THE EFFECT OF INSTRUCTOR EXPERIENCE AND MANIKIN KR FEEDBACK ON THE ACQUISITION OF CARDIOPULMONARY RESUSCITATION SKILL PROFICIENCY

by

NOREEN AGNES ANNE CAMPBELL
B.Sc.N., University of Alberta, 1970

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FACULTY OF GRADUATE STUDIES
[redacted]
DEAN
DATE Nov 25, 83

We accept this thesis as conforming
to the required standard

[redacted]
Dr. Geoffrey P. Mason

[redacted]
Dr. David Docherty

[redacted]
Dr. Walter Muir

[redacted]
Dr. Loren E. Acker

University of Victoria
September 1983

Supervisor: Dr. Geoffrey P. Mason

ABSTRACT

This study evaluated the proficiency of cardiopulmonary resuscitation (CPR) skill demonstrated by forty-eight female subjects enrolled in a Basic Life Support Course. Instructor experience and the knowledge of results (KR) potential of the CPR training manikin were independent variables while CPR proficiency was the dependent variable. Aspects of CPR performance analyzed were ventilation technique, compression technique, incidence of camping, incidence of pressure points, and timing of performance (ventilation phase, compression phase and total cycle).

The criterion performance was the Canadian Heart Foundation standard for Single Person Rescue (1978). Prior to skill practice with the manikin a taped criterion was obtained as a control. A learning trial consisted of three minutes of instruction by either an inexperienced or experienced instructor on a manikin with either gross or precise KR potential. Three consecutive trials were conducted to provide information about the acquisition of CPR skill. A post-test performance was recorded after a minimum of fifteen minutes to reduce the possible effect of fatigue and determine CPR skill proficiency at the time of certification.

Data from performance tracings were used to calculate absolute error (AE), constant error (CE), and variable error (VE). Proficiency is based on the degree to which the magnitude of error (AE) approximates the criterion performance which is considered error free (zero).

The CE score indicates the directional bias of the errors relative to the criterion and may be used to provide specific remedial instruction. The VE value reflects the consistency of the subject's performance. Error analysis provides quantitive and qualitive data which is sensitive to gradual changes in motor skill performance.

Results were subjected to two-way ANOVA (2 x 2, instructor experience x type of KR) and significant differences were further tested by three-way ANOVA (2 x 2 x 5, instructor experience x type of KR x time). Evidence of superior performance by the experienced instructor group compared to the inexperienced instructor group was obtained for timing of the ventilation phase (p=.000) and total cycle time (p = .002). Subjects using manikins with precise KR potential were superior in compression technique (p =.001), timing of the compression phase (p =.03) and total cycle time (p =.02), compared to the group using gross KR manikins. No significant difference in the post-test was identified for an interaction between instructor experience and type of KR.

Although the study failed to identify a clear advantage of either instructor experience or type of KR provided by the manikin it provided descriptive information about the acquisition of CPR skill proficiency. The error information identified a graded response to instruction, with unique patterns of error change relative to the four treatment groups. A possible speed/accuracy trade-off may exist for ventilation time and technique. Further research is required to identify effective instructional strategies. A gender effect is suspected in view of the finding of under-ventilation and compression by the female subjects while in Tweed's study (1980, b) male subjects demonstrated over-ventilation and over-compression errors. The disparity between actual and assumed CPR proficiency of certified learners, if the finding of this study are replicated, may indicate experimental error in determining CPR skill retention and subsequent interpretation of the significance of retention studies. This study indicates the need for objective methods to evaluate CPR proficiency and determine the efficacy of instructional strategies.

Examiners: [redacted]

Dr. Geoffrey P. Mason

[redacted]

Dr. David Docherty

[redacted]

Dr. Walter Muir

[redacted]

Dr. Loren E. Acker

TABLE OF CONTENTS

Chapter		Page
	Abstract	ii
	Table of Contents	v
	List of Tables	ix
	List of Figures	xiv
	Acknowledgements	xvii
	Dedication	xviii
I	INTRODUCTION	1
II	STATEMENT OF THE PROBLEM	5
III	DEFINITIONS	11
IV	REVIEW OF THE LITERATURE	14
	Terminology	14
	Functions of Feedback	14
	Investigation of Knowledge of Results	16
	Summary	18
V	SPECIFIC RESEARCH QUESTIONS	19
	Statement of Hypotheses	21
VI	PROCEDURES	23
	Subjects	23
	Equipment	23
	Independent Variables	23
	Instructor Experience	23
	Knowledge of Results (KR)	24
	Dependent Variable	24
	Testing Procedure	24
	Statistical Analysis	25

Chapter		Page
VII	RESULTS OF THIS STUDY	29
	Results of the Ventilation Sub-routine Analysis	33
	Hypothesis One	35
	Hypothesis Two	35
	Hypothesis Three	35
	Results of the Compression Sub-routine Analysis	37
	Hypothesis One	38
	Hypothesis Two	38
	Hypothesis Three	40
	Results of the Compression (Camping) Sub-routine Analysis	40
	Hypothesis One	42
	Hypothesis Two	42
	Hypothesis Three	43
	Results of the Compression (Pressure Point) Sub-routine Analysis	43
	Hypothesis One	45
	Hypothesis Two	45
	Hypothesis Three	45
	Results of Time Analysis	45
	Results of Time (Ventilation Phase) Analysis	46
	Hypothesis One	49
	Hypothesis Two	49
	Hypothesis Three	50
	Results of Time (Compression Phase) Analysis	50
	Hypothesis One	51
	Hypothesis Two	51

Chapter		Page
	Hypothesis Three	51
	Results of Time (Total) Analysis	53
	Hypothesis One	55
	Hypothesis Two	55
	Hypothesis Three	56
	Summary of Hypothesis Testing	56
VIII	DISCUSSION	58
	Learning Principles Relevant to This Study	58
	The Role of the Instructor in Motor Learning	64
	Task Analysis	64
	Assessment of Proficiency	66
	Instructional Strategy Selection	72
	Effect of KR in Acquisition of CPR Proficiency	76
	Time Management	77
	Practice Strategies	78
	Information Management	79
	CPR Training in Hospitals	85
	Conclusion	92
	Recommendation One	94
	Recommendation Two	94
	Recommendation Three	95
	Recommendation Four	95
	Recommendation Five	95
	BIBLIOGRAPHY	97
	APPENDIX A Procedure Information	108
	APPENDIX B Ventilation Sub-routine: Tables and Figures	112

Chapter		Page
APPENDIX C	Compression Sub-routine (Compression): Tables and Figures	129
APPENDIX D	Compression Sub-routine (Camping): Tables	144
APPENDIX E	Compression Sub-routine (Pressure Points): Tables	149
APPENDIX F	Time (Ventilation Phase): Tables and Figures	154
APPENDIX G	Time (Compression Phase): Tables and Figures	170
APPENDIX H	Time (Total): Tables and Figures	184

LIST OF TABLES

Table		Page
1	Summary of Studies Concerning the Role of Bystander Rescue	3
2	Cardiopulmonary Resuscitation Training Manikins Classified According to KR Potential: Gross KR	8
3	Cardiopulmonary Resuscitation Training Manikins Classified According to KR Potential: Quantitative Feedback	9
4	Cardiopulmonary Resuscitation Training Manikins Classified According to KR Potential: Quantitative and Qualitative Feedback (Precise)	10
5	Description of Treatment Groups	24
6	Sources of Error for Ventilation, Compression and Timing Sequence; Assigned Error Units and Method of Measurement	26
7	Method of Coding Subject Data	27
8	Hypothetical Results for Three Trials: Raw Data, Absolute Error (AE), Constant Error (CE), and Variable Error (VE)	32
9	Summary of Probability Results for Ventilation Sub-routine Analysis: Two-way ANOVA: Instructor Experience (I) and KR	36
10	Summary of Probability Results for Compression Sub-routine Analysis: Two-way ANOVA: Instructor Experience (I) and KR	39
11	Summary of Probability Results for Camping Analysis: Two-way ANOVA: Instructor Experience (I) and KR	41
12	Summary of Probability Results for Pressure Point Analysis: Two-way ANOVA: Instructor Experience (I) and KR	44
13	Summary of Probability Results for Time (Ventilation Phase) Analysis: Two-way ANOVA: Instructor Experience (I) and KR	47
14	Summary of Probability Results for Time (Compression Phase) Analysis: Two-way ANOVA: Instructor Experience (I) and KR	52
15	Summary of Probability Results for Time (Total) Analysis: Two-way ANOVA: Instructor Experience (I) and KR	54

Table		Page
16	Summary of Statistical Analysis for Sub-routine Hypothesis Analyzed: Ventilation, Compression, Camping, Pressure Points, and Time	57
17	Hypothetical Results for Three Trials: Results, Percentage Correct, Absolute Error (AE), Constant Error (CE), and Variable Error (VE)	63
18	Recorder Tape Analysis for Certification: Degree of Error, Pass or Fail Rating for Sub-routines and Overall Performance: Inexperienced Instructor/gKR Group	67
19	Recorder Tape Analysis for Certification: Degree of Error, Pass or Fail Rating for Sub-routines and Overall Performance: Inexperienced Instructor/pKR Group	68
20	Recorder Tape Analysis for Certification: Degree of Error, Pass or Fail Rating for Sub-routines and Overall Performance: Experienced Instructor/gKR Group	69
21	Recorder Tape Analysis for Certification: Degree of Error, Pass or Fail Rating for Sub-routine and Overall Performance: Experienced Instructor/pKR Group	70
22	Guidelines to Mosston's Spectrum of Treaching Styles with Comments on Relevance in Application in CPR Instruction	74
23	Incidence of Staff Involvement in Resuscitation Attempts Number of Staff Reporting Activity and Total Number of Staff Contacted by Type of Unit in a Referral and Community Hospital	87
24	Skills Utilized by Staff in Reported Arrest Situations at the Referral and Community Hospital (October 1, 1980 until April 1, 1981)	88
25	Comparison of Cardiopulmonary Arrest Response Factors Between a CPR team and Expanded Response Group, Adapted From Bernhard et.al., 1979	90
26	Sources of CPR Training for Nursing Staff in Referral and Community Hospital	91
27	Absolute Error Mean Scores of the Ventilation Sub-routine	113
28	Two-way ANOVA for Absolute Error Ventilation Sub-routine Between Instructor Experience and KR	116
29	Constant Error Mean Scores for Ventilation	117
30	Two-way ANOVA for Constant Error for Ventilation Sub-routine Between Instructor Experience (I) and KR	121

Table		Page
31	Variable Error Mean Scores for Ventilation	122
32	Two-way ANOVA for Variable Error for Ventilation Sub-routine Between Instructor Experience (I) and KR	125
33	Three-way ANOVA of Absolute Error for Ventilation Sub-routine Between Instructor Experience (I), KR and Time	126
34	Three-way ANOVA of Constant Error for Ventilation Sub-routine Between Instructor Experience (I), KR and Time	127
35	Three-way ANOVA of Variable Error for Ventilation Sub-routine Between Instructor Experience (I), KR and Time	128
36	Absolute Error Mean Scores for Compression	130
37	Two-way ANOVA for Absolute Error for Compression Sub-routine Between Instructor Experience (I), and KR	133
38	Constant Error Mean Scores for Compression	134
39	Two-way ANOVA for Constant Error for Compression Sub-routine Between Instructor Experience (I) and KR	136
40	Variable Error Mean Scores for Compression	137
41	Two-way ANOVA for Variable Error for Compression Sub-routine Between Instructor Experience (I) and KR	141
42	Three-way ANOVA of Absolute Error for Compression Sub-routine Between Instructor Experience (I), KR and Time	142
43	Three-way ANOVA of Constant Error for Compression Sub-routine Between Instructor Experience (I) KR and Time	143
44	Absolute Error Mean Scores for Camping	145
45	Two-way ANOVA of Absolute Error for Camping Between Instructor Experience (I) and KR	146
46	Variable Error Mean Scores for Camping	147
47	Two-way ANOVA of Variable Error for Camping Between Instructor Experience (I) and KR	148
48	Absolute Error Mean Scores for Pressure Points	150
49	Two-way ANOVA of Absolute Error for Pressure Points Between Instructor Experience (I) and KR	151

