-mail at RRKNCP@RIT.EDU or by telephone at (716)475-6802.

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hearing college students (n = 12) were given a total of 30 math problems to solve. These problems were presented under both graphic and word conditions. For both conditions, the problems were similar (the numbers in each problem were different) and sequenced to be increasingly more complex. The computation skills needed to solve these problems required multiplication, or a combination of addition, subtraction and multiplication.

There were 15 equivalent problems presented within each condition similarly sequenced in three sets of five problems. The first set of five problems was two-dimensional, requiring multiplication to calculate the area of a flat surface. The second set of five problems also required multiplication to calculate area while increasing the difficulty by requiring addition to, or subtraction from, the area. The third set of five problems further increased difficulty by requiring the students to find the total surface areas of a three dimensional figure, as well as requiring the computational skills of multiplication, addition, and subtraction.

Upon completing the 15 graphic math problems, the students were given 15 similar word problems that matched the difficulty of the graphic problems. The readability levels of the 15 word problems ranged from 5.0 to 8.2 grade levels as measured by the Flesch-Kincaid readability criteria for number of words in the passage, number of sentences, average number of words per sentence and number of characters per word.

Results

The results showed that increased problem complexity similarly influenced the performance of both the deaf and hearing students. The data presented in Table 1 below indicates that, regardless of hearing status, all students scores declined as problem complexity and difficulty increased from problem sets 1 through 3. There were five problems within each of the three sets under both the graphic condition and the word condition, for a total of 15 problems per condition.

For the graphically presented math problems (sets 1, 2, 3, & total) and the least difficult word problems (set 1), the performance pattern of the deaf students was generally comparable to the hearing students, and not statistically different. The exception involved the students in classes 2 and 3, for the math problems presented in graphic set 2. This seems to be an anomaly, however, because the other two classes of deaf students performed comparably to the hearing students. All of the deaf students performed equally well on the graphically presented math problems in sets 1 and 3, resulting in no significant differences for the total score.

This was not the case when comparing performances of the deaf and hearing college students between the graphic and word conditions. The problem solving performance of the hearing students remained consistent across the two conditions, while the deaf students' problem solving performance showed a sharp decrease with the word problems presented in sets 2 and 3 of the word condition, which, of course, influenced their total performance score for the word condition. The problem solving performance of the deaf students in each of the four different classes, when compared to the hearing

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Table 1.
Comparison of mean scores of deaf and hearing college students for solving similar math problems presented graphically and as word problems.

Significant group comparisons =*

	Graphic Math Problems				Word Math Problems			
Group	**1**	**2**	**3**	**Total**	**1**	**2**	**3**	**Total**
Deaf students								
Class 1 (n=8)	4.9	4.1	2.3	**11.3**	3.9	2.9*	1.7*	**8.4***
Class 2 (n=10)	4.8	3.0*	2.4	**10.2**	4.3	2.6*	1.6*	**8.5***
Class 3 (n=8)	4.9	3.1*	2.6	**10.6**	4.6	2.4*	1.6*	**8.6***
Class 4 (n=11)	5.0	3.9	2.3	**11.2**	4.5	1.5*	.18*	**6.2***
Hearing students comparison group (n=12)	5.0	4.1*	3.7	**12.8**	4.9	4.4*	3.4*	**12.8***
Significance (F test)	**ns**	**p<.05**	**ns**	**ns**	**ns**	**p<.01**	**p<.01**	**p<.01**

Keith Mousley taught science (basic science and chemistry) at the Scranton State School for the Deaf in Scranton, PA, for six years, and for the last ten years has taught math (everything from algebra to concepts of calculus) at NTID. His research interests include finding how students solve word problems in math and science, and alternative assessments. For more information, he can be contacted at KXMNTM@RIT.EDU.

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comparison group, was significantly different for word problem sets 2 and 3, as well as for the total on the word problems.

With respect to reading ability, since this study used intact classes created by the natural enrollment patterns, students were not originally grouped by reading level. To examine the possible influence of reading abilities, students with measured reading scores in the ranges of 7.8 or lower, 8.0-8.8, and 9.3 or higher were grouped accordingly and analyzed (n = 10 per group). The 30 deaf students in the three grouped categories of reading levels performed comparably on the math problems in the graphic condition and for set 1 of the word problems. The problems in the graphic condition required no reading, while the first set of the word problems was the least complex or difficult.

