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ABSTRACT

This project identified over 500 critical incidents of successful and unsuccessful instruction in science and mathematics courses reported through interviews of 105 blind college students. The principal categories of effective teacher behavior included planned concrete learning experiences, creative use of learning materials, and detailed descriptions/instructions. Principal consequences of effective teacher behaviors included cognitive learning and emotional satisfaction with the learning process. Reasons for positive perception of the learning process included being provided with access to information, enhanced motivation/interest, social interaction, and flexible time allotments. Ineffective teacher behaviors included absense of detailed directions/explanations, lack of planned concrete learning experiences, and inappropriate materials, resulting in reduced learning and dissatisfaction with the learning process due to lack of access to information and reduced interest/motivation. Students indicated that although they believe the teacher is the key factor in instruction, they themselves must accept responsibility for improving their own learning. Demographic analysis revealed the existence of a pool of blind students who might pursue studies in science, but who avoid mathematics. These critical incidents may be used to improve instructional practices to help blind students progress in science and mathematics courses at the post-secondary level. (Author/JN)

BLIND PERSONS REPORT

CRITICAL INCIDENTS

OF

SCIENCE AND MATHEMATICS INSTRUCTION

FUNDED BY THE NATIONAL SCIENCE FOUNDATION

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TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

TABLE OF CONTENTS (cont'd)

ABSTRACT

This project identified over 500 critical incidents of successful and unsuccessful instruction in science and mathematics courses reported through interviews of 105 blind college students. The principal categories of effective teacher behavior are planned concrete learning experiences, creative use of learning materials, and detailed descriptions and explanations. The principal consequences of the effective teacher behaviors are increased cognitive learning and emotional satisfaction with the learning process. Their reasons for positive perception of the learning process include being provided with access to information, enhanced motivation and interest, social interaction, and flexible time allotments. Ineffective teacher behaviors include absence of detailed descriptions and explanations, lack of planned concrete learning experiences, and inappropriate materials. The consequences are reduced learning and dissatisfaction with the learning process because of lack of access to information and reduced interest and motivation. Their suggestions for improving instruction indicate that although they believe the teacher is the key factor in instruction, they themselves must accept responsibility for improving their own learning. The demographic analysis reveals that there exists a pool of blind students who might pursue studies in the sciences, but they avoid mathematics. The critical incidents may be used to improve instructional practices and meet the needs of this group.

BLIND PERSONS REPORT CRITICAL INCIDENTS OF SCIENCE AND MATHEMATICS INSTRUCTION

I. Introduction

The Purpose and Procedure

The purpose of this project is to discern factors which help and hinder blind students' progress in science and mathematics courses at the post-secondary school level of instruction. One hundred and five blind persons in Southern California were interviewed to record on tape critical incidents of successful and unsuccessful science and mathematics teaching which they experienced. The research procedure employed a modified version of the Critical Incident Technique described by John C. Flanagan.[1]

Identification of the Sample

During the months of January and February of 1980, the investigator communicated with agencies concerned with education and/or rehabilitation of the blind. Included were Centers for handicapped student services at community colleges, four-year colleges, and universities, offices of the Braille Institute, and offices of state vocational rehabilitation services. While all of the institutions and agencies provided

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[1]John C. Flanagan, "The Critical Incident Technique", Psychological Bulletin, 51 (July, 1954), 327-358

valuable assistance, the most prolific sources for recruitment of the sample were the centers for handicapped student services at the several institutions of higher education. In addition, blind persons who were interviewed also suggested friends who might wish to participate.

The sample upon which this study is based consists of 105 blind persons, virtually all of whom are either totally blind or have very low vision. Sixty percent of the group are males. Additional background information relating to the sample was also obtained. Of particular interest were reports of the group's predisposition and exposure to science and mathematics courses. The tabulated demographic characteristics of the sample are given as Appendix A. An intensive analysis of significant characteristics of the sample that are relevant to education in the sciences and mathematics is presented later in this report.

Training of Interviewers

The staff of interviewers included the principal investigator and students who attended California State University, Fullerton. All had experience with laboratory science courses in college and in high school. Four students were totally blind, and the fifth, who was legally blind, had very low vision. A person with normal vision also conducted interviews, and in addition, assisted with the transportation of blind persons, arranged interviews, and performed clerical tasks. The blind persons were upper class

university students, while the sighted person was a recent graduate with a degree in Human Services.

The training program consisted of first familiarizing the team of interviewers with survey procedures and the use of the Critical Incident Technique. Then the principal investigator held sessions in which he interviewed and tape recorded in turn each of the blind members of the team.[2] Those who witnessed the interview used Brailled copies of the interview schedule to follow the line of questioning. After each demonstration, the team asked questions relative to the technique and at times, parts of the tapes were re-run for special examination, criticism, and suggestions for improvement. In this manner the interviewers had an opportunity to participate in the development and improvement of the interview schedule, particularly with respect to formulating probing questions. After all of the blind persons were themselves interviewed, they practiced interviewing one another by means of the Brailled schedule of questions. In addition, they accompanied the principal investigator to other locations and witnessed his interviews of persons who were amongst the first group of participants to be sampled.

Interviewing the Participants

All of the interviews took place during the year 1980 primarily in three counties of Southern California: Orange,

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[2]When the person who was legally blind withdrew from the project, he was replaced by a totally blind person who was given individual training. This person attended California State University at Long Beach.

Los Angeles, and Riverside. About half of the interviews took place at facilities provided by cooperating institutions of higher learning. Most of the others took place in the homes of the persons who were interviewed. Each interview was of approximately one hour duration.

The interviewers employed a schedule of questions which was standardized so that, as nearly as possible, comparable information could be obtained from each interviewee. It included both demographic information and a set of questions which is given in outline form below. In addition to the broad questions, "follow-up" questions were also included to assist in probing for more detailed information. The blind interviewers used a Brailled copy of the schedule of questions.

However, although this procedure was appropriate for obtaining information relating to the Critical Incidents, it was rather cumbersome and time-consuming to record the demographic information on tape. Therefore, after the first fifteen interviews took place, the procedure was changed. Thereafter, the principal investigator or the sighted assistant acquired the demographic information from the interviewees and then recorded their responses directly on the schedule of questions.

Each person who interviewed a blind individual did so in the presence of the principal investigator, except in a few rare instances when this was not possible because of conflicts in schedule. The role of project director was principally that of an aide to both the blind interviewer and

the interviewee to assist them in overcoming either mechanical problems with the tape recorder or inconveniences of the environment. Nevertheless, there were times when it was necessary for the principal investigator to interrupt the interview because of unnecessary departures from the schedule of questions or when time to complete the interview was running short. Since all of the blind assistants were enrolled in University classes and because most interviews took place more than twenty-five miles from the California State University campus, the interviewers were not always available for conducting interviews. Hence, approximately 50 percent of the interviews were conducted by the project director himself.

OUTLINE OF THE SCHEDULE OF QUESTIONS
EMPLOYING THE CRITICAL INCIDENT TECHNIQUE[3]

1. Interview #_____

2. _____Effective
_____Ineffective

3. What the teacher did:

4. Where the incident occurred:

5. Context in which it occurred:

6. Why the incident was critical to learning:

7. New learning, understanding, etc., that resulted:

8. Suggestions which might help teachers improve learning for students:

9. Why these suggestions will promote science learning:

10. How they might lead to understanding:

[3]For a full copy of the schedule which includes probing questions as well, please see Appendix B.

Processing Information from Tapes

The information which was recorded on tapes had to be processed in order to put it in a proper form for presentation, organization, and analysis. To accomplish this task, the interview outline which was previously presented served as the guide for studying the tapes and describing the critical incidents that were reported. Each incident was typed in a standard report format consisting of: (1) the interviewee number; (2) type of incident, effective or ineffective; (3) description of the incident; (4) location; (5) context in which incident occurred; (6) the reason for judging the incident as effective or ineffective; and (7) the consequence of the incident for the student. The standard Critical Incident report sheets were subsequently transcribed into Braille and also recorded on tape.

A total of 504 Critical Incidents were identified as effective and ineffective teacher behaviors. In addition, the respondents were generous in providing helpful suggestions which they believed teachers and blind students might use in improving instruction and learning in science and mathematics courses. Finally, many of the respondents also provided information about their experiences in Schools for the Blind, "Mainstream" classes, and resource room situations.

Development of the System of Categories

In order to prepare the data for presentation and analysis, the incidents were classified, inductively, into a system of categories. In constructing this classification system, samples of incidents were first read and then each

was compared with another to determine whether it was alike or different. Those that appeared to be alike were categorized as one group. Then the remaining incidents were classified, and a written description of each of the categories was made. Next, a consultant and the principal investigator each reclassified the reports of Critical Incidents in accordance with the written descriptions of each category.

In instances where there was disagreement between the "classifiers" concerning the category to which a given incident belonged, the reason for the discrepancy was discussed, and then the "classifiers" decided by mutual consent into which category the incident should be classified. Where agreement was not possible, the category description was revised to accommodate the incident. In this manner a more refined classification scheme was developed. A description of each category is given as Appendix C.

In a similar manner, two additional classification schemes were developed: categories of consequences of incidents and categories of reasons for judging the critical incidents as effective and ineffective. Descriptions of the categories of each of the two classification schemes are given as Appendices D and E, respectively. After the three basic classification schemes were developed, the data were then tabulated. The basic information is presented in Tables 1 through 5 inclusive, in Appendix F.

The categories of effective and ineffective Critical Incidents, the consequences of the incidents, and the reasons

given for judging the incidents as effective or ineffective are given in the following chart. The number which is associated with each category indicates its rank according to frequency of response. In the next section of this report, the basic data will be presented systematically and then analyzed more intensively.