Table		Page
50	Variable Error Mean Scores of Pressure Points	152
51	Two-way ANOVA of Variable Error for Pressure Points Between Instructor Experience (I) and KR	153
52	Absolute Error Mean Scores for Time (Ventilation Phase)	155
53	Two-way ANOVA for Absolute Error for Time (Ventilation Phase) Between Instructor Experience (I) and KR	158
54	Constant Error Mean Scores for Time (Ventilation Phase)	159
55	Two-way ANOVA of Constant Error for Time (Ventilation Phase) Between Instructor Experience (I) and KR	162
56	Variable Error Mean Scores for Time (Ventilation Phase)	163
57	Two-way ANOVA of Variable Error for Time (Ventilation Phase) Between Instructor Experience (I) and KR	166
58	Three-way ANOVA of Absolute Error for Time (Ventilation Phase) Between Instructor Experience (I), KR and Time	167
59	Three-way ANOVA of Constant Error for Time (Ventilation Phase) Between Instructor Experience (I), KR and Time	168
60	Three-way ANOVA of Variable Error for Time (Ventilation Phase) Between Instructor Experience (I), KR and Time	169
61	Absolute Error Mean Scores of Time (Compression Phase)	171
62	Two-way ANOVA of Absolute Error for Time (Compression Phase) Between Instructor Experience (I) and KR	174
63	Constant Error Mean Scores of Time (Compression Phase)	175
64	Two-way ANOVA of Constant Error for Time (Compression Phase) Between Instructor Experience (I) and KR	178
65	Variable Error Mean Scores of Time (Compression Phase)	179
66	Two-way ANOVA of Variable Error for Time (Compression Phase) Between Instructor Experience (I) and KR	182
67	Three-way ANOVA of Constant Error for Time (Compression Phase) Between Instructor Experience (I), KR and Time	183
68	Absolute Error Mean Scores for Time (Total)	185
69	Two-way ANOVA of Absolute Error for Time (Total) Between Instructor Experience (I) and KR	186

Table		Page
70	Constant Error Mean Scores for Time (Total)	139
71	Two-way ANOVA of Constant Error for Time (Total) Between Instructor Experience (I) and KR	192
72	Variable Error Mean Scores for Time (Total)	193
73	Two-way ANOVA of Variable Error for Time (Total) Between Instructor Experience (I) and KR	196

LIST OF FIGURES

Figure		Page
1	Motor learning curve characteristics	60
2	Relationship between ventilation time absolute error and ventilation absolute error on the post-test	82
3	Relationship between compression time, absolute error and compression absolute error on the post-test	82
4	Absolute error mean scores for ventilation for inexperienced (I) and experienced (E) instructors	114
5	Absolute error mean scores for ventilation for gKR (g) and pKR (p)	114
6	Absolute error mean scores for ventilation for treatment groups	115
7	Constant error mean scores for ventilation for inexperienced (I) and experienced (E) instructors	118
8	Constant error mean scores for ventilation for gKR (g) and pKR (p)	119
9	Constant error mean scores for ventilation for treatment groups	120
10	Variable error mean scores for ventilation for inexperienced (I) and experienced (E) instructors	123
11	Variable error mean scores for ventilation for gKR (g) and pKR (p)	123
12	Variable error mean scores for ventilation for treatment groups	124
13	Absolute error mean scores for compression for inexperienced (I) and experienced (E) instructors	131
14	Absolute error mean scores for compression for gKR (g) and pKR (p)	131
15	Absolute error mean scores for compression for treatment groups	132
16	Constant error mean scores for compression for inexperienced (I) and experienced (E) instructors	135

Figure		Page
17	Constant error mean scores for compression for gKR (g) and pKR (p)	135
18	Constant error mean scores for compression for treatment groups	138
19	Variable error mean scores for compression for inexperienced (I) and experienced (E) instructors	139
20	Variable error mean scores for compression for gKR (g) and pKR (p)	139
21	Variable error mean scores for compression for treatment groups	140
22	Absolute error mean scores for time (ventilation phase) for inexperienced (I) and experienced (E) instructors	156
23	Absolute error mean scores for time (ventilation phase) for gKR (g) and pKR (p)	156
24	Absolute error mean scores for ventilation time for treatment groups	157
25	Constant error mean scores for ventilation time inexperienced (I) and experienced (E) instructors	160
26	Constant error mean scores for ventilation time for gKR (g) and pKR (p)	160
27	Constant error mean scores for ventilation time for treatment groups	161
28	Variable error mean scores for ventilation time for inexperienced (I) and experienced (E) instructors	164
29	Variable error mean scores for ventilation time for gKR (g) and pKR (p)	164
30	Variable error mean scores for ventilation time for treatment groups	165
31	Absolute error mean scores for compression time for inexperienced (I) and experienced (E) instructors	172
32	Absolute error mean scores for compression time for gKR (g) and pKR (p)	172

Figure | Page

33 Absolute error mean scores for compression time for treatment groups 173

34 Constant error mean scores for compression time for inexperienced (I) and experienced (E) instructors 176

35 Constant error mean scores for compression time for gKR (g) and pKR (p) 176

36 Constant error mean scores for compression time for treatment groups 177

37 Variable error mean scores for compression time for inexperienced (I) and experienced (E) instructors 180

38 Variable error mean scores for compression time for gKR (g) and pKR (p) 180

39 Variable error mean scores for compression time for treatment groups 181

40 Absolute error mean scores for total time for inexperienced (I) and experienced (E) instructors 187

41 Absolute error mean scores for total time for gKR (g) and pKR (p) 187

42 Absolute error mean scores for time (total) for treatment groups 188

43 Constant error mean scores for time (total) for inexperienced (I) and experienced (E) instructors 190

44 Constant error mean scores for time (total) for gKR (g) and pKR (p) 190

45 Constant error mean scores for total time for treatment groups 191

46 Variable error mean scores for total time for inexperienced (I) and experienced (E) instructors 194

47 Variable error mean scores for total time for gKR (g) and pKR (p) 194

48 Variable error mean scores for total time for treatment groups 195

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DEDICATION

To Ann Schweitzer who has given years to the instruction of CPR and has an incrediable desire to pursue the truth.

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CHAPTER I

INTRODUCTION

Kouwenhoven and associates (1960) identified cardiopulmonary resuscitation (CPR) as a technique by which circulation could be provided to sustain vital organ function during a cardiopulmonary arrest. Each year thousands die unexpectedly from heart disease, drug overdose, suffocation, drowning and trauma. The American Heart Association (AHA) estimates that 40% to 80% of these mortalities could be avoided with immediate application of CPR (AHA, 1980). During the past twenty-five years, CPR has moved out of medical research units and into everyday life. The factors influencing this shift will be reviewed briefly to provide background information relevant to this study.

Cole and Corday (1954) found that severe damage occurred to the brain when it was deprived of oxygenated blood for more than four minutes. Consequently, speed is of the utmost importance in the resuscitation of a cardiopulmonary arrest victim. Medical acceptance of CPR as a means of resuscitating arrest victims has led to the development of teams of medical and paramedical staff, specially trained for response to alarm situations within the hospital complex. However, experience has shown that the majority of cardiopulmonary arrests occur outside the hospital, suggesting the necessity of transmitting CPR training (identification and treatment) to non-professional individuals who may one day be present at the scene of a cardiopulmonary arrest.

Research has consistently found that recovery and discharge rates are doubled when resuscitation is started immediately by a trained individual (i.e. bystander rescue), as opposed to situations when CPR is delayed. In response to these findings, the AHA expanded the target population for basic life support (BLS) instruction to include the general public (AHA, 1978). Table 1 summarizes the statistical evidence supporting the value of bystander rescue for the period 1974 to 1980.

Extensive community training programs have increased the possibility of bystander rescue, but ultimate chances of survival remain dependent on the speed with which definitive medical treatment can be obtained. Mobile rescue units reduce delay in acquiring definitive treatment, and thereby increase survival rates. Originally, paramedic teams responding to suspected 'heart attack' calls were directed by physicians, and this system demonstrated life saving potential. However, the dependence on physicians was costly. When the effectiveness of solely paramedic teams was compared to that of physican-directed teams, no detrimental effects of the former were identified. In some cases even superior paramedic performance was documented. (DeLeo, 1977; Diamond, Schofferman & Elliott, 1977; Hampton, 1977; Lewis, Stang, Fulkerson, Sampson, Scoles & Warren, 1979; White & Parker, 1973).

A mobile rescue program in Columbus (Ohio) is respresentative of how most of these units function. The regular and paramedic rescue units are dispatched simultaneously in response to an emergency call of a life-threatening nature. The average arrival time is three minutes. This free service, supported by city taxes, is reported to cost less than four dollars per taxpayer (Lewis et al., 1979). Eisenberg, Hallstrom & Bergner (1979) identified several factors that may interact to limit the effectiveness of mobile units. First, is the cost of developing and operating an education program for paramedics. Second, there

Table 1

Summary of Studies Concerning the
Role of Bystander Rescue

Author	Factors	Number (%) Successful Resuscitation	Discharged
Liberthson et al. 1974[a]	bystander		43%
	no bystander		28%
Eisenberg et al. 1979[b]	bystander	123 (20%)	
	no bystander	3 (4%)*	
Thompson et al. 1979[c]	bystander	(67%)	43%
	no bystander	(61%)	22%
Cobb 1980	bystander		43%**
	no bystander		21%
McSwain et al. 1980[d]	bystander	5 (26%)	11%
	no bystander	4 (33%)	8%
Tweed et al. 1980[e]	bystander	65 (29%)	25%***
	no bystander		5%

* p .01

** p .001

*** p .0001

a Liberthson, Nagel, Hirschman, & Nussenfeld

b Eisenberg, Hallstrom, & Bergner

c Thompson, Jackson, Mattox, & McIntosh

d McSwain, Garrison, & Artz

e Tweed, Bristow, Donen, & Kirk

is the additional cost of establishing and operating the mobile rescue units. Third, there are various geographic factors, such as low population density and increased transportation time. Eisenberg suggests that, in order to improve mobile unit success, the skill level required to instigate definitive treatment should be reassessed, and "fail-safe" equipment, minimizing the role of the operator's clinical judgement, should be developed. There is a relationship between bystander rescue and the rapid provision of definitive treatment that determines the ultimate probability of resuscitation. Reduced effectiveness of either component seriously affects survival (Eisenberg, Bergner & Hallstrom, 1979; Eisenberg, Hallstrom & Bergner, 1981; Myerburg, Kessler, Zaman, Conde & Castellano, 1982).

In summary, effective resuscitation frequently depends on the combination of bystander CPR and prompt provision of definitive care. The past decade has seen extensive activity in general public education programs and sophisticated emergency medical intervention, but the gain in survival rates has been modest. Bernhard, Turndorf, Cottrell, Vea and Basak (1979) concluded that the ability of the rescuer to produce a palpable pulse while conducting CPR was the most important factor in determining the resumption of adequate spontaneous cardiac function. Failure to adequately ventilate, compress the chest, or maintain the timing sequence, will reduce the effectiveness of CPR and may result in increased risk of brain damage and/or ultimate failure to resuscitate Thompson, Hallstrom & Cobb, 1979). The challenge is to develop an instructional program in which there is a high probability that the learner will efficiently achieve and retain CPR proficiency.

CHAPTER II

STATEMENT OF THE PROBLEM

> "The primary objective of any course in BLS is to insure that each student accurately learns and retains the psychomotor skills of cardiopulmonary resuscitation."
> American Heart Association: Manual for Instructors of Basic Life Support, 1977, page 27.

Since the introduction of CPR, over 21 million Americans have been trained in its application (Page, 1980). Magill and Dowell (1977), and Wrisberg (1975) report that retention is generally better for motor learning than for verbal learning; however, CPR retention studies conflict with motor learning research in that CPR proficiency appears to decline within one year (Birch, 1967; Weaver, Ramirez, Dorfam & Ramirez, 1979; Winchell & Safar, 1966). As it is the proficiency achieved during instruction that is the principal determinant of the skill retention level (Fleishman & Parker, 1962; Melnick, 1971; Purdy & Lockhard, 1962), improvement of instruction technique should influence the level of competence retained. Factors in the instructional phase of CPR are the task characteristics of the skill, the instructor, and the training manikin.

Analysis of motor skills is based on motor pattern complexity, the controlling environmental cues, and the performance speed. Continuous tasks involve repetition of the motor pattern. Discrete tasks have a motor pattern with readily identified beginning and end points. When discrete tasks rapidly follow each other, the term "sub-routine" is used, and the chain of behaviors is a "serial task". Generally, continuous tasks are learned faster, and are retained better, than comparable discrete skills (Ammons, Farr, Block, Neumann, Marion & Ammons, 1958; Battig, Nagel, Voss & Brogden, 1950; Bell, 1950; Bilodeau & Levy, 1964; Lersten, 1969; Neumann & Ammons, 1957; Smith, 1970; Stelmach, 1974). Schmidt (1972) and Stelmach (1974) found that an interaction between cognitive and motor abilities was required to maintain the order of sub-routines that compose the performance. Increased recall for the beginning and end of serial elements has consistently been demonstrated for verbal recall and supported in motor studies of linear position (Magill & Dowell, 1977; Wilberg & Gerard, 1977; Wrisberg, 1975). CPR is a serial task composed of sub-routines of varying complexity which must be performed in a specified time span. The determination of proficiency level for specific sub-routines as a function of instructional approach should enable selective modification and evaluation.

Instructors influence learning by providing initial information relative to the activity and later, feedback about performance. Mastery of the motor task was identified by Locke (1972) as a determinant of the instructors ability to appraise performance. Hoffman (1977) found that effective instructors were able to detect problems and provide constructive feedback that enabled changes in behavior, and subsequently increased learner proficiency. Although feedback may increase the learning rate, ambiguous information and omissions (due to inept appraisal of the performance) interfere with efforts to meet the criterion (Robb, 1972). Ideally, the instructor should be able to provide a critique of the performance and plan remedial learning experiences so that the criterion performance may be most expediently achieved.