However, as problem complexity and difficulty increased in sets 2 and 3 of the word condition, students with the higher reading levels demonstrated better problem solving performance. In fact, their pattern of performance looked similar to the comparison group of hearing students. It is surprising that the problem solving performance of the deaf students in the middle reading level range (8.0 – 8.8) was nearly identical to the students in the lower reading level range (6.6 – 7.8).

Discussion

Given their similarity in performance with the graphic problems and the least complex word problems (word set 1), the data suggest that the deaf college students' computation and solving skills for these kind of problems are comparable to their hearing peers. Since the computational requirements were the same for both the graphic and word conditions, the deaf students' decline in performance with the word problem condition cannot be attributed to a lack of math computation and problem solving skills.

Previous research (Pau, 1995) has shown that reading comprehension is a factor affecting younger deaf students' performance with math word problems. It was initially thought that reading ability would not influence the deaf college students' performance, since the word problems were written at the 5th to 8th grade readability levels – a range well within the measured reading ability levels of the participating deaf college students. Nonetheless, the students' problem solving performance dramatically declined as the complexity of information increased in problem sets 2 and 3 of the word condition.

Thus, it is plausible to assume that reading ability could partially explain this decline in performance with the more difficult word problems. The generally lower reading skills of deaf college students could likely have hindered their ability to recognize the similarity of the math problems in the word condition to the almost identical problems that they successfully solved in the graphic condition. Failure to recognize the similarity of the word problems to the graphic problems would have prevented them from utilizing the same skills to solve the same kind of problems that they successfully solved under the graphic condition.

The comparative analysis with respect to the reading grade levels of the participating deaf students suggests that reading ability measured at 9.3 and above contributes in part to the deaf students' performance in solving the more difficult

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The US Department of Education has recently awarded grants to three NTID projects: the MSSE program, a C-Print network project, and Project Inclusion.

The grant to the NTID Master of Science in Secondary Education of Students who are Deaf or Hard of Hearing (MSSE) program will provide tuition support to students with undergraduate degrees or majors in secondary content areas, thus preparing dually-certified teachers of secondary-level academic subjects (7-12) and of students who are deaf or hard of hearing (K-12). For more information, contact **Gerald Bateman**, program director, at *GCBNMP@RIT.EDU*.

The C-Print grant will allow **Michael Stinson** and others at NTID to develop a national network of trainers for C-Print, a real-time speech-to-print transcription system. For more information about the C-Print project, or the trainer network, contact Stinson at *MSSERD@RIT.EDU*.

math word problems. Other factors that may also contribute to deaf students' ability or inability to successfully solve math word problems will be discussed in the forthcoming full manuscript of this study.

The authors are pursuing further studies of transfer and application of computation skills for solving math word problems. These will include the examination of English words or sentence structures that either confuse or contribute to the students' understanding and successful solution of word problems. They are also interested in examining the problem solving heuristics used by deaf students at different ability levels and grade levels. Teachers and other educators who are interested in learning more about problem solving or want to get involved in problem solving research in the classroom should contact the authors.

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Project Inclusion, developed and authored by **Ken Nash** and **Jim DeCaro**, will develop a course that details the cultural, social, historical and economic forces which frame current education policies for deaf people in the US, Sweden, Greece and Holland. For more information, contact Nash at *KRNNIS@RIT.EDU*.

A website devoted to the life histories of several deaf Americans has been developed at NTID by **Gail Kovalik**. The *Gene and Inez Petersen Collection of Life Stories* is based on interviews of more than 160 deaf individuals conducted by Gene Petersen during the 1980s. The manuscript, supplemented by materials from several of the original interviewees, presents a fascinating glimpse of life in the Deaf community in the United States.

The website is at *http://www.rit.edu/~glk9638/history/index.htm*, and remains very much a work in progress. Interested in helping to locate some of the "missing individuals" or in developing curricula based on these life stories? Contact Kovalik at *GLK9638@RIT.EDU*.

Table 1

Deaf and Hard-of-Hearing RIT/NTID Student MBTI® Types (n=612)

(Discrepancies in percentages between 16 types and function types is due to rounding.)