RANK ORDER OF THE CATEGORIES OF CRITICAL INCIDENTS, CONSEQUENCES, AND REASON

INCIDENTS	CONSEQUENCES	REASONS
Category	Category	Category
1. The teacher planned and devised appropriate concrete learning experiences	1. Mastery of Information, concepts, procedures, or skills, including confidence in ability to function in science and mathematics	1. Provided access to information through detailed verbal communication
2. The teacher provided appropriate learning materials	2. Emotional satisfaction with learning experience in science and mathematics	2. Provided opportunity to perceive information through non-visual exploration
3. The teacher provided detailed verbal description and explanation	3. Motivation to pursue further study of science and mathematics	3. Provided increased motivation, interest and intellectual or physical participation in learning
4. The teacher gave individual attention to instructional needs	4. Integration of learning into a larger system, including application of learning to life situation	4. Provided opportunity to perceive information visually and aurally through mechanical aids and special adaptations
5. A reader, teaching assistant, sighted partner, or tutor provided help to facilitate learning	5. Discovery of alternative means of learning in place of the instructor	5. Provided experience in interacting with the instructor and with peers as an equal member of the group
6. The teacher's personal attributes helped establish a comfortable learning environment	6. Communication of needs to the instructor to establish a working relationship with him	6. Provided additional time to complete tasks and gave evaluative information simultaneously while performing an activity
7. The teacher employed appropriate evaluation and grading procedures		
8. The teacher provided special assistance outside of class		
9. Administrative adaptations were made to facilitate learning		

II

PRESENTATION AND ANALYSIS OF BASIC DATA

Broad Categories

In general, what is the nature of the critical incidents that are reported? The frequency of incidents, classified within nine categories are given in Appendix F, (Tables 1-3).

The nine categories of effective and ineffective incidents can be regrouped into four broad categories of educational activity. Table 1 below shows that the major portion of the incidents, 81%, involve teacher-initiated behavior (or the lack of it) which is cognitively oriented. In addition, the ratio of effective to ineffective critical incidents is about two to one. It is apparent that when blind persons were given the opportunity to ponder their experiences in science and mathematics courses, their recollections seemed to be more positive than negative.

Table 1

Broad Categories of Critical Incidents of
Effective and Ineffective Teaching
Reported by Blind Students

Incidents	Effective	Ineffective	Sum	% of Total Incidents
A. Teacher-Initiated Behavior, cognitively oriented (categories 1, 2, 3, 4, 7, 8)	274	136	408	81
% of Sum	80%	82%		
B. Non-Professional Instruction, cognitively oriented (category 5)	37	8	45	9
% of Sum				
C. Teacher Behavior, Affectively oriented (category 6)	21	16	37	7
% of Sum				
D. Administrative Arrangements (category 9)	9	5	14	3
% of Sum				
Total Number of Incidents	341	163	504	100
	(67.6%)	(32.3%)	(100%)	

Presentation of the principal categories of effective critical incidents, consequences, and reasons.

The principal categories of effective critical incidents are defined as the upper third of the nine categories.[4] These include 188 or 55% of the effective critical incidents. Ninety-three persons reported 341 effective incidents. Fifty-five percent of the incidents are included in the three categories given in Table 2.

Table 2. Principal Categories of Effective Critical Incidents

The Teacher: Category	No. of Incidents	% of Total Effective Incidents, N=341
1. Planned and devised appropriate concrete learning experiences.	73	21.4
2. Provided appropriate learning materials.	75	22.0
3. Provided detailed verbal description and explanation.	40	11.7
	188	55

The principal categories of consequences of the effective critical incidents are defined as the upper third of the six categories.[5] These include 282 of the 341 consequences reported. Eighty-three percent of the consequences of effective incidents are included in the two categories given in Table 3.

[4]Appendix F, (Table 1).

[5]Appendix F, (Table 4).

Table 3. Principal Categories of Consequences of Effective Critical Incidents

	Number of Consequences	% of Total Consequences, N=341
The Student acquired:		
Category		
1. Mastery of information concepts, procedures, or skills, including confidence in ability to function in science and mathematics.	230	67.4
2. Emotional satisfaction with learning experiences in science and mathematics.	52	15.2
	282	83

The principal categories of reasons for judging critical incidents to be effective are defined as the upper third of the six categories of reasons.[6] These include 169 of the 340 reasons given. Approximately fifty percent of the reasons are included in the two categories presented in Table 4.

[6]Appendix F, (Table 5).

Table 4. Principal Categories of Reasons for Judgment of Critical Incidents as Effective

	Number of Reasons	% of Total Reasons, N=340
The Experience:		
Category		
1. Provided access to information through detailed verbal communication.	82	24.1
2. Provided opportunity to perceive information through non-visual exploration	87	25.6
	169	50

Presentation of the principal categories of ineffective critical incidents, consequences, and reasons.

The principal categories of ineffective critical incidents are defined as the upper third of the nine categories. These include 100 or 61% of the ineffective critical incidents. Seventy-eight persons reported 163 ineffective incidents. Sixty-one percent of the incidents are included in the three categories given in Table 5.

Table 5. Principal Categories of Ineffective Critical Incidents

The teacher had not Category	Number of Incidents	% of Total Ineffective Incidents, N=163
1. Planned and devised appropriate, concrete learning experiences.	34	20.8
2. Provided appropriate learning materials.	24	14.7
3. Provided detailed verbal descriptions and explanations	42	25.7
	100	61

The principal categories of consequences of ineffective critical incidents are defined as the upper third of the six categories. These include 115 of the 163 consequences reported. Seventy percent of the consequences of ineffective incidents are included in the two categories given in Table 6.

Table 6. Principal Categories of Consequences of Ineffective Critical Incidents

The Students had not acquired:	Number of Consequences	% of Total Consequences, N=163
Category		
1. Mastery of information concepts, procedures, or skills, including confidence in ability to function in science and mathematics.	71	43.5
2. Emotional satisfaction with learning experiences in science and mathematics.	44	26.9
	115	70

The principal categories of reasons for judging critical incidents to be ineffective are defined as the upper third of the six categories of reasons. These include 97 of the 162 reasons given. Approximately 60 percent of the reasons are included in the two categories given in Table 7.

Table 7. Principal Categories of Reasons for Judgment of Critical Incidents as Ineffective

	Number of Reasons	% of Total Reasons N=162
Category		
1. Lack of access to information through detailed verbal communication.	52	32.1
3. Reduced motivation, interest, and intellectual or physical participation in learning.	45	27.7
	97	60

In the previous part of this section, Tables 2 through 7, inclusive, have presented the principal categories of effective and ineffective critical incidents, together with the principal categories of consequences of the critical incidents and the principal categories of reasons for judging the incidents to be effective or ineffective. With the basic descriptive information thus presented, Tables 8 through 13, inclusive, will be presented in the remaining portion of this section in order to analyze relationships between categories by means of cross-tabulations of data.

Analysis of the significant consequences of the principal critical incidents, effective and ineffective.

A cross tabulation of the upper third of the categories of the effective incidents and the categories of the consequences may reveal the significant consequences of the principal categories of effective incidents. Ninety-three persons reported one or more incidents and the consequence of each. The significant consequence of the incident is defined as the cell of the categories of consequences in which at least 50% of the consequences of the principal incident are located. The relationship between the three principal categories of effective incidents and their significant consequence is given in Table 8.

In like manner, a cross tabulation of the upper third of the categories of ineffective incidents and the categories of the consequences may reveal the significant consequences of the principal categories of ineffective incidents. Seventy-eight

persons reported one or more incidents and the consequences of each. The relationship between the three principal categories of ineffective incidents and their significant consequence is presented in Table 9.

Table 8 is based upon a cross-tabulation of the total of effective incidents and consequences. It indicates what the blind students perceived to be the consequences of the effective teacher behaviors that they reported. It is apparent that when the teachers provide appropriate materials (Category 1), plan creative concrete learning experiences (Category 2), and communicate well (Category 3), the principal consequence is increased cognitive learning. On the other hand, Table 9 shows that the principal consequence of the absence of these three categories of teacher behavior is decreased cognitive learning.

Table 8

BASED UPON A CROSS TABULATION
OF THE TOTAL OF EFFECTIVE INCIDENTS AND CONSEQUENCES
N = 341

Category of Incident:	Number and Percentage in Category of Consequence: Mastery of Information, concepts, procedures, or skills, including confidence in ability to function in science and mathematics.	Other	Total
The Teacher:			
1. Provided appropriate learning materials.	48 65%	26 35%	74 100%
2. Planned and devised appropriate concrete learning experience.	43 59%	30 41%	73 100%
3. Provided detailed verbal descriptions and explanation.	32 80%	8 20%	40 100%
	TOTAL		187

Table 9

BASED UPON A CROSS TABULATION OF THE
TOTAL OF INEFFECTIVE INCIDENTS AND CONSEQUENCES
N=163

Category of Incident:	Number and Percentage in Category of Consequence: Lack of Mastery of Information, concepts, procedures, or skills, including confidence in ability to function in science and mathematics.	Other Five Categories	Total
The teacher had not:			
Category			
1. Planned and devised appropriate concrete learning experiences.	19 56%	15 44%	34 100%
2. Provided appropriate learning materials	13 54%	11 46%	24 100%
3. Provided detailed verbal description and explanation	20 48%*	22 52%	42 100%
TOTAL			100

*This value is sufficiently close to the 50% criterion to warrant its use, cautiously.

Analysis of the significant reasons for judging the principal critical incidents as effective and ineffective.

A cross tabulation of the upper third of the categories of the effective incidents and the categories of the reasons may reveal the significant reasons blind persons give for judging the principal categories of incidents to be effective. The significant reason is defined as that cell of the categories of reasons in which 50% of the reasons for judgment of a principal category of incident is located. The relationship between the three principal categories of effective incidents and the significant reasons for judging them to be effective is presented in Table 10.

In like manner a cross tabulation of the upper third of the categories of the ineffective incidents and the categories of the reasons may reveal the significant reasons blind persons give for judging the principal categories of incidents to be ineffective. The relationship between the three principal categories of ineffective incidents and the significant reasons for judging them to be ineffective is presented in Table 11.

An examination of Table 10 indicates that blind persons believe teachers are most effective when they give the student access to information either through detailed description and explanation (Category 1) or through non-visual, tactual exploration (Category 2). On the other hand, Table 11 shows that they judge teaching to be ineffective when the teacher does not give them access to information through detailed verbal communication

(Category 1), or when because of the teacher they are either less motivated to learn or are unable to participate actively in the learning process (Category 3).