CPR instruction and practice depends on the use of training devices referred to as manikins. The Canadian Heart Foundation (CHF) recommends that the manikin provide simulated practice in airway maintenance, ventilation and compression (CHF, 1978). Cues that provide feedback are inherent in the manikin design. This information may be used by the learner or instructor to evaluate and modify performance in order to meet the criterion. Manikins differ in the presentation, precision and type of feedback provided. The cost of the manikin reflects the precision of feedback provided. Tables 2, 3, and 4 reviews the feedback capability and cost of manikins currently marketed in North America. Although there may be assumptions regarding the advantages of using sophisticated manikins (such as the recording Resusci Anne[R]), there has been no objective research comparing the proficiency achieved on particular models.

Critical variables in the training of CPR appear to be the instructor and manikin. The focus of this study is the evaluation of CPR performance/proficiency after receiving instruction from either an experienced or inexperienced instructor, with manikins having different feedback potential. If a difference in proficiency were to be demonstrated, selection of training manikins could be based on some objective findings regarding their potential to facilitate the acquisition of the skill of CPR in the light of their costs.

Table 2

Cardiopulmonary Resuscitation Training Manikins Classified According to KR Potential: Gross KR

Manikin	Ventilation	Compression	Timer	Carotid	Recorder	Cost[a]	Comments
			Visual Feedback (Gross)				
Ambu International Ambu CPR Simulator II	Visual Optional	Visual Optional	No	Yes	Optional	$495	Basic unit not human form.
Laerdal Medical Corp. Resusci Anne Torso Practice	Visual	Visual	No	Yes	No	$290	Torso may be converted to full body
Anatomic Anne	Visual	Visual	No	No	No	$350	Designed to illustrate internal organs.
Bio-Medical Engineering Ressi Jane RJ 1000-1	Visual	Visual	No	No	No	$299	

[a] Cost subject to change

Table 3

Cardiopulmonary Resuscitation Training Manikins Classified According to KR Potential: Quantitative Feedback

Manikin	Ventilation	Compression	Timer	Carotid	Recorder	Cost[a]	Comments
		Visual Plus Light Indicators					
Ambu International		Optional Gauge ($135)				$765	Adapt to basic CPR Mani
Bio-Medical Engineering Ressi Jane RJ 1000	Green light- Adequate volume	Yellow light- Adequate pressure Blue light- (Continuous 'camping' Blue light- (Flash) incorrect hand position	No	No	No	$489	Batteries
Brunswick Manufacturing CPR Mani	Light- Adequate volume	Light- Adequate pressure Light- Correct hand position	Optional	Yes	Optional	$375	CPR Mani with recorder sensor extra ($475) Child simulator models interchangeable springs for simulating different chest sizes Batter - Option CPR Performance Analyzer Timer, metronome
Laerdal Medical Corp Resusi Anne Torso	Green light- Adequate volume	Amber light- Adequate pressure Red light- Incorrect hand position	No	Yes	No	$435	May be converted to full body Full body model ($545)

[a] Cost subject to change

Table 4

Cardiopulmonary Resuscitation Training Manikins Classified According to KR Potential: Quantitative and Qualitative Feedback (Precise)

Manikin	Ventilation	Compression	Timer	Carotid	Recorder	Cost[a]	Comments
			Visual, Light, and Tape Recording				
Ambu International Ambu CPR Simulator	Light Adequate Volume	Light - Adequate pressure Light - Correct hand position	Audible Optional Tape	Yes	Optional	$1080	-Recorder plug in -Performance Analyzer -metronome -timer (2 minute) -Records -ventilation volume -compression depth -incorrect hand position -Paper 4 rolls/16.50
Laerdal Medical Corp Recording Resusi Anne	Green Light Adequate Volume	Amber light Adequate Pressure Red Light Incorrect Hand position	Tape	Yes	Yes	$1100	-Records -ventilation volume -compression depth -incorrect hand position -carotid pulse -Metronome -60 beats/minutes -80 beats/minutes -Paper -Battery

[a] Cost subject to change

CHAPTER III

DEFINITIONS

Some definitions of terms used in this thesis are as follows:

1. AUGMENTED FEEDBACK: Information that is not inherent in the task (Sage, 1977, page 413). This information may be perceived by the performer, or provided by an instructor or mechanical device.

2. BASIC LIFE SUPPORT (BLS): An emergency first-aid procedure that consists of 1) the recognition of airway obstruction, respiratory arrest, and cardiac arrest, and 2) the proper application of cardiopulmonary resuscitation (CPR).

3. CAMPING: An error in compression performance from failure to relieve the pressure on the chest after the downward thrust.

4. CARDIOPULMONARY RESUSCITATION (CPR): A sequence of activities directed towards maintaining vital functions of an individual who is not breathing and is without a heart beat. For the purpose of this study the criterion skill is Basic Life Support, Single Rescuer (CHF, 1978).

5. CLOSED-SKILL: A skill in which consistency of movement pattern is required, and the cues to initiate the behavior are specific stimuli present in the environment. The environmental cue for the initiation of CPR is the absence of a carotid pulse.

6. COMPRESSION SUB-ROUTINE: A series of behaviors consisting of obtaining the appropriate pressure site, performing the downward thrust and establishing the correct rhythm.

7. CONCURRENT FEEDBACK: Information received by the performer during

the activity (Sage, 1977, page 414). Intrinsic feedback is received during the movement, whereas augmented feedback is related to the task characteristics. For example, the performer feels the amount of pressure applied to the chest during the CPR movement, and sees the chest move in response to the compression.

8. FEEDBACK: Information a performer receives about the behavior enacted and/or the consequences of that behavior (Sage, 1977, page 411).

9. INTRINSIC FEEDBACK: Information produced by the response that is supplied to the performer as an inherent consequence of the performance.

10. KNOWLEDGE OF PERFORMANCE: Information about the performer's movement pattern (Sage, 1977, page 414). The instructor observes the skill performance and interprets the degree to which the appearance of the movement possesses characteristics that would support successful outcomes.

11. KNOWLEDGE OF RESULTS (KR): Information provided about the change in the environment that the activity produced (Sage, 1977, page 414). Although it is possible to see the manikin chest move with ventilation and compression, the amount of information provided by this observation is limited compared to electronic feedback (KR) provided by lights indicating adequate volume or compression weight. The tape recording provides a permanent record of performance characteristics: ventilation volume, compression depth, camping, pressure points and timing or events.

12. MANIKIN: Term applied to the training devices developed to provide simulated practice for CPR skill.

13. MOTOR LEARNING: Improvement in proficiency of a motor skill that is due to experimental or practice conditions rather than to maturational processes or temporary motivational and physiological fluctuations (Stallings, 1973, page 9). Proficiency may be measured by comparing the performance with the criterion skill.

14. MOTOR PERFORMANCE: The achievement of the performer on a given trial (Sage, 1977, page 349).

15. PRESSURE POINTS: An error in technique due to performing a compression movement at the wrong site. The recorded performance of the error is indicated by a dot below each incorrect compression.

16. PROFICIENCY: The level of performance relative to the criterion.

17. SERIAL TASK: A behavior where the beginning and end of the task units are identifiable, and the units follow each other in a sequence (Fitts and Posner, 1964).

18. SUB-ROUTINE: A specific motor task unit which, when performed in order, comprises a serial task.

19. TERMINAL FEEDBACK: Information received as a normal consequence of activity (Sage, 1977, page 414). Augmented terminal feedback may be provided by an observer or mechanical device. There is not intrinsic terminal feedback potential for CPR on a manikin. Therefore, information must be provided by the instructor or a mechanical source, such as the tape recording of the performance.

20. VENTILATION SUB-ROUTINE: A series of behaviors consisting of obtaining an airway, and providing a specified number of breaths, within a five second time interval.

CHAPTER IV

REVIEW OF THE LITERATURE

> "Studies of feedback or knowledge of results show it to be the strongest most important variable controlling performance and learning." (Fitts, 1964).

Terminology

Information received as a result of an activity is called feedback. Information may be inherent in performance of the activity, or augmented by outside sources such as the performer's experience, an observer or a mechanical device. Concurrent feedback is perceived during performance, whereas terminal feedback is information received after completion of the task. Knowledge of results (KR) is information provided about the result or change in the environment that the activity produced. Knowledge of performance (KP) is the information about the performer's movement pattern. Both KR and KP may be provided concurrently with the activity or terminally after the activity has finished.

Functions of Feedback

Feedback serves three functions: information, motivation and reinforcement (Ammons, 1956). There may be an interaction between these functions, but few investigations have resulted in conclusive findings (Allan & Clark, 1979; Sage, 1977).

Informational aspects of KR are described as quantitative or qualitative. Research indicates that quantitative KR is the more important aspect relative to improving performance (McGligan, 1959; Smoll, 1972; Throwbridge & Cason, 1932). Gill (1965) studied the effect of KR precision on learning by using centimeters or millimeters to provide quantitative KR to subjects. Gill reported equal performance proficiency but the precise feedback group was more negative in its evaluation of performance. Some writers suggest a curvilinear relationship between performance and precision where there is an optimal level of precision beyond which learning may show no improvement or even be adversely affected (Ammons, 1956; Bilodeau, 1966; Newell & Kennedy, 1978; Rogers, 1972; Smoll, 1972).

The informational value of KR varies with individual performer differences and task demands (Hayes & Marteniuk, 1976). Several studies support the effectiveness of visual, auditory and kinesthetic feedback (Chase, Harvey, Steadfast, Rapin, & Sutton, 1961, a and b; Lincoln, 1956). Robb (1968) used combinations of visual, proprioceptive, concurrent and terminal feedback to develop an arm movement pattern. She found that increased proficiency in performance correlated with the variety of KR provided.

The mental developmental level of the learner has been thought to influence the ability to use KR in motor learning. Children are less able to use precise forms of feedback than adults (Connoly & Jones, 1970; Newell & Kennedy, 1978). Tally (1976) found that retarded children improved more with auditory KR, while a normal group did better with visual KR. It is possible that lack of knowledge rather than maturation limits a child's ability to utilize various types of feedback to modify his performance towards a criterion.

Elwell and Grindley (1938) demonstrated the motivational aspect of KR. They did not permit subjects to see a target on which they were attempting to focus a light. The subjects expressed anger and became unreliable about arriving for scheduled sessions. In another study (MacPherson, Dees & Grindley, 1949), scores were immediately reduced by warning subjects not to expect KR for the next block of trials.

Reinforcement is demonstrated when an event following a response alters the probability of that response recurring under similar environmental circumstances. The direction of the rate of change is reflected by the type of reinforcer. The presentation of a positive reinforcer will increase the probability of occurrence, while the presentation of a negative reinforcer does the opposite. The schedule under which reinforcers are presented has an effect on the acquisition or extinction of the response.

Investigation of Knowledge of Results

Concurrent KR facilitates the acquisition of sub-routine proficiency. Chase et al. (1961, a) used concurrent augmented auditory KR to improve key-tapping proficiency. Studies agree that concurrent and terminal augmented KR will accelerate acquisition of skills (Lincoln, 1956; Reynolds & Adams, 1953; Robb, 1968; Smode, 1958). Terminal augmented KR has been classified according to the time of administration and the relationship to task responses.

There is no agreement among investigators about the effect of delay in KR. Lorge and Thorndike (1935) launched the debate when they found no detrimental effect from delaying KR up to six seconds for a ball-tossing task. They argued that the principle of reinforcement as soon as possible is acceptable in animal studies but not in regard to human motor learning. Bilodeau (1956), found that learning still occurred when KR was provided three, four or five trials apart from the reference response. She stated that performance improves relative to the absolute number of trials for which KR was provided, and consequently, the more frequently KR was provided, the better the performance. Magill (1977) has successfully replicated Bilodeau's findings. Researchers who have found KR delay to interfere with skill acquisition are Greenspoon and Foreman (1956), Dyal (1964, 1966), and Shea and Upton (1976).

Some studies have argued that activity during the post-KR interval is of no significance, but Boucher (1974) suggested a detrimental effect. In their analyses of these equivocal findings, Schendel and Newell (1976) cited procedural differences that may account for the range in results. These differences included instructions to subjects, control factors, task criteria and the specific type of post-KR activity.

Withdrawal of KR has been cited by some researchers to result in deterioration of a performance (Bilodeau, Bilodeau & Schamsky, 1959). This phenomenon has been labelled 'extinction' and is thought to be related to the schedule of KR administration. McGuigan (1959) and Taylor and Nobel (1962) have demonstrated that when KR is provided for each response, learning is efficient but more susceptible to extinction when KR is withdrawn. An intermittent schedule of KR has been found to be more resistant to extinction.