Deaf and Hard-of-Hearing Students (N=612)

Dichotomous Preferences		**Function Types**	
E=310	51%	ST=260	42%
I=302	49%	SF=175	29%
S=435	71%	NF=70	11%
N=177	29%	NT=107	17%
T=367	60%		
F=245	40%		
P=257	42%		
J=355	58%		

ISTJ N=89 (15%)	ISFJ N=60 (10%)	INFJ N=9 (1%)	INTJ N=18 (3%)
ISTP N=46 (8%)	ISFP N=31 (5%)	INFP N=18 (3%)	INTP N=31 (5%)
ESTP N=41 (7%)	ESFP N=32 (5%)	ENFP N=26 (4%)	ENTP N=32 (5%)
ESTJ N=84 (14%)	ESFJ N=52 (8%)	ENFJ N=17 (3%)	ENTJ N=26 (4%)

Psychological Types of Deaf College Students at a Technical University: Implications for Research

By Gail A. Rothman-Marshall

Gail Rothman-Marshall is an associate professor in the Liberal Arts Support department at NTID.

Rothman-Marshall, a former counselor and Chair of Counseling Services at NTID for over 20 years, currently teaches special NTID sections of Liberal Arts Psychology and serves as NTID liaison to RIT's new Psychology major. Her graduate work was in Counseling and Educational Psychology. Research interests include student satisfaction, retention, and the implications of Psychological Type for counseling and instruction. She currently is one of 20 RIT faculty participating in a pilot of an alternative course delivery and assessment system that uses online WWW and intranet resources to supplement classroom instruction. Rothman-Marshall can be contacted at GARNCD@RIT.EDU

The Myers-Briggs Type Indicator (MBTI®) has become the most well-known and commonly used measure of psychological type. A four-letter code denotes preferences for Extroversion (E) versus Introversion (I), Sensing (S) versus Intuition (N), Thinking (T) versus Feeling (F), and Perception (P) versus Judgment (J), generated based on each subject's response. (See sidebar, p.7, for brief descriptions of these dimensions.)

There is no information on type and deaf or hard-of-hearing college students. Many counselors and educators working with deaf students may be hesitant to administer the MBTI®, which has a 12th grade reading level, since the reading level of many deaf students entering colleges in the US is considerably below this level. The MBTI® is, nonetheless, being used to assess the psychological type of deaf college students attending the Rochester Institute of Technology (RIT). The resulting Type information is used by faculty to better understand their students, and by students to better understand themselves.

This article describes data that has been collected on psychological types of deaf college students, and suggests ways to incorporate this information into research with them.

Sample

The sample consists of 612 deaf and hard-of-hearing students who have attended RIT (65 percent were enrolled in technical programs at NTID, and 35 percent were cross-registered in one of the other six colleges at RIT). There are 285 female and 327 male students in the sample. A second sample of 1,112 RIT students with normal hearing was used for purposes of comparison.

Data Collection

The MBTI® was administered to various groups of deaf RIT students in preparation for type-related workshops requested for several classes, as well as for the resident advisors, and student development educators. Collected over the course of the past 10 years, the database is continually being expanded. Assessed career interest, grade point average, choice and changes of major, attention/retention, and degree earned is available for many students in the sample.

The data on the hearing sample was collected in the fall of 1985 when the incoming freshman class at RIT was given the MBTI® as part of freshman orientation.

Descriptive Analysis of Data

A type table is the traditional way of displaying psychological type information. The type table in Table 1 (above) displays the distribution of the 16 complete Myers-Briggs types, the dichotomous preferences and the function types for the deaf sample. Table 2 (p.7) represents the same data for the hearing sample.

The students in the deaf sample show a preference for Sensing over Intuition, for Thinking over Feeling and for Judging over Perceiving. No appreciable E/I difference is apparent. Four of the 16 types, ISTJ (15%), ESTJ (14%), ISFJ (10%), and ESFJ (8%) account for almost one-half of the deaf sample and share S and J. The ST "function type," i.e., the combination of perception and judgment variables within each type, accounts for 42% of the deaf sample.

The hearing sample shows slight preferences for N and P, and a strong preference for T. As with the deaf students, there was no appreciable difference between the E and I attitudes. The four types with the most hearing subjects per cell were ISTJ (14%), ENFP (10%), ENTP (9%), and INTP (7%), with three out of the four sharing N and P. As with the deaf group, the ST function type was the most common, with 34%. While 29% of the deaf sample showed a preference for the SF function type, only 14% of the hearing students were found in this category. Conversely, while only 17% of the deaf students preferred NT, 29% of the hearing students preferred this function type.

Chart 1 (p.8) graphically compares the individual dimensions of type for deaf and hearing students. Deaf students show an overwhelming preference for sensing. A slight difference is also present for the T/F dimension, with deaf students showing slightly more preference for F than do the hearing students, although, like their hearing peers, deaf students

Table 2

Hearing RIT Student MBTI® Types (n=1,112)

(Discrepancies in percentages between 16 types and function types is due to rounding.)