Table 10

BASED UPON A CROSS TABULATION
OF THE TOTAL OF EFFECTIVE INCIDENTS AND REASONS

N=340

Category of Incident:	Number and Percentage in Category of Reason 1. Provided Access to information through detailed verbal description and explanation.	2. Provided opportunity to perceive information through non-visual exploration.	Other	Total
The Teacher:				
1. Provided appropriate learning materials.		37	36	73
		51%	49%	100%
2. Planned and devised appropriate concrete learning experiences.		35	38	73
		48%*	52%	100%
3. Provided detailed verbal description and explanation.	30		10	40
	75%		25%	100%
	TOTAL			187

*The value is sufficiently close to the 50% criterion to warrant its use, cautiously.

Table 11

BASED UPON A CROSS TABULATION OF THE
TOTAL OF INEFFECTIVE INCIDENTS AND REASONS
N=162*

Category of Incident:	Number and Percentage in Category of Reason 1. Lack of access to information through verbal communication.	2. Reduced motivation, interest, and intellectual or physical participation in learning.	Other Categories	Total
The teacher had NOT:				
Category				
1. Planned and devised appropriate concrete learning experiences.		19 56%	15 44%	34 100%
2. Provided appropriate learning materials.				24 100%
3. Provided detailed verbal description and explanation.	31 76%		10 24%	41 100%

*One reason is invalid.

Analysis of the reasons that are associated with the predominant category of consequences of critical incidents, effective and ineffectiv

The final analysis in this section is concerned with the reasons why blind persons believe academic mastery seems to occur. A cross tabulation of the categories of reasons for judging incidents as effective or ineffective with the predominant category of consequences of the critical incidents may reveal the subjects' perceptions of why the critical incidents had certain results. An examination of Table 3 indicates that of the 341 consequences of effective critical incidents, 230 are in Category 1 alone: Mastery of Information, Concepts, Procedures, and Skills, including confidence in ability to function in science and mathematics. This is 67% of the total number of consequences of effective critical incidents. Also included in Category 1 are 71 or 43% of the consequences of ineffective critical incidents. This information is given in Table 6.

Table 12 which follows next, is based upon a cross tabulation of the principal category of consequences of effective incidents, Category 1, and the six categories of reasons. An examination of the table reveals that although the reasons which blind persons give for their increased cognitive learning appear to be spread out across the set of categories, three appear to stand out. Blind persons indicate that learning took place when they were given access to information through detailed verbal communications from instructors (Category 1). In addition, learning took place because they were given the opportunity to perceive information through non-visual (tactual) exploration

(Category 2) and because of the availability of special visual and aural mechanical aids and adaptations (Category 4). However, Table 12 also indicates that there were three additional reasons for increased learning: teacher behaviors that enhanced motivation and active participation in the learning process (Category 3), personal interaction with the instructor and with peers (Category 5), and having been given either additional time to complete assignments or appropriate evaluative feedback during the learning process (Category 6). It seems that when teachers do engage in activities which promote cognitive learning for blind persons, a variety of reasons for positive perception of the learning process appears.

Table 12

BASED UPON A CROSS TABULATION OF THE

CONSEQUENCES OF TOTAL EFFECTIVE INCIDENTS

AND THE REASON GIVEN

N=340*

Category of Reason:	Number and Percentage in Category of Consequence Mastery of information, concepts, procedures, or skills, including confidence in ability to function in science and mathematics.	%
The student had experienced:		
1. Access to information through detailed verbal communication.	60	26%
2. The opportunity to perceive information through non-visual exploration.	54	23%
3. Increased motivation, interest and intellectual or physical participation in learning.	28	12%
4. The opportunity to perceive information visually and aurally through mechanical aids and special adaptations.	42	18%
5. Interaction with the instructor and with peers as an equal member of the group.	26	11%
6. Additional time to complete tasks and was given evaluative information simultaneously while performing an activity.	20	9%
TOTAL	230	99%

*One reason is invalid.

Table 13 indicates that the reasons given for reduced cognitive learning are also spread out across the set of categories, but two appear to stand out. In particular, the students believe that they failed to learn because they were denied access to information as a result of inadequate verbal communications from instructors (Category 1). In addition, students attribute lack of learning to teacher behavior that either reduced motivation to learn or did not afford them the opportunity to participate actively in the learning process (Category 3). Other reasons for reduced learning include the absence of opportunity to acquire information tactually (Category 2), lack of special visual and aural mechanical aids and adaptations (Category 4), lack of opportunity to interact with instructors and peers (Category 5), and either insufficient time to complete tasks or inappropriate evaluative feedback during the learning process (Category 6). It seems that when teachers do not engage in activities that result in improved cognitive learning for blind persons, a variety of reasons for negative perception of the learning process appears.

Table 13

BASED UPON A CROSS TABULATION OF THE

CONSEQUENCES OF THE TOTAL INEFFECTIVE INCIDENTS

AND THE REASON GIVEN

N=162*

Category of Reason:	Number and Percentage in Category of Consequence Lack of mastery of information, concepts, procedures, or skills, including confidence in ability to function in science and mathematics.	
		%
The student did not experience:		
1. Access to information through detailed verbal communication.	24	34%
2. The opportunity to perceive information through non-visual exploration.	9	13%
3. The motivation, interest and intellectual or physical participation in learning.	19	27%
4. The opportunity to perceive information visually and aurally through mechanical aids and special adaptations.	8	11%
5. Interaction with the instructor and with peers as an equal member of the group.	6	8%
6. The additional time to complete tasks and was not given evaluative information simultaneously while performing an activity.	5	7%
TOTAL	71	100%

*One reason is invalid.

SUMMARY

Within this section of the report categories of critical incidents, their consequences, and reasons for judging incidents as effective or ineffective are presented. The major portion of the incidents involve teacher oriented behavior (or the absence of it) which is cognitively oriented. Since the ratio of effective to ineffective incidents is about two to one, one may assume that the recollection of science and mathematic experiences offered by the blind persons is generally positive.

For the most part, the blind persons perceive effective teaching as involving carefully planned concrete learning experiences, the use of appropriate concrete learning materials, and detailed verbal description or explanation. The principal consequence of such teacher behavior is increased cognitive learning, while a secondary consequence appears to be emotional satisfaction with the learning process. Among the reasons blind persons give for judgment of effective teacher behavior, two stand out: learning takes place when blind persons are given access to information through detailed verbal communications from instructors and when they are given the opportunity to perceive information through non-visual tactual exploration.

The blind persons perceive ineffective teaching principally as absence of the instructor's use of detailed verbal descriptions and explanations, lack of carefully planned concrete learning experiences, and failure to provide appropriate learning materials.

The predominant consequence of such ineffective teaching behavior is reduced cognitive learning, while a secondary consequence is a lack of emotional satisfaction with the learning process. The reasons for judgment of ineffective teaching are quite varied, but two stand out: blind persons judge teaching as ineffective when they are not given access to information through detailed verbal communication or when because of the teacher they are either less motivated to learn or are unable to participate actively in the learning process.

The predominant consequence of both the effective or ineffective incidents relates to cognitive learning. When the set of categories of reasons is associated with Category 1, the predominant category of consequences of effective and ineffective incidents, the reasons which blind persons give for their increased or diminished cognitive learning are spread out across the set of categories of reasons. It seems that when teachers engage in activities which promote cognitive learning, a variety of reasons for positive perception of the learning process appears. When they do not, blind persons also offer a variety of reasons for their negative perception of the learning process.

The Challenge of Improving the Learning of the Blind: Objectives of a program.

In the previous portion of Section Two of this report analyses of the critical incidents were made. The results provided direction concerning the kinds of behaviors teachers might engage in to improve the learning of blind people in science and mathematics courses. In the ensuing pages of this section, additional data will be presented. Through an analysis of the suggestions blind persons give for improving instruction, it may be possible to identify the individuals or groups within post-secondary institutions whose activity might lead to improved learning for the visually impaired.

When the blind persons were asked to suggest ways in which their learning might be improved, ninety-seven persons responded with one or more. A total of 347 suggestions were then classified inductively according to the blind persons' perception of individuals or groups whose behavior might contribute to their learning. Through the use of this criterion for classification, six categories were identified: (1) the instructional staff, (2) the blind students themselves, (3) the administration, (4) non-professional aides, (5) guidance personnel, and (6) a small number of non-classifiable items. The frequency and percentage within each category is given in Table 14.

Table 14. Agents Responsible for Improvement of Instruction

Learning will be improved through:	Number	%
1. Activities or predispositions of the instructional staff and laboratory assistants.	120	35
2. Behaviors or attitudes of the blind persons themselves.	99	28
3. Administrative arrangements or special materials, equipment, and environments provided by the administration.	86	25
4. Activities or predispositions of non-professional aides, including peers, tutors, and "readers".	21	6
5. Services of guidance or disabled student center personnel.	17	5
6. Unclassifiable.	4	1
TOTAL	347	100

An examination of Table 14 reveals that blind persons rank teachers first as agents for the improvement of instruction. They look to the instructors to plan experiences, provide detailed verbal communications, and interact with the students in positive ways. In short, learning can be improved when instructors engage in the variety of critical behavior that were categorized as effective in Appendix F. Ranking in third place are arrangements, special equipment and environments provided by the administration.

Perhaps the most enlightening result of this analysis is information about the extent to which blind persons feel that they themselves must take responsibility for improving their own learning. Ranked in second place are suggestions for courses of action that blind students must initiate, including hints about the attitudes which they must cultivate in themselves in order to be successful. Their suggestions seem to imply that blind persons who manage to gain entrance into post-secondary school institutions are likely to find themselves in environments that are generally insensitive, if not hostile, to people with visual impairment. Hence, the individuals who hope to succeed must carefully plan a course of action which will enable them to wrest learning from the environment.