Adam's Closed-loop Theory postulates that there are two memory states involved in performance (Adams, 1971). First, is the memory trace, which is the ability to select the appropriate response. Second, is the perecptual trace, which is the ability to recognize appropriate performance. KR is essential in the learning stage, but, once developed, the performance will not deteriorate if KR is withdrawn. Studies that have withdrawn KR at different points during skill acquisition trials have supported Adam's hypothesis (Newell, 1974; Schmidt & White, 1972).

Most research on the effect of KR has been directed at novel motor tasks which meet control criteria, but few studies have been conducted with respect to gross motor skills. Howell (1956) improved sprinters' starting by providing a force/time graph for each practice session. Malina (1969) demonstrated specific improvement in throwing speed or accuracy, depending on the KR information provided to the performer.

Summary

Research about the effects of KR has resulted in three empirical findings. First, the performance does not improve without KR. Second, the rate of performance improvement is related to the absolute frequency of KR provision. Third, performance may deteriorate or fail to improve after withdrawal of KR. Augmented KR has improved proficiency when KR is inherent in the task for the performer (Smode, 1958), but there is conflicting evidence regarding lack of improvement when there is adequate inherent feedback to judge the success of performance (Bell, 1968; Bilodeau, 1969).

CHAPTER V

SPECIFIC RESEARCH QUESTIONS

Three factors have significantly escalated the demand for BLS training: CPR becoming a requisite for health care education programs, legislation pertaining to safety requirements in work or public environments, and an increased participation of lay individuals in community rescue programs. Marshall (1981) predicted the Metro-Save-A-Life program (Toronto) could train 200,000 persons over a five year span. Unfortunately, the provision of training is restricted by the number of instructors and manikins available. It is further stressed by the AHA (1978) recommendation that each person participate in a refresher yearly, which would also limit the present ability to expand the bystander rescuer pool. On the other hand, if proficiency could be improved and retention prolonged, energies and resources could be redirected, so that additional rescuers would receive training. Skill retention is the major issue. The role of initial proficiency (vis a vis retention) has been adequately supported by research to warrant study of the acquisition of CPR skill within the context of current instructional practices. Factors influencing the selection of specific research questions for this study will be briefly presented.

Gagne (1970) classifies instruction as being 'pre-designed' if procedures are proven prior to application, or 'extemporaneously designed' if the instructor selects methods based on intuition or past experience. To develop an instructional strategy Gagne recommends that four conditions be considered. First, the pre-requisite capabilities of the learner should be identified. Second, the program plan should provide for motivational and educational needs. Third, planning and evaluation of instructional procedures should be relevant to external conditions, such as sequencing, presentation, or feedback. Fourth, instructional media or equipment should be evaluated on the basis of utility and effectiveness in facilitating learning.

Briggs (1970) used Gagne's learning taxonomy to develop guidelines to evaluate instructional media. He proposed a 'systems' model of instruction characterized by a terminal performance goal, an assessment of progress, and a selection of alternative instructional procedures or materials, based on empirical evidence. Further, he contends that specific elements, for example, the instructor, method, or media, may influence learning singularly, or in combination.

There appears to be little research specifically related to the learning of CPR skill. Since the manikin is a highly controllable component of CPR instruction, it would seem advisable to commence specific research by examining the relative instructional value(s) of manikins with different KR potentials.

If improved proficiency is demonstrated, the potential to facilitate skill acquisition could be used, in conjunction with durability and cost factors, in making decisions concerning selection and purchase of specific manikins. Unfortunately, however, even if a given model proves superior, the additional cost of purchase, operation, and/or maintenance may limit the number an agency could afford. In order to have an adequate number of manikins to operate programs, many agencies have a limited number of sophisticated models and augment these with less expensive models. Objective information about the potential to facilitate proficiency could be utilized to set priorities for the allocation of models to learner groups. For example, paramedics might use precise KR models whereas groups with less likelihood of having to apply CPR skills could be assigned less complex models.

It is possible that proficiency may not be significantly better with precise KR. Inappropriate feedback, failure to utilize available information, and unfavourable learner characteristics can inhibit skill acquisition. Advice about how to utilize manikin feedback is scarce and ambiguous. Smith and Newman (1982) warn that students may become dependent on feedback, and thus, may not be able to respond properly when the patient does not produce signals to indicate appropriate performance. Further, they recommend that the student not be allowed to monitor his own technique, but have another student provide information at the completion of the activity (Smith & Newman, 1982, page 76). Instructor opinion varies widely concerning the instructional merits of manikin models with sophisticated KR features. Some consider them to be frivolous gadgetry, while others feel they are almost capable of replacing the instructor. The goal of this study is to provide an objective analysis regarding the effect of manikin KR on proficiency acquisition in CPR instruction.

Statement of Hypotheses

The parameters of CPR performance analysed were: ventilation volume, compression depth, incidence of camping, incidence of pressure point error and timing. Each parameter will be tested using the following null hypotheses:

Hypothesis One

There is no difference in CPR skill proficiency following instruction by an inexperienced or experienced instructor.

Hypothesis Two

There is no difference in CPR skill proficiency following instruction and practice with a manikin having gross KR or precise KR.

Hypothesis Three

There is no differential difference in CPR skill proficiency following instruction and practice with an inexperienced or experienced instructor using a manikin having gross KR or precise KR.

CHAPTER VI

PROCEDURES

Subjects

The subjects were forty-eight female volunteers who had never practised CPR on a manikin prior to the study. The group was composed of thirty-six first-year nursing students (Camosun College) and twelve employees of the University of Victoria Extention Department. The age range was from eighteen to forty-eight years.

Equipment

The recording Resusci Anne[R] provides KR visually, electronically, and graphically for carotid pulse, ventilation, compression, pressure points, and timing. This model is the most popular sophisticated manikin, has an acceptable reputation as a training device, and has been used in studies of CPR proficiency.

Independent Variables

1. Instructor Experience

Experienced instructors employed in this study had taught a minimum of six sessions, with the assigned KR feedback, during the period of 1979-1981. Inexperienced instructors had not taught CPR other than during their instructors' training program.

It was considered essential to the study that the experienced instructor be familiar with the operation of the Resusci Anne[R] manikin in order to evaluate the effect of the KR provided in the learning situation. Consequently, each experienced instructor was assigned to a treatment group in which she had the most experience. Inexperienced instructors were randomly assigned to KR treatment groups.

2. Knowledge of Results (KR)

The Resusci Anne[R] manikin was used for both gross and precise KR treatment groups. The 'torso' models provide KR in the form of chest movement subsequent to adequate ventilation and compression (Gross KR). The Resusci Anne[R] was reduced to a torso manikin by eliminating electronic and graphic feedback. In the precise KR treatment groups the Resusci Anne[R] was used with complete information available to the instructor and the subject. Table 5 describes the characteristics of the treatment groups.

Table 5

Description of Treatment Groups

Group Designation	N	Code
Experienced Instructor/gross KR	12	E/gKR
Experienced Instructor/precise KR	12	E/pKR
Inexperienced Instructor/gross KR	12	I/gKR
Inexperienced Instructor/precise KR	12	I/pKR

Dependent Variable

The dependent variable is the CPR skill proficiency achieved by the subject. Performance was recorded prior to practice and instruction, and every three minutes during the data collection phase. The Canadian Heart Foundation (1978) standard for Single Rescuer Basic Life Support was the criterion by which performance was evaluated, (Appendix A).

Testing Procedure

The subjects attended a CPR education program in which the slide and tape program 'Time is in Your Hands' was shown followed be a demonstration of CPR, using a manikin without sophisticated feedback. Prior to practice and instruction, each subject performed the criterion task, and the performance was recorded to provide control data. Three consecutive practice and instruction trials were provided for each subject. The post-test performance was recorded after a minimum of fifteen minutes rest, in order to reduce possible effects of fatigue.

Each instructor was randomly assigned four subjects. The same manikin was used for recording and practice activities to prevent data error from manikin differences.

Statistical Analysis

For the purposes of this study, measurement of skill proficiency was based on the elimination of error from the performance. This approach is suitable for skills in which the criterion may not be accomplished by the time of assessment. It also enables a comparison of skill performance at different levels of proficiency. Performance is compared to a criterion, and deviations are identified as errors.

The sequence, sources of error, and method of measuring error units are identified and listed in Table 6 . In this study, absolute, constant, and variable errors were measured.

Absolute error (AE) is the deviation from the criterion that is observable. The criterion performance has zero error. The magnitude of the error in the measured performance reflects the degree of deviation relative to the criterion. Improved proficiency is indicated by a reduction in performance error.

Constant error (CE) reflects directional bias in performance. The calculation of CE involves the use of signs. Scores in excess of the criterion are designated as positive, and scores below the criterion as negative. The sign of the CE indicates the average directional character of the error.

Table 6

Sources of Error for Ventilation, Compression and Timing Sequence; Assigned Error Units and Method of Measurement

Sub-routine	Type of Error	Error Unit Measurement
Ventilation	Inadequate	One unit per millimeter below the 800 ml line.
	Excessive	One unit per millimeter above the 1200 ml line.
Compression	Inadequate	One unit per millimeter above the accepted compression boundary line.
	Excessive	One unit per millimeter below the accepted compression boundary line.
	Camping: Failure to release pressure after compression.	One unit per millimeter below a line drawn from the no pressure on the chest recording to the following no pressure point.
	Pressure Point: Faulty hand position.	One unit per mark on recording incorrect hand position space.
Time	Fast	One unit per second deficient of the number of seconds allowed as minimum.
	Slow	One unit per second in excess of the number of seconds allowed as maximum.

Table 7

Method of Coding Subject Data

Instructor	Knowledge of Results	Subject Number	Code
Experienced	Gross	1, 2, 3 ... 12	E/gKR#
Experienced	Precise	13, 14, 15 ... 24	E/pKR#
Inexperienced	Gross	25, 26, 27 ... 36	I/gKR#
Inexperienced	Precise	37, 38, 39 ... 48	I/pKR#

The variable error (VE) reflects the degree of variation or inconsistency in the subject's performance, relative to her own mean performance. If the scores are the same, the VE value is zero. Increased variability in scores results in an increased VE score.

Subjects were identified by a code that specified the instructor, treatment group, and subject number (Table 7). Each performance recording was labelled with the subject's code identification and the appropriate trial number (pre-test, practice and instruction trial 1-3, post-test).

Random numbers were selected from a random number table and assigned to the subjects' recordings to provide blind scoring by the judges. A record was kept of each subject's identification code and random number (Appendix A).

Two independent judges scored the recordings. The scores for each sub-routine were compared to determine inter-judge reliability. The data were remeasured when any difference in scores existed. When there was agreement between the scores, the data were entered into analyses of the absolute, constant, and variable error types. The group results are represented graphically for each type of error.

A two-way (2 x 2, instructor experience x KR) ANOVA was conducted on post-test scores to determine if there was a significant difference in proficiency between the level of experience and KR. Additionally, sub-routines which demonstrated a significant difference were subjected to a three-way ANOVA (2 x 2 x 5, instructor experience x KR x time) in an effort to provide post-hoc hypothesis, which could be useful for subsequent investigations of trial by trial behaviors of instructors and students. Significant differences found at this stage were further analyzed by Scheffe post-hoc comparison in order to identify specific differences.

CHAPTER VII

RESULTS OF THIS STUDY

The results of this study were assessed in terms of the following parameters: ventilation, compression, camping, pressure points, and time. Mean values for absolute error (AE), constant error (CE), and variable error (VE), were analyzed by two-way ANOVA (2 x 2, instructor experience x KR). Significant findings were subjected to three-way ANOVA (2 x 2 x 5, instructor experience x KR x time). A post hoc Scheffe comparison was conducted on all significant three-way ANOVA results but no significant differences were identified.

Error measurement was used to determine performance proficiency on the assumption that absence of error reflects criterion performance. Methods of calculating error measurements may be illustrated as follows:

1. Raw Data (example ventilation analysis)

> There are 10 ventilation units in the Single Rescue CPR cycle. The taped performance is measured according to Table 6. The following error scores indicate the relative magnitude and direction of the error for each ventilation. A positive value indicates over-ventilation while a negative value indicates under-ventilation.