Hearing Students (N=1112)

Dicotomous Preferences		**Function Types**	
E=545	49%	ST=373	34%
I=567	51%	SF=160	14%
S=533	48%	NF=259	23%
N=549	52%	NT=320	29%
T=693	62%		
F=419	38%		
P=590	53%		
J=522	47%		

ISTJ N=159 (14%)	ISFJ N=31 (5%)	INFJ N=35 (3%)	INTJ N=60 (5%)
ISTP N=75 (7%)	ISFP N=53 (5%)	INFP N=74 (7%)	INTP N=80 (7%)
ESTP N=60 (5%)	ESFP N=34 (3%)	ENFP N=109 (10%)	ENTP N=105 (9%)
ESTJ N=79 (7%)	ESFJ N=42 (4%)	ENFJ N=41 (4%)	ENTJ N=75 (7%)

Descriptions of Type Preferences

Attentional Attitude and Source of Energy
Extraversion (E): focus on outside world, enthusiastic, expressive, initiator, action-oriented, breadth of interests
Introversion (I): focus on inner world, intimate, quiet, contained, reflective, receptive

Information Gathering
Sensing (S): concrete, traditional, literal, methodical, exact, factual, cautious
Intuition (N): abstract, unconventional, intellectual, theoretical, original, focuses on possibilities, adventurous, insightful

Decision-Making
Thinking (T): objective, skeptical, logical, demanding, critical, analytical, blunt, opinionated, argumentative, exact
Feeling (F): subjective, accepting, appreciative, considerate, tolerant, lenient, sentimental, warm, sympathetic, empathic, tactful

Lifestyle Attitudes
Judging (J): organized, structured, methodical, decisive, expedient, likes tested routines, pragmatic, plans ahead, seeks closure
Perceiving (P): spontaneous, disorderly, changeable, adventurous, forgetful, easy-going, uncomfortable with routine.

are decidedly more T than F.

The four “function types” in Chart 2 (p.8) are an indication of cognitive or learning styles, and appear to have more potential for exploring salient differences between these two groups. Chi-square analysis of the function types for deaf and hearing students indicated a significant difference ($p<.1$).

Deaf students are similar to their hearing peers on both the E/I and J/P dimensions. The disparity on the S/N dimension and the comparatively high number of SF students within the deaf sample suggests that deaf students, as a group, are somewhat different from their normal hearing RIT peers.

Type and Attrition

Baudouin and Uhl (1998) found that “Ss, SFs, and ESFPs were significantly over-represented among nonpersisters.” Provost (1985) found ISTPs at risk at a four-year liberal arts college. Anchors, et al. (1989) found ENFPs to be less likely to persist at a public four-year college. And Rothman (1988) found that the NF group showed the highest risk of leaving RIT, perhaps because there are only a few career areas offered at this highly technologically-oriented university that appeal to the typical ENFP. These and attrition studies of other student characteristics indicate that person-environment fit issues can signal the need for intervention.

Type and Teaching Style

The strong sensing preference within the deaf population indicates the need for a modification of the traditional lecture style of teaching common in higher education. For most NTID programs, much of the theory, which is normally taught before skills in most college programs, comes later, after mastery of basic skills learned through hands-on work in the lab or studio, and practical application through cooperative work experience. This supports the S student’s learning style preference for repetition and practice, and to create tangible products.

Although lecturing is unavoidable, other strategies such as small group discussions, projects, peer tutoring, lab work and occasional classroom competitions are a better fit with the S learning style of the deaf sample. The relationship between type, learning style, teaching style and such variables as academic achievement and persistence are potentially fruitful areas of research and should be examined.

Type, Academic Advising and Career Counseling

Grade Point Average (GPA) and type was investigated for 346 of the 612 subjects in the deaf sample. The highest average GPA (3.1) was achieved by type INFJ, with only four students. The 38 ENFP students achieved the lowest average GPA (2.1). Areas that could be investigated include the fit between programs offered and the student body, student satisfaction with a teaching style geared to the majority _STJ student preference, or the interaction between type, English level and career choices available. The relationships between type and success in various programs could be made available to faculty advisors and counselors to implement appropriate interventions.