In general, the three high-ranking categories which include the activities of the instructional staff, the students, and the administration are indeed familiar to educators. The interlocking behaviors of the three groups form the foundation for successful learning amongst most students at the post-

secondary level whether handicapped or not. However, categories one and three pose unique problems for blind students because for the most part traditional practices are more suited to the sighted than the blind. Under such circumstances, how may improvement in learning opportunities for the blind be accomplished? The answer to this question is likely to be found in the activities of people within each of the three categories already identified.

Two facts remain, however, instructors must teach according to the needs of the predominant group of students who are sighted and secondly, few instructors know how to teach blind students or have the equipment to do so. Therefore, a way must be found to help instructors make appropriate modifications in both teaching style and attitude toward the blind students who are either already enrolled in science and mathematics courses or who would like to enroll. Given the nature of such courses the blind persons must be provided with the skills to meet the challenging tasks that they encounter, and they must be assisted in succeeding in these courses through special administrative arrangements, environments, materials, and equipment. How might this be accomplished? Perhaps one small but very important step can be taken toward coping with the challenge.

One procedure which appears to be feasible involves working directly with the blind persons themselves, to help them achieve greater independence in learning. Educators

within post-secondary school institutions can design training programs for their visually impaired students that will try to foster such independence. The program must seek to attain at least two important objectives:

1. Help blind persons learn how to prepare themselves to take a specific course in science or mathematics.
2. Assist blind persons to develop plans for teaching the instructor of that course how to promote the learning of the blind student.

One outcome of the current project will be the development of plans for such a training program. To this end the variety of critical incidents that were reported by blind persons and the many suggestions for improvement of instruction which they offered shall be used to develop curriculum, methods, and materials to accomplish the two basic objectives.

III

Presentation and Analysis of Demographic Characteristics of the Sample.

The purpose of this section of the study is to present some of the significant characteristics of the sample.[7] Two analyses will be made: (1) to examine demographic information reported by the blind persons in order to discern the extent of their exposure to science and mathematics courses; and (2) to assess their degree of preference for these subjects relative to other courses.

A review of significant demographic characteristics that are relevant to education in the sciences and mathematics reveals that males comprised about 60 percent of the sample. About 70 percent was aged 30 or younger. Almost 80 percent was of Caucasian ancestry, while Spanish-speaking and Blacks comprised 10 and 7 percent, respectively. About half of the group is totally blind, and 48 percent has been blind from birth or less than 3 months of age. For an additional 17 percent, blindness occurred between four months of age to 6 years.

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[7]Tabulated demographic characteristics are given as Appendix A.

Two thirds of the group attended school in California only, and almost three-fourths attended "Mainstreamed" elementary and secondary schools. Ten percent attended special schools for the blind only, and the remainder attended both types of institutions. About three-fourths of the group achieved post-secondary education between 15 and 16 years, and the remainder has seventeen years of education or more.

A third of the respondents indicated that amongst all subjects of the high school curriculum they preferred either science or mathematics. The percentages are 22 and 11 respectively. Twenty-five percent completed one or two courses in science while 66 percent had more than two.[8] Nine percent had none. While in high school the blind persons seemed to participate in mathematics to a considerable degree as well: 46 percent had at least one or two courses while 45 percent completed more than two. Nine percent had none. At the college level, the group's preference for science remained about the same level as in high school, but preference for mathematics dropped to 4 percent. Fifty-two percent completed more than two courses in science; 33 percent took one or two; and 15 percent had not yet taken one.[9] However, mathematics seems to be somewhat different: 57 percent had not yet taken any, 30 percent had one or two; and only 13 percent completed

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[8]For purposes of this study a course is considered to be of either one or two semester's duration.

[9]The duration of a college level course is considered to be of one or two semesters or one or two quarters.

more than two.

A preliminary review of the data suggests that in comparison to high school, there is a sharp drop in enrollment in college mathematics courses among the blind. But it is not clear to what extent this may be due to traditional differences between the sexes in enrollment in such courses. Whether the degree of visual impairment has an influence on enrollment in mathematics is also unclear. Therefore, further analysis is required. The extent of preference and of exposure to science and mathematics courses will be compared by gender and by degree of visual impairment. These data are given below in Tables 15 and 16.

TABLE 15

Comparison of Preference and Exposure to Science and Mathematics Courses by Sex

	Male		Female	
	No.	%	No.	%
High School				
Number and % who preferred science or mathematics	28	44	7	17
Number and % who completed:				
2 or more science courses	40	63	30	71
1 science course	17	27	9	21
No science courses	6	9	3	7
	63	99%	42	99%
Number and % who completed:				
2 or more mathematics courses	29	46	18	43
1 mathematics course	28	44	20	48
No mathematics course	6	9	4	9
	63	99%	42	100%
College and University				
Number and % who preferred science or mathematics	24	38	12	28
Number and % who completed:				
More than two science courses	30	48	24	57
1 or 2 science courses	22	35	13	31
No science courses	11	17	5	12
	63	100%	42	100%
Number and % who completed:				
More than two mathematics courses	8	13	6	14
1 or 2 mathematics courses	21	33	10	24
No mathematics course	34	54	26	62
	63	100%	42	100%

Comparison of Preference and Exposure to Science and Mathematics Courses by Sex

Are there differences between the sexes concerning their preference for science and mathematics and their degree of exposure to such disciplines? Forty-four percent of the males indicated that they preferred science or mathematics in high school as compared to only 17 percent of the females. But 71 percent of the girls, as compared to 63 percent of the boys, took two or more courses in science, while 27 percent of the boys and 21 percent of the girls took one course. Concerning mathematics, there was relative similarity in enrollment: 46 percent and 43 percent for males and females, respectively, who completed two or more courses. Forty-four percent of the boys and 48 percent of the girls took one class. It would appear that there are differences between the sexes in their expressed preference for science and mathematics in high school, but it seems that requirements for graduation may expose members of each sex to these subjects to about the same degree.

At the college level, preference for science or mathematics decreases slightly for males to 38 percent, but increases slightly to 28 percent for females. Amongst males, 48 percent take more than two science courses, while the percentage is 57 percent for females. The percentage taking only one or two science courses is 35 and 31 for men and women, respectively. Seventeen percent of the males and 12 percent of the females had not yet taken one science course. However, with regard to mathematics, 54 percent of the males and 62 percent of the

females had not yet taken one course, while for each group the percentage taking one or two courses is 33 percent and 24 percent, respectively. Only 13 percent of the men and 14 percent of the women had enrolled in more than two courses.

It would appear that differences between the sexes in preference for science and mathematics courses do persist to a slight degree at the college level, but actual exposure to such courses is roughly equivalent. For the sciences, there is a small margin in favor of the females while for mathematics, the reverse is apparent for males. Both sexes tend to avoid mathematics to a considerable extent.

Comparison of Preference and Exposure to Science and Mathematics Courses by Degree of Visual Impairment .

Are there differences between persons who are totally blind and those who have limited vision concerning either preference for science and mathematics or degree of exposure to such disciplines? Table 16 reveals that in high school, both groups express preference for science and mathematics to about the same degree. The percentage of totally blind persons who took two or more science courses is somewhat greater than those with limited vision: 72 percent and 62 percent, respectively. A larger proportion of those with limited vision had no science courses, 13 percent, as compared to persons who are totally blind, 4 percent. For both groups, the percentages indicating participation in mathematics are virtually identical. It would appear that in high school the presence or absence of sight had little effect on preference or exposure to science and mathematics courses.

In college a larger percentage of those with limited vision, as compared to persons who are totally blind, expressed preference for science and mathematics. Table 16 shows that the percentages are 34 and 14, respectively, in favor of the former group. Nevertheless, a slightly larger percentage of the totally blind group took more than two science courses: 56 percent as compared to 47 percent for persons with limited vision. The percentage of the totally blind group that took one or two science courses is greater also. Twenty-two percent of the group with limited vision had not yet enrolled in any science courses as compared to 8 percent of those who were totally blind.

It would appear that at the college level, blind persons who have some vision report greater preference for science and mathematics than do those who are totally blind, but in fact, the latter group actually enrolls in science courses to a greater degree. On the other hand, while a large percentage of each group tends to avoid or delay enrolling in mathematics courses, the greater proportion is amongst those who are totally blind, 70 percent as compared to 45 percent of those with limited vision.

SUMMARY AND IMPLICATIONS

This sample of blind persons is part of the group that "made it" in education to the post-secondary level. Do the demographic data provide any information that could be of

TABLE 16

Comparison of Preference and Exposure to Science and Mathematics Courses by Degree of Visual Impairment

High School	Limited Vision		Totally Blind	
	No.	%	No.	%
Number and % who preferred science or mathematics	18	33	17	34
Number and % who completed:				
2 or more science courses	34	62	36	72
1 science course	14	25	12	24
No science courses	7	13	2	4
	55	100%	50	100%
Number and % who completed:				
2 or more mathematics courses	25	45	22	44
1 mathematics course	25	45	23	46
No mathematics courses	5	9	5	10
	55	99%	50	100%
College and University				
Number and % who preferred science or mathematics	19	34	7	14
Number and % who completed:				
More than 2 science courses	26	47	28	56
1 or 2 science courses	17	31	18	36
No science courses	12	22	4	8
	55	100%	50	100%
Number and % who completed:				
More than 2 mathematics courses	9	16	5	10
1 or 2 mathematics courses	21	38	10	20
No mathematics courses	25	45	35	70
	55	99%	50	100%

interest to educators in general and in particular to educators in the fields of science and mathematics? A review of the evidence suggests that 65 percent of the group entered their formal years of schooling under the handicap of blindness and then functioned successfully, for the most part, in a "mainstream" situation. In spite of the handicap of blindness, as much as a third of the group indicated preference for science or mathematics courses in high school. That this was not just verbalization is attested by the fact that 66 percent took more than two science courses and 45 percent had more than two mathematics courses. Twenty-five percent continued to prefer science and mathematics at the post-secondary level, and although most of the blind persons were still enrolled in college at the time of this survey, 52 percent had already completed more than two science courses. On the other hand, 57 percent seemed to be delaying or avoiding mathematics and only 13 percent had completed more than two courses.