1.	-7	6.	0
2.	-7	7.	0
3.	-7	8.	0
4.	-7	9.	0
5.	0	10.	0

2. Absolute Error Calculation

The AE is the arithmetic mean of the error disregarding the sign.

$$AE = \frac{\text{error scores}}{\text{number of units}} = \frac{(7) + (7) + (7) + (7)}{10} + \ldots (0)$$

$$AE = 3.5$$

3. Constant Error

The CE is the average of the signed differences between the criterion and the performance score.

$$CE = \frac{(-7) + (-7) + (-7) + (-7) + (-7)}{10}$$

$$CE = -3.5$$

4. Variable Error

Variable error is the standard deviation of the subject's scores.

$$VE = \sqrt{\frac{\sum_{t=n}^{n} (X_t - CE)^2}{n}}$$

$$VE = \sqrt{\frac{-7 - (3.5)^2 + (-7 - 12.25) + \ldots . (-19.55)}{10}}$$

$$VE = 3.12$$

To facilitate interpretation of the error mean scores, a set of hypothetical results are presented in Table 8 . The results reflect different performance characteristics for each trial. The AE indicates that the magnitude of error tended to decrease in successive trials (from 3.5 in Trial 1 to 0.5 in Trial 3). The CE score indicates that the subject under-ventilated to a greater degree in Trial 1 (-3.5) then Trial 2 (-1.5), but over-ventilated slightly in Trial 3 (+0.5). VE is sensitive to the consistency of the subject's performance. If every score was the same the performance would be consistent and the VE would be zero. The VE score is expressed as a standard deviation of the subject's scores and, therefore, increased values indicate greater inconsistency. The information in Table 8 reveals that in Trial 1 the subject demonstrated a greater magnitude of error, under ventilated more and showed less consistency in ventilation performance than in Trial 2. Trial 3 demonstrates reduction in AE and VE scores, indicating a more proficient and consistent performance. The CE reflects slight over-ventilation, relative to the criterion.

Error measurements provide quantitative and qualitative information, but the interpretation of the scores depends on the relationship of the measurement to the task. In this case, measurements for ventilation, compression, and camping do not represent absolute values, but rather degrees of approximation to the criterion. The time measurement was based on the second marks on the tape, therefore error scores reflect time in terms of seconds. A time CE value of +2 indicates two seconds over the criterion. In contrast, ventilation CE values of -2 and +2 indicate degrees of deviation below and above the criterion, respectively, but cannot be translated into air volume measures.

Table 8

Hypothetical Results for Three Trials:
Raw Data, Absolute Error (AE), Constant Error (CE),
and
Variable Error (VE)

Trial	Results	AE	CE	VE
1	-7, -7, -7 -7, -7, 0 0, 0, 0, 0	3.5	-3.5	3.12
2	-1, -2, -3 -4, -5, 0 0, 0, 0, 0	1.5	-1.5	1.62
3	+1, +1, +1 +1, +1, 0 0, 0, 0, 0	0.5	+0.5	0.61

To facilitate interpretation of the results each parameter analyzed will be discussed separately with a summary table of statistical findings for AE, CE and VE provided within the text. Mean error scores, statistical analysis data and figures depicting skill acquisition are collected in appendices relating to the parameter studied. Description of the independent variables and treatment groups are abbreviated as follows:

I	inexperienced instructor
E	experienced instructor
gKR	gross KR
pKR	precise KR
I/gKR	inexperienced instructor with gross KR
I/pKR	inexperienced instructor with precise KR
E/gKR	experienced instructor with gross KR
E/pKR	experienced instructor with precise KR

Results of the Ventilation Sub-routine Analysis

All treatment groups reduced the magnitude of error over the trials (Appendix B; Figures 4, 5 and 6). The AE for instructor experience and KR were significantly different in Trials 1 to 3, but not in the post-test (Appendix B; Table 28). Groups with I had a lower AE mean score than groups with E (Appendix B; Figure 4). This result was similar to that of lower scores associated with KR (Appendix B; Figure 5). The I/pKR group in Trial 3 had the highest magnitude of error compared to the remaining three groups ($p = .004$; Appendix B; Table 28). The groups with E or pKR were more effective during training, but post-test differences were not significant (Appendix B; Table 28). The significant difference associated with the I/pKR group was probably the result of the other treatment groups having reduced AE mean scores (resulting in an increased difference for Trial 3), but the gap was closed during the post-test (Appendix B; Table 28). Consistently higher AE mean scores occurred in the I/pKR group, suggesting less benefit from the experience. However, no evidence of advantage for either of the main effects or an interaction was obtained.

Under-ventilation was demonstrated by all groups throughout the trials (Appendix B; Table 29). Reduction of the deficit with I was superior in Trial 1 ($p = .04$), Trial 2 ($p = .02$), and Trial 3 ($p = .001$), but not in the post-test (Appendix B; Table 30). A significant pKR effect was maintained, and was characterized by a rapid and steady deficit reduction from Trial 1 to the post-test: Trial 1 ($p = .005$), Trial 2 ($p = .004$), Trial 3 ($p = .02$), and post-test ($p = .02$; Appendix B; Table 30). The failure of the I/pKR group to demonstrate comparable error reduction was significant in Trial 3 ($p = .02$; Appendix B; Table 30). I/pKR group lagged behind the other treatment groups, and finished with a greater under-ventilation error than the other treatment groups in Trial 1 (Appendix B; Figure 9).

There were no definite trends evident in the VE mean scores. However, the E/gKR group (Trial 2) and I group (Trial 3) achieved a statistical difference (Appendix B; Table 30) which may be associated with factors specific to the aspect of skill instruction being conducted at that particular time.

Three-way ANOVA of the AE scores (Appendix B; Table 33), indicated a significant difference for instructors experience ($p = .02$), KR ($p = .006$), time ($p = .000$), and instructor experience x KR x time ($p = .009$). Only the instructor experience x KR x time interaction was significant (p = .03) in the three-way ANOVA for the VE measurement (Appendix B; Table 35). Apparently there are effects associated with instructor experience, KR, and time, that influence the achievement of CPR proficiency. These variables may be isolated with continued research.

Table 9 summarizes statistical data shown in Tables 28, 30, and 32 (Appendix B), this information indicates that the attainment of superior proficiency was not significantly affected by instructor experience, KR or their interaction. Precise KR was significantly better in reducing the degree of under-ventilation error (CE) compared to gross KR (Table 9). There was evidence of change in performance consistency (VE), but no trend or sustained effect was reflected by the data (Table 9).

Hypothesis One

The null hypothesis, that there was no difference in ventilation skill proficiency following instruction by an experienced or inexperienced instructor, cannot be rejected by the results of this study.

Hypothesis Two

The null hypothesis, that there was no difference in ventilation skill proficiency following instruction and practice with a manikin having gross KR or precise KR, cannot be rejected by the results of this study.

Hypothesis Three

The null hypothesis, that there was no difference in ventilation skill proficiency following instruction and practice with an inexperienced or experienced instructor using a manikin having gross KR or precise KR, cannot be rejected by the results of this study.

Table 9

Summary of Probability Results for Ventilation Sub-routine Analysis:
Two-way ANOVA: Instructor Experience (I) and KR

Source of Variation	df	Absolute Error[a]	Constant Error[b]	Variable Error[c]
		Control		
Instructor	1	ns	ns	ns
KR	1	ns	ns	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 1		
Instructor	1	0.045	0.04	ns
KR	1	0.006	0.005	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 2		
Instructor	1	0.048	0.02	ns
KR	1	0.010	0.004	ns
I/KR	1	ns	ns	0.03
Error	44			
		Trial 3		
Instructor	1	0.001	0.001	0.004
KR	1	0.036	0.02	ns
I/KR	1	0.004	0.02	ns
Error	44			
		Post-test		
Instructor	1	ns	ns	ns
KR	1	ns	0.02	ns
I/KR	1	ns	ns	ns
Error	44			

[a] Appendix B, Table 28

[b] Appendix B, Table 30

[c] Appendix B, Table 32

Results of the Compression Sub-routine Analysis

A significant advantage of pKR as a factor in reducing the AE mean scores was demonstrated in Trial 2 (p =.002), Trial 3 (p =.002), and the post-test (p =.001; Appendix C; Table 37). The Trial 1 AE mean score achieved by the E group was better than that of the I group (p =.03; Appendix C; Table 37). Because of the isolated occurrence of this finding the causative factor may be emphasis on compression technique at that time. The degree of proficiency exhibited by the treatment groups varied from 0.19 to 2.54 (Appendix C; Table 36), but there was no significant difference from one group to another (Appendix C; Table 37).

CE mean scores indicate under-compression by all treatment groups throughout the study, however the E/pKR group achieved close approximation to the criterion depth in Trial 2 (-0.08). Trial 3 (-0.07) and in the post-test (-0.03; Appendix C; Table 38). The E group had a lesser degree of under-compression that I group in Trial 1 (p =.01) and in the post-test (p =.05; Appendix C; Table 39). A significant trend in reduction of the compression deficit was demonstrated by the pKR group in Trial 2 (p =.002), Trial 3 (p =.001) and the post-test (p =.001; Appendix C; Table 39). There was no evidence of an interaction between instructor experience and type of KR provided (Appendix C; Table 39). The E/pKR group mean CE score during the post-test (0.03; Appendix C; Table 38) closely approximates the criterion. On the other hand the large deficit of -2.53 scored by the I/gKR group, indicates the broad range in error (Appendix C; Table 38).

No significant differences were detected for VE mean scores (Table 10). In general, all groups reduced their inconsistency in compression error relative to controls (Appendix C, Figures 19, 20 and 21).

According to the results of the three-way ANOVA, KR and time were important factors in reducing the magnitude of error reflected by the AE scores ($p= .002$ and $p= .000$ respectively; Appendix C; Table 42). Similarly, three-way ANOVA of the CE mean scores revealed significant effects of KR ($p =.002$) and time ($p =.000$; Appendix C; Table 43).

In summary, the compressions were more proficient during the learning and practice trials (2 and 3) and the post-test for the pKR group (Table 10). pKR reduced the magnitude of error (AE) and the deficit in compression pressure (CE). This trend was established during Trial 1 and maintained throughout the study (Table 10). An indication of experienced instructor advantage, during Trial 1, was probably an artifact and may be due to emphasis on compression instruction at that point (Table 10).

Hypothesis One

The null hypothesis, that there was no difference in compression skill proficiency following instruction by an inexperienced or experienced instructor, cannot be rejected by the results of this study.

Hypothesis Two

The results of this study reject the null hypothesis and indicate a significant difference in compression skill proficiency following instruction and practice with a manikin having precise KR ($p = .001$; Table 11).

Table 10

Summary of Probability Results for Compression Sub-routine Analysis: Two-way ANOVA: Instructor Experience (I) and KR

Source of Variation	df	Absolute Error[a]	Constant Error[b]	Variable Error[c]
		Control		
Instructor	1	ns	ns	ns
KR	1	ns	ns	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 1		
Instructor	1	0.03	0.01	ns
KR	1	0.04	ns	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 2		
Instructor	1	ns	ns	ns
KR	1	0.002	0.002	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 3		
Instructor	1	ns	ns	ns
KR	1	0.001	0.001	ns
I/KR	1	ns	ns	ns
Error	44			
		Post-test		
Instructor	1	ns	0.05	ns
KR	1	0.001	0.001	ns
I/KR	1	ns	ns	ns
Error	44			

[a] Appendix C, Table 37

[b] Appendix C, Table 39

[c] Appendix C, Table 41

Hypothesis Three

The null hypothesis, that there was no difference in compression skill proficiency following instruction and practice with an inexperienced or experienced instructor using a manikin having gross KR or precise KR, cannot be rejected by the results of this study.

Results of the Compression (Camping) Sub-routine Analysis

AE scores for camping were of low magnitude, ranging from 0.20 to 1.17 (Appendix D; Table 44). There appears to be a slight trend towards camping error in all groups except the I/gKR when the control and post-test AE scores are compared (Appendix D; Table 44). This trend may reflect either fatigue or the development of inferior compression technique in order to increase compression depth. The only significant ($p = .05$) point for an interaction between instructor experience and type of KR occurred during Trial 2 (Table 11). This is likely a random effect, as no other differences were identified. CE analysis was not conducted for camping as it is only possible to err in one direction and therefore the CE results would be the same as the AE findings.

Generally, the VE scores were low, indicating consistent performance. However two isolated points of difference were detected during Trial 2 and the post-test (Table 11). As the AE in the post-test was not significant it is assumed that the camping errors which occurred during the post-test were significant in terms of consistency but not in incidence.

Table 11

Summary of Probability Results for Camping Analysis:

Two-way ANOVA: Instructor Experience (I) and KR

Source of Variation	df	Absolute Error[a]	Variable Error[b]
		Control	
Instructor	1	ns	ns
KR	1	ns	ns
I/KR	1	ns	ns
Error	44		
		Trial 1	
Instructor	1	ns	ns
KR	1	ns	ns
I/KR	1	ns	ns
Error	44		
		Trial 2	
Instructor	1	ns	ns
KR	1	ns	ns
I/KR	1	0.05	0.04
Error	44		
		Trial 3	
Instructor	1	ns	ns
KR	1	ns	ns
I/KR	1	ns	ns
Error	44		
		Post-test	
Instructor	1	ns	ns
KR	1	ns	ns
I/KR	1	ns	0.05
Error	44		

[a] Appendix D, Table 45

[b] Appendix D, Table 47

Although, camping errors were low in incidence the relevance of this finding to the performance of CPR and victim outcome depends on the identification of empirical evidence by which the degree of error can be evaluated. There may be a relationship between attempting to increase compression pressure and the incidence of camping in that the correction of inadequate compressions by the pKR group is paralled by increased incidence of camping error. The I group failed to improve compression depth and demonstrated a reduced camping incidence. In view of the failure to demonstrate significant difference in the magnitude of camping error in the post-test analysis the following conclusions are made concerning the hypotheses for this study.