Future Plans

This research is an on-going process. Additional data will be collected before any strong conclusions are inferred. Type data from deaf students attending colleges with a more liberal arts emphasis, e.g., Gallaudet University or California State University at Northridge needs to be collected and compared to this sample before making inferences about deaf college students in general and determining various environment-fit factors within each type of college environment. The study of type in relation to such variables as student retention, cognitive style, teaching-learning style interaction, social integration, and satisfaction with the college experience might also yield useful information. Perhaps even more basic is the need to validate the MBTI® with a deaf population and to explore ways to insure that type results truly reflect the preferences of this group.

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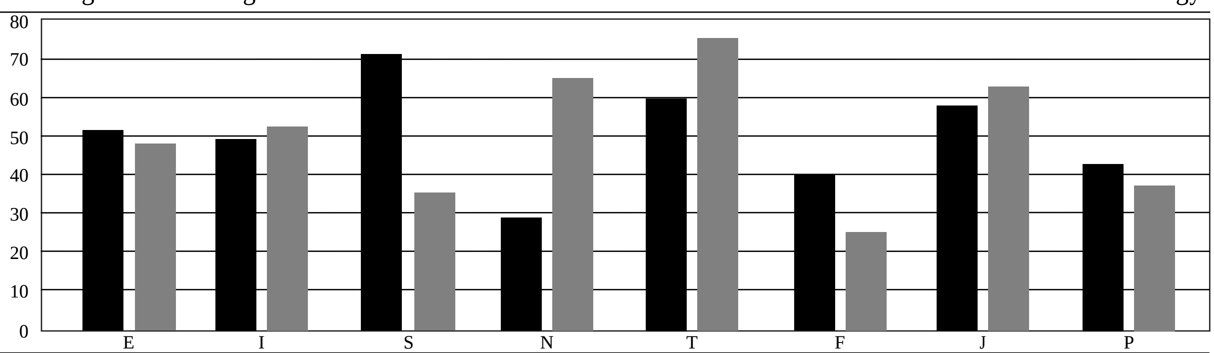
Chart 1

Comparison of Hearing and Deaf Students at RIT on the Eight Dimensions of Type

See article on p.6

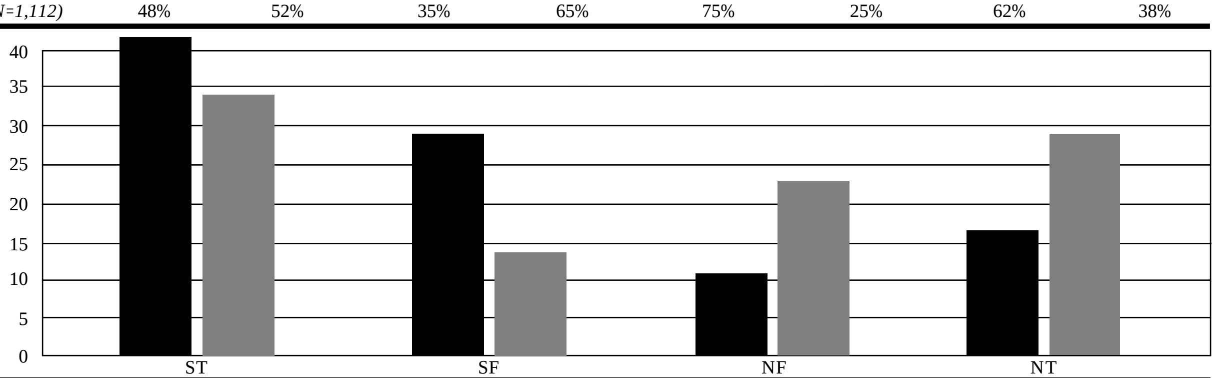


	E	I	S	N	T	F	J	P
■ *Deaf RIT Students (n=612)*	51%	49%	71%	29%	60%	40%	58%	42%
■ *1985 Hearing RIT Freshmen (N=1,112)*	48%	52%	35%	65%	75%	25%	62%	38%

Chart 2

Hearing and Deaf Function Types (Learning and Decision-making Styles)

See article on p.6



	ST	SF	NF	NT
■ *Deaf RIT Students (n=612)*	*42%*	*29%*	*11%*	*17%*
■ *1985 Hearing RIT Freshmen (n=1,112)*	*34%*	*14%*	*23%*	*29%*

IMPLICATIONS OF NTID RESEARCH

FOR DEAF AND HARD-OF-HEARING PEOPLE • NTID RESEARCH BULLETIN

Vol. 4 No. 3 Fall 1999

In 1993, the National Technical Institute for the Deaf established the Center for Research, Teaching and Learning. A primary mission of the Center is to "foster advances in teaching and learning that enhance the academic, professional, social and personal lives of people who are deaf or hard of hearing." Among its other functions, the Center both conducts research relevant to that goal and supports research conducted by colleagues from across NTID.