Further analysis revealed that in high school, there does appear to be a difference between the sexes in preference for science and mathematics courses, but nevertheless, although a greater percentage of males prefer these subjects, requirements for graduation seem to ensure that both sexes are exposed to these courses to about the same degree. At the college level, differences between the sexes in preference for science and mathematics persist to a slight degree in favor of males. While all but a few blind students take at least one science

course, there appears to be a slight percentage difference in favor of females in the actual number of science courses taken. In mathematics, the differences in enrollment favor the males to a small degree, but both sexes appear to avoid or delay enrollment.

Those persons with limited vision and those who are totally blind do not appear to be different in preference for science and mathematics at the high school level. Neither do there appear to be differences in actual exposure to these subjects. While those at the college level who have limited vision may report that they prefer science and mathematics more than do the totally blind persons, the latter group seems to have actually taken more science courses. However students in both groups, and particularly those who are totally blind, tend to avoid or delay mathematics.

The implication of these findings is evident: Within colleges and universities, there is a potential group of blind students who might be induced to pursue serious study in the sciences or at least enroll in more elective courses. Educators may find it profitable to explore this possibility. Further, whether blind persons are indeed avoiding mathematics should also be studied to try to identify factors which might be responsible for their failure to enroll in those courses. Higher education cannot casually dismiss the problem as just another high school failure because schools appear to be doing their part to expose blind students to mathematics: enrollment

is relatively high at the secondary level. It is in college that the effect of blindness on enrollment in mathematics courses appears to be catastrophical!

IV

Dissemination of the Materials Developed and the Research Findings

Dissemination of information concerning the nature of the project, its results, and products has occurred and continues to take place through a variety of activities:

1. Conferences with personnel of institutions and agencies that are concerned with the education and/or rehabilitation of the blind.

2. Involvement of individuals of diverse professional backgrounds in the classification of critical incidents.

3. Development of manuscripts for publication in scholarly journals.

4. Information released to newspapers, television studios, and persons attending conventions or meetings of professional organizations.

The objective of one dissemination activity is to introduce persons of diverse backgrounds, sighted and unsighted, to the products of this research and how they might be used to improve learning. This was accomplished principally through conferences with individuals who are interested in problems of the blind. The group included professional people in science and mathematics education, science and mathematics education for the blind, blind persons, counselors and rehabilitators of blind persons, teacher educators, Special Education experts,

and post-secondary professors of science and mathematics. Each person was given materials consisting of a random sample of approximately one hundred critical incidents, together with a set of descriptions of each of the three classification systems, Appendices C, D, and E, as well as the summary tables of data included in Appendix F.[10] The variety of roles and professions represented by the group that was provided with these materials is given as Appendix I (Table 2).

A portion of this group also expressed an interest in becoming more actively involved in the research project. They participated in assessment of the reliability of the classification systems by employing the description of categories to classify critical incidents independently. To accomplish this task they were provided with sets of random samples of critical incidents and descriptions of the various categories within each of the three classification systems. In addition, they were also provided with a set of instructions explaining how to use the classification systems for classifying the critical incidents.[11] A copy of the set of instructions used by sighted persons is given as Appendix G. Blind persons used Braille and/or taped copies of instructions, and in addition were provided with the set of pre-instructions given as Appendix H.[12]

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[10] These materials were also reproduced in Braille and recorded on tape for use by blind persons.

[11] It is important to note that at this point the independent "classifiers" had not yet been provided with the summary tables, and hence their decision about specific categories into which to classify the critical incidents were not influenced by those of the Principal Investigator.

[12] Please see footnote 10.

Technical information about the procedure for assessing reliability, the statistics which were employed, and tables of basic data derived from the analysis is given as Appendix I. Summary information is presented below. First, a percentage breakdown of the several groups that classified samples of critical incidents will be discussed. It can be observed from the percentages given in Appendix I (Table 2) that the individuals who became intimately acquainted with the products of this research indeed represented diversity of role and a variety of agencies and institutions.

An examination of data tabulated in Appendix I (Table 1) reveals that for each of the three classification systems there appears to be substantial agreement in assignments of incidents to categories by the independent "classifiers" and those made by the originators of the classification scheme. The agreement appears to be far greater than would be expected by chance at the .05 level of statistical significance. Hence, one may assume that if careful attention is given to the category description, the systems of categories can be successfully employed by other investigators. In particular, the categories of critical incidents can be used either for research purposes or for helping teachers develop curricula and improved methods of instruction for the blind.

Dissemination activities also include preparation of manuscripts to be published in scholarly journals. One article has been submitted to the Journal of College Science Teaching under the title: "Blind Students Disclose Their Predisposition

and Exposure to Science and Mathematics Courses."

A second manuscript which is based upon the critical incidents is in preparation. It seeks to explore the instructional implications of the research data at the post-secondary school level. Finally, a manuscript which summarizes and reports highlights of the current research findings has been submitted for publication in the CAPED Newsletter under the title: "Blind Students Report Critical Incidents of Science and Mathematics Teaching." CAPED is the acronym for the California Association of Post-secondary Educators of the Disabled.

Dissemination activities also include information releases to agencies of communication:

1. Descriptions of the project and its research activities were published in newspapers through releases prepared by the Office of Public Information, California State University, Fullerton.

2. At the invitation of Dr. Robert Fuller, University of Nebraska, Lincoln, three-hundred copies of critical incidents together with a large poster, were presented for display at the 1981 meeting, American Association of Physics Teachers, Stoney Brook, New York. The Continuous Poster Session displayed instructional materials for teaching science and mathematics.

3. In cooperation with the Department of Communications, California State University, Fullerton, the results

of this research were presented for Cable TV broadcast by means of a thirty minute video-taped interview with the principal investigator. The video-tapes titled, "University Spotlight #8, Research on the Blind" were to be broadcast during 1982 by the Storer Cooke TV system of Anaheim and Teleprompter Cable TV of Fullerton.

4. A packet of 100 critical incidents were sent to Larry Small, Coordinator of Display Materials for the Handicapped in Science at the April meeting in Chicago, Illinois, of the National Science Teachers Association.

5. Appropriate responses to letters of inquiry from persons who were informed of the project through publication of the National Science Foundation or other media were made and materials were distributed.

As a final note concerning all of the activities described in Section IV of this report, it must be emphasized that information concerning the nature of this project, its results, and products will continue to be disseminated beyond the date of publication of this report.

APPENDIX A

DEMOGRAPHIC CHARACTERISTICS OF THE SAMPLE

	No.	%
Age in years		
20 or less	16	15
21 to 30	57	54
31 to 40	17	16
41 to 50	11	10
51 or more	4	4
Total	105	99
Sex		
Male	63	60
Female	42	40
Total	105	100
Marital Status		
Single	70	67
Married	23	22
Divorced or Separated	12	11
Total	105	100
Ethnic Group		
Caucasian	83	79
Spanish-speaking	10	10
Black	7	7
Other	5	4
Total	105	100
Type of School Attended (Elementary, Secondary)		
Special School for the Blind only	11	10
"Mainstream"	76	72
Both	18	17
Total	105	99
Years of Education		
14 years or less	41	39
15-16	37	35
17 years or more	27	26
Total	105	100

Appendix A, continued

	No.	%
School Location, Elementary, Secondary		
Outside California	34	32
California	70	67
Both	1	1
Total	105	100
H.S. Subjects Preferred		
Science	23	22
Math	12	11
Social Science	29	28
English	14	13
Other	27	26
Total	105	100
No. of H.S. Science Courses Completed		
None	9	9
One or Two	26	25
More than Two	70	66
Total	105	100
No. of H.S. Math Courses Completed		
None	10	9
One or Two	48	46
More than Two	47	45
Total	105	100
Preferred College Subjects		
Science	22	21
Math	4	4
Social Studies	41	39
English	6	6
Other	32	30
Total	105	100
No. of College Science Courses Completed		
None	16	15
One or Two	35	33
More than Two	54	52
Total	105	100

Appendix A, continued

	No.	%
No. of College Math Courses Completed		
None	60	57
One or Two	31	30
More than Two	14	13
Total	105	100
Reading Interests and Hobbies		
Non-science or Math Related	85	81
Science or Math Related	20	19
Total	105	100
Family Income (est. SES)		
Below $10,000	30	28
Between $10,000 and $20,000	49	47
Above $20,000	26	25
Total	105	100
Age Visual Impairment Occurred		
Adult	23	22
Age Seven to Eighteen	14	13
Four Months to Age Six	18	17
Birth to Three Months	50	48
Total	105	100
Degree of Impaired Vision		
Partially Sighted	12	11
Legally Blind	43	41
Totally Blind or Light Perception Only	50	48
Total	105	100
Occupational Experience		
Non-Science or Math Related	91	87
Science or Math Related	14	13
Total	105	100
Career Goals		
Non-Science or Math Related	90	86
Science or Math Related	15	14
Total	105	100

Appendix A, continued

	No.	%
Quality of Readers		
Poor	23	22
Fair	9	9
Good	26	25
Excellent	41	39
Not Applicable	6	6
Total	105	100

APPENDIX B

Interview Schedule of Questions*

1. Identifying information about the informant.
   - A. Number of schedule.
   - B. Name, address, telephone number.
   - C. Place of interview, special characteristics.
   - D. Date and time of interview.
   - E. Degree of cooperation and attitude of informant.
2. Social background data.
   - A. Age, sex, ethnic group, marital status.
   - B. Education, information about attendance at
     1. Segregated school for blind.
     2. "Mainstream" school.
     3. Home tutoring.
   - C. Years of schooling, location of schools.
   - D. Secondary school, preferred subjects, number and type of science and mathematic courses completed.
   - E. Postsecondary school, preferred subjects, number and type of science and mathematics courses completed.
   - F. Special "reading" interest areas.
   - G. Other interests and hobbies.
   - H. Family income.
   - I. Age of onset of blindness.
   - J. Degree of sightedness.
   - K. Occupational experiences.
   - L. Career goals.
   - M. Quality of "reader".

*Transcribed into Braille for blind interviewers.

Appendix B, continued

Part One: Successful Critical Incidents

Think of a teacher in a high school, junior college or university course (or less formal learning situation) who on one occasion was extremely effective in helping you learn a particular concept, skill, procedure, or perhaps just an attitude toward science or mathematics. (If no effective teacher is remembered, go to Part Two.)