Hypothesis One

The null hypothesis, that there was no difference in the incidence of camping error following instruction by an inexperienced or experienced instructor, cannot be rejected by the results of this study.

Hypothesis Two

The null hypothesis, that there was no difference in the incidence of camping error following instruction with a manikin having gross KR or precise KR, cannot be rejected by the results of this study.

Hypothesis Three

The null hypothesis, that there was no difference in the incidence of camping error following instruction with an inexperienced or experienced instructor using a manikin having gross KR or precise KR, cannot be rejected by the results of this study.

Results of the Compression (Pressure Point) Sub-routine Analysis

Pressure point errors are thought to identify poor compression technique which may potentially cause injury to the victim. Unless the learner's hand position is grossly deviant it may be impossible for the instructor to detect errors when a manikin without electronic feedback is used. The recording Resusci Anne[R] manikin indicates the occurrence of a pressure point error by means of a red light and as a dot on the performance tape.

The incidence of pressure point error was sporadic and low, ranging from 0 to 0.1 (Appendix E; Table 48). The low incidence of pressure point error may reflect the concentration on hand position measurement prior to initiating compressions. Table 12 summarizes the statistical findings related to pressure point AE and VE analysis which indicates no significant differences in performance for either main effect or an interaction. CE analysis would be equal to the AE results due to the unidirectional nature of the error.

Table 12

Summary of Probability Results for Pressure Point Analysis:
Two-way ANOVA: Instructor Experience (I) and KR

Source of Variation	df	Absolute Error[a]	Variable Error[b]
		Control	
Instructor	1	ns	ns
KR	1	ns	ns
I/KR	1	ns	ns
Error	44		
		Trial 1	
Instructor	1	ns	ns
KR	1	ns	ns
I/KR	1	ns	ns
Error	44		
		Trial 2	
Instructor	1	ns	ns
KR	1	ns	ns
I/KR	1	ns	ns
Error	44		
		Trial 3	
Instructor	1	ns	ns
KR	1	ns	ns
I/KR	1	ns	ns
Error	44		
		Post-test	
Instructor	1	ns	ns
KR	1	ns	ns
I/KR	1	ns	ns
Error	44		

[a] Appendix E, Table 49

[b] Appendix E, Table 51

Hypothesis One

The null hypothesis, that there was no difference in the incidence of pressure point error following instruction by an inexperienced or experienced instructor, cannot be rejected by the results of this study.

Hypothesis Two

The null hypothesis, that there was no difference in the incidence of pressure point error following instruction and practice with a manikin having gross KR or precise KR, cannot be rejected by the results of this study.

Hypothesis Three

The null hypothesis, that there was no difference in the incidence of pressure point error following instruction and practice with an inexperienced or experienced instructor using a manikin having gross KR or precise KR, cannot be rejected by the results of this study.

Results of Time Analysis

Ventilation time, compression time, and the total amount of time for the Single Person Rescue were analyzed in this study. There are several factors that justify the division of time into ventilation and compression phases. First, there is a detrimental physiological effect associated with cessation of compressions during the ventilation phase. Progressive decreases in cardiac output and pressure result in limiting the delivery of oxygenated blood to the tissues. Second, the teaching strategies directed towards correcting specific errors differ according to the phase involved. Ventilation delay requires increased speed and efficiency of airway maintenance, ventilation, and resumption of compressions. Correction of compression phase errors usually involves control of compression rhythm. Third, the total magnitude of time error may be dampened if errors in one phase offset those in the other; for example, if ventilation is slow and compressions are fast.

Results of Time (Ventilation Phase) Analysis

The control trial failed to demonstrate homogeneity of performance, in that the experienced instructor group had significantly (p =.04) less error (Appendix F; Table 53). Subsequent treatment trials had increased significance of p =.000 throughout the experience, in view of the extreme significance demonstrated the main effect of instructor experience should be accepted as a legitimate factor rather than an experimental artifact. Figure 22 (Appendix F) illustrates a steady decline in the magnitude of AE which reflects increasing approximation of the criterion time for ventilation for the E group. In contrast, the I group did not reduce the magnitude of AE during the study, the control AE mean score was 2.83 with an increase of error during the instruction trials and a score of 2.81 during the post-test (Appendix F; Table 52; Figure 22).

There was no significant difference for either the type of KR or an interaction between instructor experience and type of KR (Table 13). This may suggest that developing proper timing is more difficult for

Table 13

Summary of Probability Results for Time (Ventilation Phase) Analysis: Two-way ANOVA: Instructor Experience (I) and KR

Source of Variation	df	Absolute Error[a]	Constant Error[b]	Variable Error[c]
		Control		
Instructor	1	0.04	0.03	ns
KR	1	ns	ns	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 1		
Instructor	1	0.000	0.000	0.03
KR	1	ns	ns	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 2		
Instructor	1	0.000	0.000	0.008
KR	1	ns	ns	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 3		
Instructor	1	0.000	0.001	0.02
KR	1	ns	ns	ns
I/KR	1	ns	ns	ns
Error	44			
		Post-test		
Instructor	1	0.000	0.000	0.01
KR	1	ns	ns	ns
I/KR	1	ns	ns	ns
Error	44			

[a] Appendix F, Table 53

[b] Appendix F, Table 55

[c] Appendix F, Table 57

learner than is mastering the physical technique.

The three-way ANOVA indicated a significant difference between instructor experience ($p = .000$), time ($p = .05$) and an interaction between these factors ($p = .02$; Appendix F; Table 58). The ventilation time AE was decreased by all of the treatment groups except the I/gKR group which increased the magnitude of error during the post-test (Appendix F; Table 52; Figure 24). The skill acquisition time factor is important due to the limitation of time to learn the skill during the instruction program. Unfortunately this study did not isolate variables that could be interpreted as having a predictable effect on proficiency.

Positive CE values reflect overtime errors which were evident throughout the trials (Appendix F; Table 54). The E group failed to demonstrate homogeneity of proficiency during the control trial ($p = .03$), but the statistical significance of the reduced time error was increased throughout the trials 1 to 3 and the post-test ($p = .000$, $p = .000$, $p = .001$ and $p = .000$ respectively; Table 13). In view of the demonstrated trend of overtime reduction by the E group and the strong statistical probability values obtained, it is evident that an experienced instructor was advantageous to approximating the ventilation time criterion. Ventilation time has a maximum of five seconds, during which the performer moves from the chest to the head and performs a series of activities which contributes to the proficiency of the ventilation sub-routine in terms of outcome.

The success of the ventilation sub-routine in turn depends on the performer's ability to open the airway and deliver an adequate volume of air. A high degree of proficiency in the motor pattern may be a prerequisite to execution of the behavior within the time criterion.

Three-way ANOVA results supported the apparent importance of instructor experience (p = .000) and time (p = .03) in reducing the CE mean scores (Appendix F; Table 59), which is consistent with the AE results discussed earlier. In a similar vein the VE scores in three-way ANOVA demonstrated support for the instructor experience (p = .002) and time (p = .001; Appendix F; Table 60) as factors influencing the time to improve performance time.

In summary, experienced instructors reduced the magnitude of error (AE), the deficit of error (CE) and increased the consistency of performance (VE) by subjects early in the experience and throughout the trials (Table 13). There were no significant differences in the performance of various KR groups in any trials and there is no evidence of an interaction between instructor experience and KR.

Hypothesis One

The results of this study reject the null hypothesis and indicate a significant difference in time (ventilation phase) proficiency following instruction by an experienced instructor (p =.000; Table 13).

Hypothesis Two

The null hypothesis, that there was no difference in time (ventilation phase) proficiency following instruction and practice with a manikin having gross KR or precise KR, cannot be rejected by the results of this study.

Hypothesis Three

The null hypothesis, that there was no difference in time (ventilation phase) following instruction and practice with an inexperienced or experienced instructor using a manikin having gross KR or precise KR, cannot be rejected by the results of this study.

Results of Time (Compression Phase) Analysis

There were no significant differences in compression time, except for the pKR group during post-test in which the AE mean score was less than the gKR group ($p = .03$; Table 14). Mean error in the post-test ranged from 0.56 by the E/pKR group to 2.44 by the I/gKR group, indicating variability in timing proficiency between the treatment groups (Appendix G; Table 61). These differences, however, were not statistically significant (Table 14).

CE values indicate a significant effect of instructor experience commencing in Trial 1, and continuing to the post-test (Table 14). The E group demonstrated a steady reduction in CE error, ending with a compression rate that was slightly slower than the criterion (Appendix G; Table 63). Figure 35 (Appendix G) illustrates that the gKR group, unlike the pKR group, demonstrated increased overtime error for compression in the post-test ($p = .03$; Table 14).

Three-way ANOVA supports the advantage of an experienced instructor ($p = .004$), as well as a significant interaction between type of KR and time ($p = .000$; Appendix G; Table 67), in the reduction of CE error.

VE was not significant for main effects or interactions (Table 14). In general, there was reduced inconsistency in subject performance in the post-test (Appendix G; Figures 37, 38 and 39). Lack of change relative to the consistency in performance may be attributable to the emphasis placed on the compression rate mnemonic during instruction.

In summary, only the precise KR group demonstrated more proficiency in compression timing ($p = .03$; Table 14). Both experienced instructor and precise KR were effective in approximating the criterion time interval for compressions ($p = .01$ and $p = .03$ respectively, Table 14).

Hypothesis One

The null hypothesis, that there was no difference in timing (compression phase) proficiency following instruction by an inexperienced or experienced instructor, cannot be rejected by the results of this study.

Hypothesis Two

The results of this study reject the null hypothesis and indicate a significant difference in timing (compression phase) proficiency following instruction and practice with a manikin having precise KR ($p = .03$, Table 14).

Hypothesis Three

The null hypothesis, that there was no difference in timing (compression phase) proficiency following instruction and practice with an

Table 14

Summary of Probability Results for Time (Compression Phase) Analysis: Two-way ANOVA: Instructor Experience (I) and KR

Source of Variation	df	Absolute[a] Error	Constant[b] Error	Variable[c] Error
		Control		
Instructor	1	ns	ns	ns
KR	1	ns	ns	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 1		
Instructor	1	ns	0.007	ns
KR	1	ns	ns	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 2		
Instructor	1	ns	0.02	ns
KR	1	ns	ns	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 3		
Instructor	1	ns	0.009	ns
KR	1	ns	ns	ns
I/KR	1	ns	ns	ns
Error	44			
		Post-test		
Instructor	1	ns	0.01	ns
KR	1	0.03	0.03	ns
I/KR	1	ns	ns	ns
Error	44			

[a] Appendix G, Table 62

[b] Appendix G, Table 64

[c] Appendix G, Table 66

inexperienced or experienced instructor using a manikin having gross KR or precise KR cannot be rejected by the results of this study.

Results of Time (Total) Analysis

The E group performed significantly better than the I group according to two-way ANOVA of the AE (Table 15). There was early evidence of superior performance by the E group in Trial 1 (p =.005) and through to the post-test (p =.004, Trial 2; p =.009, Trial 3 and p = 002, post-test; Table 15). Although the pKR group demonstrated lower mean AE scores throughout the trials, a significant advantage over gKR did not become evident until the post-test (p =.02, Table 15). Evidence of an interaction between instructor experience and type of KR provided by the manikin was not revealed statistically (Table 15).

All groups tended towards overtime in all trials, except for the I/pKR group, which had a CE of -0.2 seconds in Trial 1 (Appendix H; Table 70). The E group failed to demonstrate homogeneity (Control, p =.02) in the control but superior reduction of the overtime error was evident by increasing probability values in subsequent trials (Trial 1, p =.000; Trial 2, p =.001; Trial 3, p =.002 and Post-test, p =.000; Table 15). The pKR effect was significant in Trial 2 through to the post-test with better approximation of the criterion interval than the gKR group (Table 15).

There were no significant differences in the consistency of performance (VE) except for an isolated instance for the treatment groups in Trial 2 favoring the E/pKR group (Table 15). Apparently the

Table 15

Summary of Probability Results for Time (Total) Analysis:
Two-way ANOVA: Instructor Experience (I) and KR

Source of Variation	df	Absolute Error[a]	Constant Error[b]	Variable Error[c]
		Control		
Instructor	1	ns	0.02	ns
KR	1	ns	ns	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 1		
Instructor	1	0.005	0.000	ns
KR	1	ns	ns	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 2		
Instructor	1	0.004	0.001	ns
KR	1	ns	0.000	ns
I/KR	1	ns	ns	ns
Error	44			
		Trial 3		
Instructor	1	0.009	0.002	ns
KR	1	ns	0.001	ns
I/KR	1	ns	ns	ns
Error	44			
		Post-test		
Instructor	1	0.002	0.000	ns
KR	1	0.02	0.000	ns
I/KR	1	ns	ns	ns
Error	44			

[a] Appendix H, Table 69

[b] Appendix H, Table 71

[c] Appendix H, Table 73

subsequent improvement in consistency of performance by the other groups diminished this difference in later trials and the post-test (Appendix H; Table 72; Figure 48).