As part of our collaborative efforts, the Center regularly undertakes the collection and dissemination of relevant research findings from across NTID. Included for each publication is a description of the implications of the research findings the author thinks will be most relevant for NTID's audiences.

Berent, G.P. (1996). The acquisition of English syntax by deaf learners. In W. Ritchie & T. Bhatia (Eds.), *Handbook of Second Language Acquisition* (pp. 469-506). San Diego: Academic Press.

This chapter reviews the existing research on English syntax acquisition by deaf learners. Based on recent theoretical developments in linguistics, it offers a new theory-based approach to understanding the impact of deafness on English language acquisition. Many of the English structures that are difficult for deaf children and adults to acquire (questions, relative clauses, auxiliary verbs, articles, quantifiers, etc.) involve "functional categories," including complementizer, inflectional, and determiner phrases. Many deaf learners learn the "lexical categories" that the functional categories contain (nouns, verbs, etc.) but not the functional categories themselves. Therefore, many deaf learners learn "smaller" languages due to the limited access they have to spoken language input.

Implications:

Much of the previous research on the English language knowledge of deaf children and adults has identified and described English language structures that cause deaf students difficulty, but it has not generally explained the relative difficulties among syntactic structures. This chapter exposes teachers of deaf students to recent developments in linguistics and offers a principled view of the variation in deaf students' English language knowledge. It also underscores the need for more research on deaf children's English language acquisition and on finding better methods for facilitating the learning of English in educational settings.

Clymer, E., & McKee, B. (1997). The promise of the world wide web and other telecommunication technologies within deaf education. *American Annals of the Deaf, 142*(2), 104-106.

This article summarizes a national survey on the instructional technology resources available at schools serving deaf students in the U.S. One of the objectives of the survey was to determine the capability of schools to participate in distance learning activities through the Internet. Over 70% of the schools have Internet and World Wide Web access for deaf students. Because access to instructional technologies is only a part of an educational solution, this article also explores some innovative uses of the Internet and provides examples of

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Opinions expressed in the *NTID Research Bulletin* do not reflect those of NTID or RIT. Your comments, questions, and requests for information are welcome.

specific applications for deaf students.

Implications:

Teachers who have convenient and regular access to technologies such as the Internet and the WWW and, more importantly, the skills to use such technologies, can offer a variety of new instructional options for their students. Those of us who work with teachers of the deaf as researchers, instructional developers, and teacher trainers need to stay abreast of such technologies. How we can most effectively train ourselves, the instructors with whom we work, and our deaf students is an issue that we have yet to resolve.

Mousley, K., & Kelly, R.R. (1998). Problem-solving strategies for teaching mathematics to deaf students. *American Annals of the Deaf, 143(4), 325-336.*

Three different teaching and learning strategies for problem solving were implemented with first and second year deaf college students enrolled in math courses at NTID. Students were asked to 1) explain a problem to a peer observer in sign language and then write their understanding of the problem and its solution; 2) visualize their problem-solving process before starting to solve the problem; and 3) observe their teacher modeling the analytical process before attempting to solving math word problems. Students were asked to solve two types of problems – typical math word problems and a visual/manipulative puzzle – presented in text format.

Implications:

Although reading levels can influence explanations of problems and their solutions, the problem-solving performance of deaf college students can be positively influenced with instructional strategies, such as applying a procedural model that was demonstrated by the teacher. Strategies that are designed to get the students to think more carefully prior to trying to solve a problem are also beneficial. These strategies would also appear to be appropriate and applicable to high school deaf students who are college bound, because they should be capable of reflective and analytical thinking. A number of related suggestions for improving problem-solving skills are presented and discussed.

If you would like to obtain information in an area beyond what you see listed, you can write to the first author of closely related papers, c/o NTID. If you are unable to obtain one of the publications on this sheet from your local library, you may send this form to: Educational Technologies Resource Room, National Technical Institute for the Deaf, 52 Lomb Memorial Drive, Rochester, NY 14623-5604.

____ *Berent,G.P. The acquisition of English syntax by deaf learners*

____ *Clymer, E., & McKee, B. The promise of the world wide web and other telecommunication technologies within deaf education*

____ *Mousley, K., & Kelly, R.R. Problem-solving strategies for teaching mathematics to deaf students*

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