1. Describe exactly what the teacher did. What specific act was critical to your learning?

2. Where did the incident take place? (Get identifying information: school, level of course, place, age, subject matter or discipline, classroom, field trip, lab, demonstration room, etc.)

3. What was happening on this occasion? (Acquire a description of the context in which the learning occurred.)

4. Why do you believe that this act was critical to your learning? Can you describe how the teacher's behavior resulted in your learning? Can you describe any instructional materials that were used? Can you tell how these materials contributed to your learning?

5. What else happened to you as a result of this successful learning experience? Did it lead to any new learning? Did it help you to understand something else that was unclear? Were you able to do anything else afterwards?

6. Can you think of another important behavior of the teacher that was critical to your learning?

   A. If the answer is yes, repeat question one through five, and then go to B. (If the answer is no, go on to question seven.)

Appendix B, continued

B. Ask question six again and continue this sequence of questioning until no additional critical incidents of successful learning in science from this particular teacher are forthcoming. Then go on to question seven.

7. Can you think of another teacher who was extremely effective in helping you learn science or mathematics?

A. If the answer is yes, repeat questions one through six and continue this sequence of questioning until no additional successful teachers are identified, then go to Part Two.

B. If the answer is no, go to Part Two.

Part Two: Unsuccessful Critical Incidents

Think of a teacher in a high school, junior college, or university course (or less formal learning situation) who on one occasion was extremely ineffective in helping you learn a particular concept, skill, procedure, or attitude in science or mathematics. (If no ineffective teacher incident is recalled go to Part Three.)

1. Describe exactly what the teacher did which was critical? What specific act blocked or reduced learning?

2. Where did the incident take place? (Get identifying information: school, level of course, place, age, subject matter or discipline, classroom, field trip, lab, demonstration room, etc.)

3. What was happening on this occasion? (Acquire a description of the context within which the unsuccessful learning experience occurred.)

4. Why do you believe that this act was critical to your lack of success in learning? Can you describe how the teacher's behavior may have blocked learning? Can you describe how instructional materials were used or misused? Can you describe how the materials restricted your learning?

Appendix B, continued

5. What else happened to you as a result of this unsuccessful learning experience? Were you able to learn other things which eliminated the need for the unsuccessful learning? Did it leave gaps in your background? Did it restrict you from engaging in further learning?

6. Can you think of another important behavior of this teacher on another occasion which was critical to your lack of success in learning science or mathematics?

   A. If the answer to this question is yes, repeat questions one through five in Part Two and then go to B. (If the answer is no, go to question 7.)

   B. Ask question six again and continue this sequence of questioning until no additional critical incidents of unsuccessful learning in science from this particular teacher are forthcoming. Then go to question 7.

7. Can you think of another teacher who was extremely ineffective in helping you learn science or mathematics?

   A. If the answer is yes, repeat questions one through six and continue this sequence of questioning until no additional unsuccessful teachers are identified, then go to Part Three.

   B. If the answer is no, go to Part Three.

Part Three: Suggested Innovations to Promote Learning

Consider your experience with the learning of science or mathematics. Consider also your experience with teachers who perhaps on one or more occasions were extremely successful or unsuccessful in promoting learning. Can you offer any suggestions which might help improve learning for blind students? Perhaps your suggestions might relate to one or more of the following categories: (The interviewer will explain the terms.)

Appendix B, continued

1. Personal attributes of a teacher.
2. Social climate of the classroom or laboratory.
3. The curriculum and its organization.
4. Teaching procedures.
5. Instructional materials.
6. Evaluation.
7. Other:

   A. Please give one specific suggestion to improve the learning of science or mathematics. (If no suggestion is given, begin to terminate the interview.) After a suggestion is given, the interviewer should probe to obtain additional detailed information.

   B. What topic, subject, or discipline is the suggestion related to? What level of learning?

   C. Can you give detailed information about:

      (1) What should be done?

      (2) Who should do it? With whom?

      (3) Where should the learning take place?

      (4) How and under what conditions should the learning occur?

      (5) What sequences of experiences should be given?

      (6) What materials and equipment should be used, developed, or constructed? If materials are suggested, descriptions should be obtained and where possible, rough drawings.

   D. Why do you believe that the suggestions which you have given will promote learning? Can you describe how learning will occur because of your ideas?

Appendix B, continued

E. What will be the result of the learning? What new learning will it lead to? How might it help the learner to understand other things?

F. Can you think of another suggestion to improve learning?

(1) If the answer is no, begin to terminate the interview.

(2) If the answer is yes, go back and repeat questions one through six and continue this sequence of questioning until no additional suggestions are forthcoming.

APPENDIX C

Description of Categories of Critical Incidents of Effective and Ineffective Teaching

Category 1.

The Teacher Provided Appropriate Learning Materials

Incidents recorded within this category describe behavior where the teacher provides appropriate tactual and other sensory materials for learning. Field trips are made, specimans are acquired, models are constructed, materials are enlarged and colors are used to show contrasts. Raised line drawings are made. Materials for learning through the use of texture, smell and hearing are developed and used.

Incidents recorded within this category also describe behavior where the teacher did not provide appropriate multisensory materials.

Category 2.

The Teacher Planned and Directed Appropriate Concrete Learning Experiences

Incidents recorded within this category describe behavior where the teacher plans and directs tactual learning through models, and concrete experiences. There is evidence that the teacher interacts with the student in the use of materials, provides assistance, supervision, guidance and builds concepts by relating the concrete to the abstract.

Incidents recorded within this category also describe behavior where the teacher did not plan and direct appropriate concrete learning experiences.

Appendix C, continued

Category 3.

The Teacher Provided Detailed

Verbal Descriptions and Explanations

Incidents recorded within this category describe behavior where the teacher clearly verbalizes what he is writing, drawing, or showing to students by means of models, charts, slides, films, or film strips. The teacher helps the student build mental images and acquire visual or abstract concepts through appropriate descriptions and explanations.

Incidents recorded within this category also describe behavior where the teacher failed to provide appropriate verbal descriptions and explanations.

Category 4.

The Teacher Gave Individual Attention to Instructional Needs

Incidents recorded within this category describe behavior where the teacher gives special attention in class to the instructional needs of an individual. The teacher answers questions, explains, challenges the student, and gives help. Adaptations are made in curriculum, procedures, room arrangements, time for completion of assignments, and freedom to explore individual interests.

Incidents recorded within this category also describe behavior where the teacher did not or was not able to give individual attention to instructional needs.

Category 5.

A Reader, Teaching Assistant, Sighted Partner,

or Tutor Provided Help to Facilitate Learning

Incidents recorded within this category describe behavior where a reader, teaching assistant, sighted partner, or tutor helps a blind student

Appendix C, continued

acquire information from a lecture, blackboard, book, experiment, or instrument. They explain concepts, develop materials, and give oral examinations. The reader generally performs according to the blind student's instructions (example: recording books on tape.). The partner sets up equipment, reads instruments, observes and describes what is happening.

Incidents recorded within this category also describe behavior where a reader, teaching assistant, sighted partner, or tutor fails to provide appropriate assistance to facilitate learning.

Category 6.

The Teacher Employed Appropriate

Evaluation and Grading Procedures

Incidents recorded within this category describe behavior where the teacher uses adequate evaluation and grading procedures. The teacher reviews for the test, and makes adaptations in time, place of testing, type of test, and use of special aids.

Incidents recorded within this category also describe behavior where the teacher did not use adequate evalution and grading procedures.

Category 7.

The Teacher's Personal Attributes Helped Establish

A Comfortable Environment for Learning

Incidents recorded within this category describe behavior where the teacher accepted the blind student as an individual and as a member of the class equal to other students. He understands the psychological needs of blind students and provides warmth and support. The teacher's personal traits of enthusiasm, friendliness, good humor, organization, and helpfulness provide a comfortable environment for learning. The blind student is

aware of the comfortable environment, responds to it positively, but does not report specific incidents.

Incidents recorded in this category also describe behavior where the blind student does not feel accepted. The teacher's personal attributes were such that he/she did not create a favorable learning environment.

Category 8.

The Teacher Provided Special Assistance Outside of Class

Incidents recorded within this category describe behavior where the teacher devotes time after class to individual instruction. The ceacher instructs, shows slides, gives oral examinations, gives lab assistance, illustrates concepts, and provides psychological support and encouragement.

Incidents recorded within this category also describe behavior where the teacher did not provide special assistance outside of class.

Category 9.

Administrative Adaptations Were Made to Facilitate Learning

Incidents recorded within this category describe administrative arrangements were special adaptations are made for the blind student or other handicapped students to facilitate learning in general. Arrangements are made outside of the classroom for advisement. Special teachers, transcribers, and facilities for storing and retrieving learning materials are provided.

Incidents recorded within this category also describe situations where administrative adaptations failed to facilitate learning.

APPENDIX D

Descriptions of Categories of Consequences of Critical Incidents of Effective and Ineffective Teaching

Category 1.

Mastery of Information, Concepts, Procedures, or Skills Including Confidence in Ability to Function in Science and Mathematics

Recorded within this category are reports that the student succeeded in the course by mastering the necessary information, concepts, laboratory procedures, or skills. The rate of learning increased. He gained experience in ability to function in science or mathematics and can communicate knowledge to others.

Recorded in this category are reports that the student did not succeed in mastering content and in functioning successfully in science and mathematics.

Category 2.

Emotional Satisfaction with Learning Experiences in Science and Mathematics

Recorded within this category are reports that the student had a positive emotional experience. The experience was comfortable, enjoyable, satisfying, and the student felt good about himself.

Recorded in this category are reports that the student had a negative, unsatisying emotional experience and a lowered self concept.

Category 3.

Motivation to Pursue Further Study of Science and Mathematics

Recorded within this category are reports that the student was motivated to pursue further his studies of science and mathematics. The

student was impelled to take additional courses, conduct experiments, and "read" books at home.

Recorded in this category are reports that the student lost interest and was discouraged from pursuing further studies of science and mathematics.