In summary both the E and the pKR groups demonstrated a positive affect on the reduction of AE scores in the post-test ($p = .002$ and $p = .02$ respectively, Table 15). The experienced instructor effect was very strong and persistent throughout the trials (Table 15). On the other hand AE reduction related to KR was apparent in Trial 3 and the probability not as dramatic (Table 15). Reduction of the CE scores was best by the E group compared to the I group and for pKR rather than gKR (Table 15). As with AE reduction, immediate impact of having an experienced instructor was apparent in Trial 1 and maintained through the trials (Table 15). The effect of pKR in reducing the CE score was significant in Trial 2 and of greater probability values than that achieved for AE analysis.

Hypothesis One

The results of this study reject the null hypothesis and indicate a significant difference in time (total) proficiency following instruction by an experienced instructor ($p = .002$, Table 15).

Hypothesis Two

The results of this study reject the null hypothesis and indicate a significant difference in time (total) proficiency following instruction and practice with a manikin having precise KR ($p = .02$; Table 15).

Hypothesis Three

The null hypothesis, that there was no difference in time (total) proficiency following instruction and practice with an inexperienced or experienced instructor using a manikin having gross KR or precise KR, cannot be rejected by the results of this study.

Summary of Hypothesis Testing

There was no clear cut evidence supporting the advantage of either instructor experience or precise KR as a factor in facilitating CPR skill proficiency. Evidence of superior performance for specific elements or sub-routines are identified and outlined in Table 16. Failure to identify a significant interaction between instructor experience and precise KR in spite of consistent lower AE mean scores than the other groups may be due to the variance of performance between group subjects. It is necessary to identify the characteristics and limitations of instructional strategies associated with proficient performance.

Table 16

Summary of Statistical Analysis for Sub-routine Hypothesis Analyzed:

(Ventilation, Compression, Camping, Pressure Points, and Time

Null Hypothesis	Sub-Routines						
	Ventilation	Compression	Camping	Pressure Points	Time		
					Ventilation	Compression	Total
Instructor Experience	ns	ns	ns	ns	Rejected experienced instructor $p = .000$	ns	Rejected experienced instructor $p = .002$
Manikin KR	ns	Rejected pKR $p = .001$	ns	ns	ns	Rejected pKR $p = .03$	Rejected pKR $p = .02$
Interaction Instructor Experience xKR	ns	ns	ns	ns	ns	ns	ns

CHAPTER VIII

DISCUSSION

> "In techniques of training, we find the experienced trainer often over-confident of the superiority of his particular methods - more by reason of his own facility in handling them than from demonstrated comparison with alternative methods."
> Meredith, 1965.

The problem of decaying CPR skill proficiency after training, as evidenced by retention studies, has evaded solution. Recommendations for longer programs, better manikins, and more skilful instruction are compromised by the limited time participants may volunteer to learn CPR, the level of funding required to provide adequate training, and the insufficient number of competent instructors. It is the position of this paper that application of selected learning principles in the instruction of CPR should be reviewed to identify strategies that could contribute to efficient skill acquisition and extended retention spans. The remainder of the study will focus on motor learning theory relevant to the investigated aspects of CPR instruction, discussion of implications of CPR training within the hospital context, and recommendations for future research.

Learning Principles Relevant to This Study

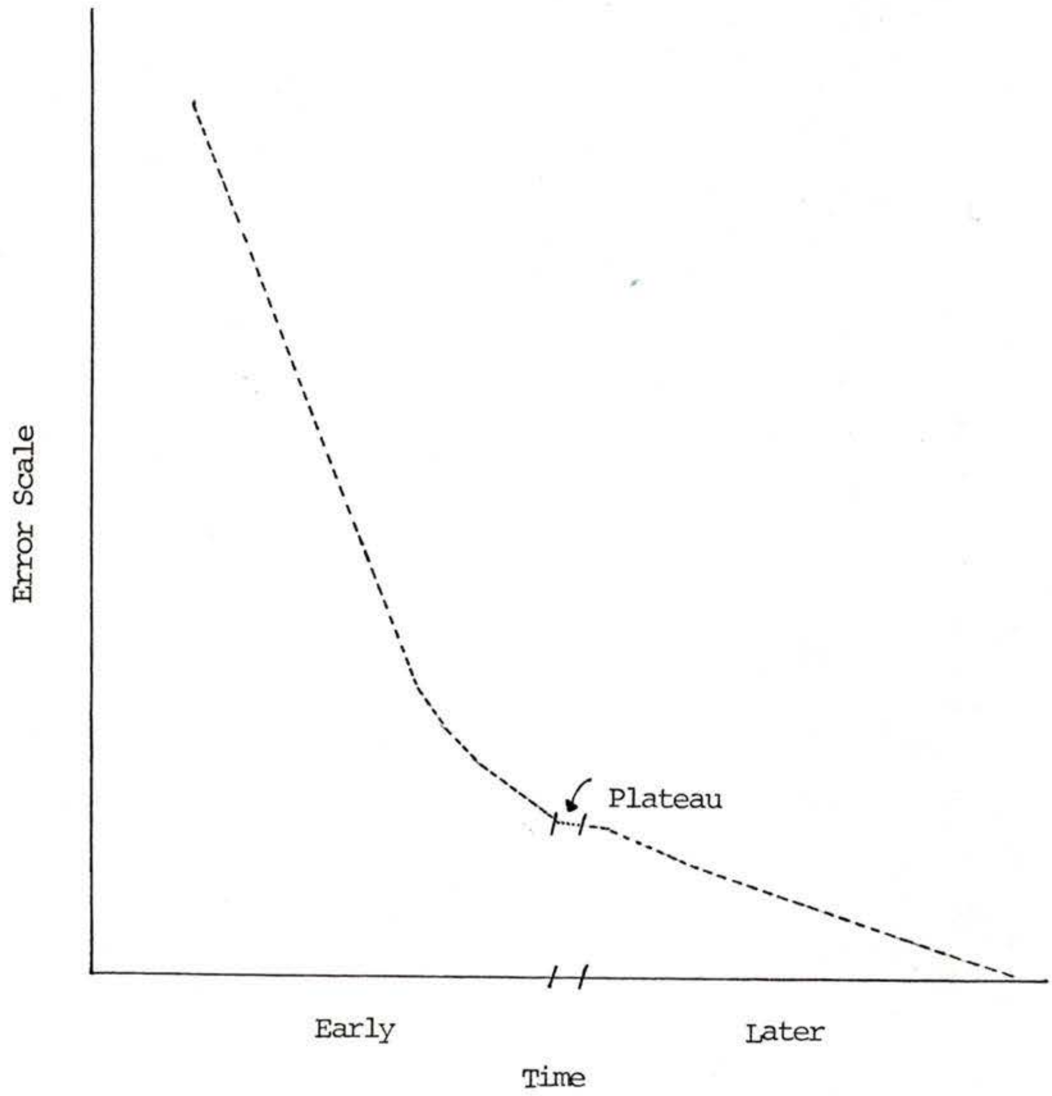
It is necessary to appreciate that research findings based on isolated tasks, or specific phenomena, are not generally applicable to practical skill instruction; however, specific principles may be beneficial. The results of this study indicate that the provision of experienced instructors or precise KR contributed to improved performance. Failure to demonstrate statistical significance of an interaction between instructor experience and KR type may indicate either an absence of an additive effect, or failure to integrate available feedback information in the instruction.

Skill performance is the behavioral demonstration of motor learning. Progress in learning, favorable or unfavorable, can be represented graphically as a learning curve. This study utilized the measurement of error as an indication of behavior proficiency, with decreasing error demonstrating improvement, and zero error, achievement of the performance criterion. Figure 1 is a learning curve portraying ideal proficiency acquisition based on the error method of analysis. The curve begins at the error score of the initial performance and declines as the rudiments of the task are mastered. A leveling of the curve, or plateau, tends to appear, and indicates a stabilization of performance characteristics. Crossman (1959) demonstrated that the plateau did not necessarily indicate maximum learning, but may be due to variables such as lack of motivation, fatigue, inadequate feedback or environmental limitations.

Motor capacity refers to the innate ability of an individual to learn and perform motor activities. Although it is not possible to objectively determine optimum proficiency, it is feasible to assign numerical values to observable parameters in order to statistically analyze changes in performance (Robb, 1972). The expectation of 'criterion' performance is dependent on the participant having the motor capacity to perform at the specified standard. To illustrate this point, the four minute mile

Figure 1

Motor learning curve characteristics



has been run only by a limited number of athletes. Therefore, it is unreasonable to expect individuals drawn from the general population to perform to this standard. However, if a standard is set that a considerable proportion of the population can achieve, then the expectation of achievement should be accordingly high. Certified CPR performance reflects approximation of the standard. It does not validate either the measurement, or the reliability of the test to assure quality CPR. However, imperfect as standards may be, they function as reference points by which performance can be measured and compared statistically.

Objective measurement requires collection of information and the assignment of numerical values to observable elements of the performance to enable statistical analysis. All of the reviewed studies concerning CPR skill utilized percentage of correct units of a sub-routine as a measurement of proficiency. In such analyses, a pass or fail rating is assigned to the unit, based on observation or performance tape analysis. Score calculations are simple:

$$\% = \frac{\text{number of correct units}}{\text{total number of units}} \times 100$$

If 5 ventilations were correct out of 10, in one minute cycle CPR, the following score would be calculated:

$$\% = \frac{5}{10} \times 100 = 50\%$$

i.e.50 percent of the ventilations were performed to the standard.

Unfortunately the percentage score is not sensitive to small changes in performance. Table 17 presents the hypothetical results given in chapter VII, with the inclusion of percentage scores to enable comparison of the interpretive value of this technique as opposed to error analysis. According to the percentage scores, the proficiency of each trial is the same. It is apparent from earlier discussion, however, that each trial performance had different characteristics in the magnitude of error (AE), the directional bias (CE), and the consistency of subject performance (VE).

Error analysis requires the assignment of numerical values to degrees of deviation, the measurement of the deviation, sophisticated calculation resources, and specialized theoretical background to interpret scores. The benefits of utilizing error analysis are; acquisition of both qualitative and quantitative error information; sensitivity to incremental performance change; provision of information about skill acquisition, and ability to compare different levels of proficiency.

Schultz and Roy (1973), contend that data with a normal distribution are uninterpretable for AE, and suggest analyses depend on CE and VE measures. Newell (1976), reports that significant information may be lost by omitting AE analysis, and therefore recommends that all error measures be considered, so as to obtain maximum information from the data. In order to verify instructional strategies (or identify variables which have an effect on CPR skill performance), it is essential to have measurements that are sensitive to research manipulations and standardized to facilitate comparison of results or replication of studies.

Table 17

Hypothetical Results for Three Trials:
Results, Percentage Correct, Absolute Error (AE),
Constant Error (CE), and Variable Error (VE)

Trial	Results	Percentage	AE	CE	VE
1	-7, -7, -7 -7, -7, 0, 0 0, 0, 0	50	3.5	-3.5	3.12
2	-1, -2, -3 -4, -5, 0 0, 0, 0	50	1.5	-1.5	1.62
3	+1, +1, +1 +1, +1, 0, 0 0, 0, 0	50	0.5	+0.5	0.61

The Role of the Instructor in Motor Learning

Programs for instructors currently focus on information content, skill proficiency, and instructional theory. The short duration, one or two days, affords little opportunity for the evaluation of instructional approaches, or discussion of research techniques which would facilitate critical investigation. Although there is a developing trend towards empirical investigation, most of the available information concerning CPR instruction is subjective and descriptive in character. Feingold (1972) suggests that inadequate preparation of instructors may account for defects in student performance. Accountability for the performance standard has resulted in research about the efficacy of instructional methods employed in general education. Glaser (1963) emphasized the importance of providing a be- behavioral criterion to assess achievement. Kimble (1961) proposes that learning is an intermediary between independent variables such as repetition, practice, or observation, and observable dependent variables such as trends in behavior, changes in behavior, or proficiency demonstrated. Several problems arise which limit the validity of behavior criteria relative to CPR instructor training. First, is the inadequate identification of the task characteristics which influence learning and proficiency. Second, assessment of proficiency varies with the instructor, manikin used, and perception of match between the performance and standard. Third, the lack of empirical knowledge about the affect of various methods on skill acquisitions. Each of these areas will be discussed in the following.