Category 4.

Integration of Learning into a Larger System

Including Application of Learning to Life Situations

Recorded within this category are reports that the student integrated learning into a larger system and acquired a clearer conception of how it functions. He was able to apply what was learned to real-life situations outside of school and acquired a better understanding of personal problems.

Recorded in this category are reports that the student did not integrate learning.

Category 5.

Discovery of Alternative Means

of Learning in Place of the Instructor

Recorded within this category are reports that the student found alternative means of acquiring the learning that he could not get from the instructor.

(no negative reports tallied)

Category 6.

Communication of Needs to the Instructor

To Establish a Working Relationship With Him

Recorded within this category are reports that the student learned that he must communicate his needs to instructors and must establish a good working relationship.

APPENDIX E

Descriptions of Categories of Reasons for Judging Critical Incidents as Effective or Ineffective

Category 1.

Provided Access to Information Through Detailed Verbal Communication

The reasons recorded in this category reflect the students' need to receive verbal information. Judgments relating to effective incidents concern verbal communications from the teacher or other persons which provide him with the opportunity to acquire, understand, or clarify concepts, and build appropriate mental images.

Judgments relating to ineffective incidents concern the failure to provide appropriate verbal communication.

Category 2.

Provided Opportunity to Perceive Information Through Non-visual Exploration

The reasons recorded in this category reflect the student's need to extract information from the environment through the haptic system, smell, taste, and hearing. Judgments relating to effective incidents concern the use of specimens, models, laboratory equipment and natural situations to help students construct mental images and conceptualize the functioning of systems.

Judgments relating to ineffective incidents concern the failure to provide opportunities to learn through non-visual exploration.

Category 3.

Provided Increased Motivation, Interest

And Intellectual or Physical Participation in Learning

The reasons recorded in this category reflect the quality of incentives to learn. Judgements relating to effective incidents concern the student's being given challenging opportunities for learning, and demands of high expectations for his performance. The student participates intellectually and physically in an activity. He is involved in the conduct of an experiment and the performance of a task. The student gains skill in solving problems and loses fear of participation.

Judgements relating to ineffective incidents concern reduced motivation, interest, expectations, and opportunity to learn. There is lack of intellectual and physical involvement in an activity.

Category 4.

Provided Opportunity to Perceive Information Visually

And Aurally Through Mechanical Aids and Special Adaptations

The reasons recorded in this category reflect the need of low vision students for learning aids. Judgements relating to effective incidents concern mechanical aids that are provided and special adaptations that are made which help the student to see or hear what must be learned.

Judgements relating to ineffective incidents concern the failure to provide mechanical aids or make special adaptations for learning.

Category 5.

Provided Experience in Interacting with the Instructor

And with Peers as an Equal Member of the Group

The reasons recorded in this category reflect the quality of social interactions in educational activities. Judgments relating to effective incidents concern friendly relationships with helpful instructors who show interest in the student. The student interacts with peers as equals. The student feels at ease, more adequate and develops enhanced feelings of self-worth.

Judgments relating to ineffective incidents concern the lack of social participation in learning, feelings of inadequacy, undue pressure, and help from unfriendly instructors and students.

Category 6.

Provided Additional Time to Complete Tasks

And Evaluative Information Simultaneously

While Evaluating an Activity

The reasons recorded in this category reflect the student's need for appropriate adaptations in order to complete work in a thorough manner and with efficiency in the rate of learning. Judgments relating to effective incidents concern the extra time he is given to complete assignments, projects and tests. The quality of his performance is enhanced because the student receives immediate and appropriate information which enables him to eliminate non-productive responses and practice correct patterns of behavior.

Judgments relating to ineffective incidents concern the instructor's failure or refusal to make appropriate time adaptations. He does not provide the student with immediate "feedback" while performing an activity.

Table 1.

A Rank Order Outline of the Categories of Critical Incidents of Effective and Ineffective Teaching Reported by Blind Students And the Frequency and Percentage of Total Response in Each

Category	Number Effective	Number Ineffective	Total in Category	Percentage of Total Response
1. The teacher planned and devised appropriate concrete learning experiences	73	34	107	21.2
2. The teacher provided appropriate learning materials	75	24	99	19.6
3. The teacher provided detailed verbal description and explanation	40	42	82	16.3
4. The teacher gave individual attention to instructional needs	35	20	55	10.9
5. A reader, teaching assistant, sighted partner, or tutor provided help to facilitate learning	37	8	45	8.9
6. The teacher's personal attributes helped establish a comfortable learning environment	21	16	37	7.3
7. The teacher employed appropriate evaluation and grading procedures	25	10	35	6.9
8. The teacher provided special assistance outside of class	26	4	30	5.9
9. Administrative adaptations were made to facilitate learning	9	5	14	2.8
Total Responses	341 (67.6%)	163 (32.3%)	504	99.8

Table 2.

A Rank Order Outline of the Categories of Critical Incidents Reported by Blind Students as Effective Teaching and The Frequency and Percentage of Total Response in Each

Rank	Category	Number Effective	Percentage of Total Response
1	2. The teacher provided appropriate learning materials	75	14.9
2	1. The teacher planned and devised appropriate concrete learning experiences	73	14.5
3	3. The teacher provided detailed verbal descriptions and explanations	40	7.9
4	5. A reader, teaching assistant, sighted partner, or tutor provided help to facilitate learning	37	7.3
5	4. The teacher gave individual attention to instructional needs	35	6.9
6	8. The teacher provided special assistance outside of class	26	5.1
7	6. The teacher employed appropriate evaluation and grading procedures	25	5.0
8.	7. The teacher's personal attributes helped establish a comfortable learning environment	21	4.2
9	9. Administrative adaptations were made to facilitate learning	9	1.8
	Total	341	67.9

Table 3.

A Rank Order Outline of the Categories of Critical Incidents Reported by Blind Students as Ineffective Teaching and The Frequency and Percentage of Total Response in Each

Rank	Category	Number Ineffective	Percentage of Total Response
1	3. The teacher provided detailed verbal descriptions and explanations	42	8.3
2	1. The teacher planned and devised appropriate concrete learning experiences	34	6.7
3	2. The teacher provided appropriate learning materials	24	4.8
4	4. The teacher gave individual attention to instructional needs	20	4.0
5	7. The teacher's personal attributes helped establish a comfortable learning environment	16	3.2
6	6. The teacher employed appropriate evaluation and grading procedures	10	2.0
7	5. A reader, teaching assistant, sighted partner, or tutor provided help to facilitate learning	8	1.6
8	9. Administrative adaptations were made to facilitate learning	5	1.0
9	8. The teacher provided assistance outside of class	4	0.8
	Total	163	32.4

Table 4.

A Rank Order Outline of the Categories of Consequences of Effective and Ineffective Critical Incidents and the Frequency and Percentage of Total Response in Each

Category	Type of Teaching Incident	Type of Effect: Promoted Growth	Type of Effect: Failed to Promote Growth	Total Category	Percentage of Total Response
1. Mastery of Information, concepts, procedures, or skills, including confidence in ability to function in science and mathematics	effective	230		301	59.7
	ineffective		71		
2. Emotional satisfaction with learning experience in science and mathematics	effective	52		96	19.4
	ineffective		44		
3. Motivation to pursue further study of science and mathematics	effective	33		54	10.7
	ineffective		21		
4. Integratio.. learning into a larger system, including application of learning to life situation.	effective	18		22	4.4
	ineffective		4		
5. Discovery of alternative means of learning in place of the instructor	effective	1		19	3.8
	ineffective	18			
6. Communication of needs to the instructor to establish a working relationship with him	effective	7		12	2.4
	ineffective	5			
Total		341	163	504	100.4

Table 5.

A Rank Order Outline of the Categories of Reasons for Judging the Critical Incident as Effective or Ineffective and the Frequency and Percentage of Total Response in Each

Category	Frequency Associated W/Effective Incidents	Frequency Associated W/Ineffective Incidents	Total in Category	Percentage of Total Response
1. Provided access to information through detailed verbal communication	82	52	134	26.7
2. Provided opportunity to perceive information through non-visual exploration	87	13	100	19.9
3. Provided increased motivation, interest and intellectual or physical participation in learning	51	45	96	19.1
4. Provided opportunity to perceive information visually and aurally through mechanical aids and special adaptations	52	19	71	14.1
5. Provided experience in interacting with the instructor and with peers as an equal member of the group	42	23	65	12.9
6. Provided additional time to complete tasks and gave evaluative information simultaneously while performing an activity	26	10	36	7.2
Total	340*	162*	502	99.9

*one reason invalid

APPENDIX G

Classification of the Critical Incidents,

Reasons, and Consequences into Categories

I. The purpose and general procedure.

The purpose of this part of the investigation is to disseminate the critical incidents and to try to discern the reliability of the classification system of incidents, reasons, and consequences. You have been given a description of each of the following classification systems:

Categories of Incidents

Categories of Reasons

Categories of Consequences

A. Please read each of the descriptions of the Categories of Incidents several times until you have some understanding and recall of the kinds of incidents included in each.

B. You also have been given a packet of approximately one hundred reports of critical incidents. Each report sheet includes the following seven items of information.

1. Interviewee identification number
2. Type of incident - effective or ineffective

Number of the incident reported

3. Description of the incident
4. Location at which incident occurred.
5. Context in which the incident took place
6. The reason for judging the incident as effective or ineffective.
7. The consequence of the incident for the student.

You will be concerned with three of the important items of information on each sheet:

item 3 Description of the Incident

item 6 The Reason for Judging the Incident as Effective or Ineffective

item 7 The Consequences of the Incident for the Student

II. The Classification of Incidents

A. Please read the report of each incident identified as number 3 on the sheet. Then make a determination of which category it might fit into. The incident must fit within one of the categories numbered 1 to 9. If you cannot readily classify the incident, put it aside temporarily.

B. Continue reading the incidents and group them together according to category number.

When you have classified about thirty, you may want to go back and see whether you need to change the category into which you have placed some of the incidents. With experience you will become more expert.

C. Finish classifying all of the incidents and then try again to classify those that you could not readily classify at first--these are in the separate group.

D. By this time you have probably acquired great familiarity with the category descriptions and the incidents. Read each incident again to verify whether it belongs in the given category. If it does not belong, change its location into the proper category.

E. Now, write the category number of each incident in pencil at the left margin just in front of the number 3. This number must correspond to one of the categories 1 to 9. For those incidents that you are unable to classify, mark a U in front of the 3.

It is important that this identification be made before going to the next step--the classification of the reasons.

III. The Classification of Reasons

A. Please study the descriptions of the categories of reasons given for judging the incidents as effective or ineffective. After you are familiar with the descriptions of categories of reasons, you will be ready to classify them.

B. For each report of an incident, please read the statement expressing the reason given for judging the incident as effective or ineffective. The reason is identified as number 6 on the incident sheet.

Then make a determination of which one of the categories of reasons it fits into. If you cannot classify it readily, put it aside temporarily.

C. Continue reading and classifying the reasons as was done previously with the classification of incidents.

D. When this is completed write the category number of each reason in pencil at the left margin just in front of the number 6.

This number must correspond to one of the categories 1 to 6. For those reasons that you are unable to classify, mark a U in front of the 6.

It is important that this identification be made before going to the final step--the classification of consequences.

IV. The Classification of Consequences

A. Please study the descriptions of the categories of consequences of the critical incidents as reported by the students.

B. For each report of an incident, please read the student's statement of the consequence of the critical incident. The consequence is identified as number 7 on the incident sheet. Then make a determination of which one of the categories of consequence it fits into.

C. Follow the procedures as in the previous two classifications.

D. After completing the classification of consequences, write the category number of each consequence in pencil at the left margin just in front of the number 7. This number must correspond to one of the categories 1 to 6. Mark a U for those that you are unable to classify.

1) Please forward to me in the envelopes provided the packet of incident sheets. These will be returned to you as soon as the information is processed.

2) Please include also the short background data sheet. We would appreciate any suggestions or criticisms.

3) Please include the consultant fee form.

THANK YOU FOR ALL YOUR ASSISTANCE

APPENDIX H

PRE-INSTRUCTIONS

You have been given five groups of information. For your convenience the information has been duplicated in five Braille packets, on tape and in print for those who wish to use a reader. Please choose which method will aid you most in completing this project. It may be helpful to use a combination of methods.

1. The first group of information is a set of instructions which outlines in greater detail the purpose and procedure of this investigation. Locate the group of information which is entitled CLASSIFICATION OF THE CRITICAL INCIDENTS, REASONS, CONSEQUENCES INTO CATEGORIES. Please read this information in its entirety before proceeding to the remaining four groups of information.

2. The second group of information is a collection of reports dealing with visually handicapped students who were involved in science and mathematics courses. Seven items will be presented in each report. You will be primarily concerned with three of these items.

   A. Item number three deals with the CRITICAL INCIDENT in which the student was involved.

   B. Item number six deals with the REASON that the student judged the incident to be effective or ineffective in helping him with the course.

   C. Item number seven deals with the CONSEQUENCES of the incident for the student.

3. The third group of information is entitled DESCRIPTION OF CATEGORIES OF CRITICAL INCIDENTS OF EFFECTIVE AND INEFFECTIVE TEACHING. Please carefully read each of the nine category descriptions. Then take the group of student reports and look at number three. Carefully read the critical incident. Then determine which of the nine categories it best fits into. Place the number of that category in pencil to the left of item three on the student report. Repeat this procedure until you have categorized each of the critical incidents.

4. The fourth group of information is entitled DESCRIPTION OF CATEGORIES OF REASONS FOR JUDGING CRITICAL INCIDENTS AS EFFECTIVE AND INEFFECTIVE. Please carefully read each of the six category descriptions. Then follow the same procedure for item six on the student reports as you did for item three.

Appendix H, continued

5. The fifth group of information is entitled DESCRIPTION OF CATEGORIES OF CONSEQUENCES OF CRITICAL INCIDENTS OF EFFECTIVE AND INEFFECTIVE TEACHING. Please carefully read each of the six category descriptions. Then follow the same procedure for categorization of item seven on the student reports as you did for items three and six.

You may wish to obtain more information on which to base your judgment for categorization by interrelating items three, six, and seven on the student reports. This may present you with a more complete picture of the interrelationship between the critical incidents, reasons, and consequences.

APPENDIX I

Assessment of the Reliability of the Classification Systems

In order to assess the extent of agreement between each of the "classifiers" and the standard classification which was set by the principal investigator and consultants, contingency tables were constructed. For the nine categories of critical incidents a 9 by 9 cell contingency table was used, while 6 by 6 cell contingency tables were utilized to analyze each set of categories of the consequences and each set of the reasons. The K statistic described by Richard J. Light was employed to assess the extent of agreement or "Goodness of Fit."[1] The K statistic is represented as:

$$K = \frac{Po - Pe}{1 - Pe}$$

Where: Po is the observed proportion of agreements in the main diagonal of the contingency table

Pe is the expected proportion of agreements in the main diagonal on the basis of chance.[2]

The value of K is zero when the observed agreement equals the expected agreement. It would equal one if all of the

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[1]Richard J. Light, "Issues in the Analysis of Qualitative Data," in Second Handbook of Research on Teaching, Robert M. W. Travers, ed., AERA, Rand McNally, 1973. Chap. 10, pp. 331-339 ff.

[2]Ibid; P. 331., "The expected number of entries is computed from the standard Chi-square multiplicative model of independence."

Appendix I, continued

responses fell on the main diagonal. The higher the value of K, the closer is the agreement between classifiers; and hence the greater is the evidence upon which to make judgements about the reliability of the classification system. The statistical significance of an observed K may be tested by means of a normal approximation of Z.[3]

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[3]Ibid., p. 332.

Appendix I, continued

TABLE 1

Values of K and Z Resulting from the Classification of Critical Incidents (K, 1), Consequences (K, 2), and Reasons (K, 3) by 26 Sighted Persons

Classifier	Pairs	(K,1) $\bar{x}$=.415	Z	(K, 2) $\bar{x}$=.456	Z	(K, 3) $\bar{x}$=.503	Z
B1	105	.44	10.7	.49	5.9	.49	10.5
B4	94	.38	9.1	.36	5.9	.40	8.5
B5	110	.34	9.4	.40	5.4	.56	11.6
C8	100	.46	11.1	.41	5.3	.49	10.3
Col6	48	.36	5.9	.75	6.1	.52	7.6
C7	103	.38	9.1	.18	2.7	.43	8.4
DEL3	102	.49	12.7	.60	8.2	.61	12.3
H7	97	.46	10.8	.58	7.4	.50	10.1
H8	105	.40	10.5	.45	6.6	.70	14.4
KN8	117	.46	11.9	.49	6.6	.54	11.7
MAL3	95	.37	8.5	.46	5.5	.54	10.7
M6	104	.47	12.7	.54	7.1	.48	10.6
M8	109	.33	8.4	.36	6.0	.30	6.8
OC6	110	.39	10.2	.25	4.3	.46	10.2
P6	103	.36	8.9	.55	7.7	.56	12.0
SC8	107	.45	11.6	.54	7.1	.58	12.3
SH6	108	.48	12.1	.56	7.2	.61	13.8
ST5	103	.43	10.8	.45	6.7	.53	11.3
TH3	107	.43	11.5	.50	7.4	.35	7.6
Tor6	95	.48	11.4	.20	2.6	.35	6.8
TULA	75	.44	9.5	.52	5.3	.61	10.6
TUR1	107	.43	11.5	.45	5.2	.46	10.0
WH5	106	.39	10.3	.43	6.8	.67	14.5
WOOD13	92	.41	10.2	.41	5.7	.45	9.2
WOO17	104	.46	12.3	.52	8.6	.53	11.9
WOO56	108	.30	8.5	.32	5.4	.36	8.2
		SUM=10.78		SUM=11.87		SUM=13.08	

APPENDIX I, (continued) TABLE 1 (continued)

Values of K and Z resulting from the classification of critical incidents (k,1), consequences (k,2), and persons (k,3) by 9 blind persons

Classifier	Pair	(k,1)	Z	(k,2)	Z	(k,3)	Z
		$\bar{X}$= .426		$\bar{X}$= .372		$\bar{X}$= .491	
Brink 9	39	.04*	0.5	.32	2.4	.59	5.4
Hens 9	65	.38	8.1	.27	1.9	.45	7.7
Jones 9	102	.44	11.2	.37	4.8	.49	10.3
Morse 69	91	.38	8.7	.40	6.2	.40	8.3
Potz 49	65	.51	10.1	.47	4.7	.37	6.0
Tsur 79	50	.54	8.5	.44	3.4	.43	6.4
Vasq 9	41	.46	7.4	.28	3.1	.66	8.5
Wern 69	56	.40	6.8	.55	5.5	.54	7.5
Whit 9	62	.30	6.1	.25	2.5	.08*	1.4
		Sum=3.41		Sum=3.35		Sum=3.93	

*This value is omitted in computation of the mean. It is likely that the blind person either erred in recording his responses or misunderstood the Brailled instructions.

APPENDIX I, (continued) Table 2

Role and Profession Represented by Participants in the Dissemination and the Classification Activity

Role or Profession	Dissemination Only		Dissemination and Classification		Total	
	Sighted	Blind	Sighted	Blind	No.	%
Professor, science, mathematics, other	7	2	3	-	12	19
Science Education Researcher	3	-	4	-	7	11
Counselor	3	1	3	2	9	14
Special Education	4	-	3	-	7	11
Institution for the blind, counselor, teacher, administrator	3	2	7	3	15	24
Specialist in instruction for the blind	-	-	6	-	6	9
Post-secondary students	-	3	-	4	7	11
Total	20	8	26	9	63	99

APPENDIX J

Personnel

Dr. Francis Collea (Science Education)
California State University, Fullerton

Dr. Morris G. Sica (Teacher Education)
California State University, Fullerton

Ms. Kathleen Vasquez (Blind undergraduate, Human Services)
California State University, Fullerton