Task Analysis

The instructor's ability to identify and evaluate performance errors vary with the individual (Bard, Fleury, Carriere and Halle, 1980) rather than with his skill proficiency or experience (Biscan & Hoffman, 1976; Gordon & Osborne, 1972). Gordon (1970) found that instructors identified correct aspects of performance more frequently than errors. Since incorrect behavior limits proficiency, development of error detection skills in the instructor should improve the quality of learner performance (Malina, 1969; Rogers, 1974; Smoll, 1972). The ability to detect errors is influenced by the instructor's perception of model performance, prediction of error occurrence, visual search efficiency, and evaluation ability (Armstrong & Hoffman, 1979). Error detection may be increased by training instructors to recall detail of movement to identify common errors, and to develop a good internal model of reference. Armstrong and Hoffman (1979) used an error detection check-list to evaluate the effect of instructor experience on the ability to correctly identify error. The experienced instructors proved slightly better than novice instructors, mainly because of fewer false error entries. Researchers (Pick, 1965; Sage, 1977) have found that practice in performance evaluation can improve identification of both correct patterns and errors. Bard et al. (1980) speculate that novice judges tend to work more with inexperienced performers and therefore, may not develop a correct reference model.

CPR performance standards describe critical aspects of performance, and thus provide a check list of behaviors that define success. Perhaps the addition of an error component to this format would facilite error detection. In this study, analysis of sub-routine error incidence indicated learner tendency towards under-ventilation, under-compression, and excessive delay during the ventilation phase. These errors may reflect a gender effect in view of Tweed's study (1980,b) of males, in which over-ventilation and over-compression were characteristic. Instructors should monitor aspects of performance not only to reinforce correct behavior but also to provide prompt remedial instruction as required. Experienced judges tend to be able to identify behavior patterns that predict sucessful outcomes, and thus require less information to assess performance (Bard et al., 1980). An illustration of a CPR behavior pattern predicting outcome is the measurement of hand position prior to initiating compression. In this study, there was a very low error role associated with hand position. This is undoubtedly attributable to correct recognition of error (relatively obvious in the case of hand position) and subsequent provision of appropriate correction.

Assessment of Proficiency

Certification of proficiency by AHA (1980) standards allows for a $\pm$10% variation in the number of ventilations and compressions, otherwise performance must match the criteria. Instructors with precise KR manikins would have accurate and complete performance information compared to those using manikins, therefore the assessment of proficiency may vary due to treatment group assignment. The performance recordings of certified subjects from gross KR groups was analyzed to provide guidelines by which subjects with precise KR manikins could be evaluated. This process prevented bias in performance appraisal, but exposed a discrepantancy between proficiency observed and the criteria performance. Tables 18, 19, 20, and 21 indicate the degree of numerical error scores (incorrect hand position and time) and percentage error scores (ventilation, compression and camping) for each subject according to treatment group. These data were used to rate the performance on a pass or fail basis for each sub-routine and overall performance. Performance tape

Table 18

Recorder Tape Analysis for Certification,

Degree of Error and Pass or Fail Rating for Sub-routines and Overall Performance;

Inexperienced Instructor/gKR Group

Subject	Ventilation		Compression		Improper Hand Position		Camping		Time		Overall
	% error	P/F	% error	P/F	% error	P/F	% error	P/F	sec.error	P/F	P/F
344	-	P	100	F	-	P	-	P	+ 11	F	F
360	-	P	100	F	-	P	25	F	+ 7	F	F
448	40	F	100	F	-	P	30	F	- 4	F	F
633	60	F	100	F	-	P	33	F	+ 6	F	F
779	-	P	-	P	-	P	-	P	- 1	F	F
941	-	P	-	P	-	P	12	F	+ 30	F	F
584	60	F	75	F	14	F	25	F	+ 42	F	F
526	80	F	-	P	-	P	-	P	+ 19	F	F
795	-	P	31	F	-	P	100	F	+ 8	F	F
692	30	F	86	F	-	P	50	F	+ 4	F	F
546	30	F	-	P	-	P	-	P	+ 10	F	F
065	40	F	75	F	-	P	30	F	+ 14	F	F

Table 19

Recorder Tape Analysis for Certification,

Degree of Error and Pass or Fail Rating for Sub-routines and Overall Performance;

Inexperienced Instructor/pKR Group

Subject	Ventilation		Compression		Improper Hand Position		Camping		Time		Overall
	% error	P/F	% error	P/F	% error	P/F	% error	P/F	sec.error	P/F	P/F
768	-	P	-	P	-	P	100	F	-	P	F
558	-	P	31	F	-	P	83	F	+ 13	F	F
570	-	P	-	P	-	P	33	F	- 3	F	F
579	-	P	-	P	-	P	100	F	+ 2	F	F
092	40	F	100	F	-	P	25	F	+ 34	F	F
392	-	P	-	P	-	P	-	P	+ 4	F	F
627	-	P	-	P	-	P	-	P	+ 19	F	F
569	30	F	-	P	-	P	-	P	+ 13	F	F
863	-	P	-	P	-	P	-	P	+ 5	F	F
338	-	P	-	P	15	F	-	P	+ 5	F	F
307	40	F	60	F	-	P	-	P	+ 5	F	F
742	100	F	-	P	32	F	-	P	+ 28	F	F

Table 20

Recorder Tape Analysis for Certification,

Degree of Error and Pass or Fail Rating for Sub-routines and Overall Performance;

Experienced Instructor/gKR Group

Subject	Ventilation		Compression		Improper Hand Position		Camping		Time		Overall
	% error	P/F	% error	P/F	# error	P/F	% error	P/F	sec.error	P/F	P/F
948	100	F	-	P	-	P	100	F	+ 3	F	F
081	100	F	-	P	-	P	75	F	+ 4	F	F
254	100	F	-	P	-	P	75	F	+14	F	F
048	-	P	-	P	-	P	70	F	-	P	F
529	30	F	60	F	3	F	50	F	-	P	F
555	90	F	-	P	-	P	50	F	+40	F	F
123	30	F	100	F	-	P	100	F	+ 3	F	F
067	-	P	37	F	-	P	55	F	+ 2	F	F
647	-	P	-	P	-	P	75	F	-	P	F
274	30	F	-	P	-	P	75	F	-	P	F
959	40	F	68	F	-	P	20	F	- 3	F	F
670	100	F	60	F	-	P	100	F	- 3	F	F

Table 21

Recorder Tape Analysis for Certification,

Degree of Error and Pass or Fail Rating for Sub-routine and Overall Performance;

Experienced Instructors/pKR Group

Subject	Ventilation		Compression		Improper Hand Position		Camping		Time		Overall
	% error	P/F	% error	P/F	% error	P/F	% error	P/F	sec.error	P/F	P/F
320	-	P	-	P	-	P	100	F	-	P	F
779	-	P	-	P	3	F	5	F	-	P	F
148	-	P	-	P	-	P	-	P	+ 6	F	F
310	-	P	-	P	-	P	-	P	-	P	P
880	50	F	-	P	-	P	-	P	+ 6	F	F
993	30	F	27	F	-	P	-	P	- 3	F	F
775	-	P	-	P	-	P	-	P	- 3	F	F
919	70	F	21	F	-	P	-	P	+ 3	F	F
017	40	F	-	P	-	P	-	P	-	P	F
352	-	P	35	F	14	F	-	P	+ 11	F	F
173	40	F	-	P	-	P	6	F	+ 5	F	F
248	30	F	-	P	-	F	100	F	-	P	F

analysis according to performance criteria would have certified one of the forty-eight subjects, this factor challenges the reliability of performance certification or the validity of the standard.

The stringent standards for taped performance incorporate information not available to an evaluator without a recorder. Visual detection of error becomes increasingly difficult as the performance approximates the criterion. Examination of the performance tapes with adjustment for low manitude errors (that may not be humanly detectable), would pass 25 subjects as having achieved the standard, and another 15 as having demonstrated an acceptably close approximation of the standard. Seven subjects committed performance errors of a magnitude that hopefully could be detected without precise KR; time exceeding 15 seconds, few ventilations of adequate volume, and/or compressions of inadequate depth. One subject (948) was passed by an experienced instructor in the gross KR group while another (555) was identified as a failure, the difference between the subjects was a 37 second time fault. There is a threshold for error detection that varies with the amount of background noise (extraneous stimuli), as well as with observer characteristics, such as motivation, training, and selective attention skill (Fitts & Posner, 1967). In two cases, inexperienced instructors failed to use precise KR information available. This implies that factors other than KR information, such as evaluative decision-making experience, ability to apply standards, or situation events may influence performance appraisal.

Adherence to standards is viewed as essential for quality control and legal protection of individuals initiating CPR (AHA, 1980; Gordon & Page, 1980; Tyson, 1980). Cobb (1980, page 4) has found very little correlation between the quality of CPR and patient outcome, provided prompt initiation of CPR has occurred. However, if prolonged CPR is required the proficiency of the rescuer appears to have an effect. Speculation about the degree of deviation from excellent manikin performance that will provide adequate life support is a subject for research (Cobb, 1980, page 16). The proficiency demonstrated may represent maximum performance due to individual limitations, gender effect, or environmental conditions.

In summary, problems of complying with AHA standards are: the amount and type of feedback available in the evaluation setting; the instructor's ability to detect errors; learner individual differences; and, the validity of the standard.

Instructional Strategy Selection

The failure to identify a statistically significant difference in the performance of various treatment groups may be explained by the combination of two factors: the small number of instructors, and the diversity of interaction between the instructor and manikin feedback. Analysis of the instructional process requires the identification of strategies applied during skill instruction. From research and theory Taylor (1975) selected a limited range of motor skill instruction behaviors to design his Physical Education Observation Instrument (PEOI). The PEOI may be used to record the frequency of teacher and student behaviors; direct teacher influence (managerial engagement, explanation, demonstration, drill or practice, and reflective engagement); indirect teacher influence (feedback, reinforcement, individualization, and disengagement); student engagement (developmental engagement, organizing movement, playing, and disengagement); and other behaviors not specified previously. Taylor (1979) demonstrated the reliability of the PEOI as an objective coding record of teacher and student behavior during volley-ball instruction. This instrument could be used to identify behavior characteristics of CPR programs relative to proficiency outcome.

Behaviors equated with high proficiency must be incorporated into a lesson plan based on proven effective teaching styles. Mosston's Spectrum of Teaching Styles (1981) classified eight theoretically based teaching styles according to the decision making process in the selection of learning strategies by the teacher or learner. Table 22 outlines Mosston's Spectrum with comments related to the instruction of CPR.

In style B (practice style), the instructor controls the presentation of material, interacts with the learner during practice, and evaluates performance. For learning of a simple motor skill by school children, Goldberger, Gerney and Chamberlain (1982) found faster achievement and highest mean scores in utilizing style B, as opposed to styles C and E. The theoretical framework of style B is amenable to standardization and therefore, a valid curriculum could be maintained with minimal variation due to instructor or learner differences. If the presentation of materials were standardized, it would follow that instructor training could focus on behaviors proven effective in facilitating acquisition of CPR knowledge and skills. Disadvantages associated with this teaching style are the dependence on the availability of instructors and the reduced opportunity for experimentation with instructional strategies.

Style C (reciprocal style) involves the instructor setting the learning goals and conducting the instructional phase of the course, but with practice monitoring and feedback provided by the learner's peers. Each member of the group performs the skill while the others observe for deviations from the set criterion. Nixon and Locke (1973) propose that the study of incorrect performance can ultimately improve

Table 22

Guidelines to Mosston's Spectrum of Teaching Styles With Comments on Relevance in Application in CPR Instruction

Style [a]	Description	Decision maker: pre-impact	impact	post-impact	Potential Application to CPR
A	Command Style	T	T	T	- affords little individualization
B	Practice Style	T[b]	L	T	- effective - efficient - quality control - teacher dependent
C	Reciprocal Style	T[b]	peer	other	- effective - efficiency varies - increased social interaction - quality control varies with rater - reduced teacher dependence
D	Self-check Style	T[b]	L	L[c]	- effectiveness varies with learner - continium of efficiency - quality control varies with rater - teacher independent
E	Inclusive Style	T	optional	L	- inappropriate due to standards of performance
F	Guided Discovery Style	T	T/L	L/T	- inefficient - questionable quality control - may be innovative
G	Divergent Style	T	L	L	
H	Learner Designed Style	L	L	L	

[a] Continuum of control in decision making: Teacher maximum A, minimum H; Learner minimum A, maximum H.
[b] Presentation of instructional material may be standardized audio-visual materials.
[c] Quality control could be improved by testing knowledge and requiring the learner to provide a performance tape.

performance. This concept is challenged by Bard et al. (1979), who felt that lack of exposure to correct performances may interfere with the ability to identify error. In practice, Goldberger et al. (1982) found no significant differences in performance outcomes when they compared style B, C, and E. Social interaction is higher in style C, and typically results in increased positive feedback, praise, and empathy being expressed by group members. Advantages of style C are the reduced dependence on the instructor during the practice phase, reduced practice contact time, and a socially positive environment. Unfortunately there is less control over the practice interval, due to the source of feedback. Variation in learners' abilities to assess performance accurately may result in inefficient learning. However, the final performance is appraised by the instructor, which provides quality control.

In style E (inclusion style), the teacher determines the content and presentation of didactic material, while the learner assumes responsibility for practice and decisions concerning learning outcome. With respect to CPR instruction, the didactic information is presented and then the learners practice on recording manikins and evaluate their performance using provided criteria (Baskett, Lawler, Hudson, Makepeace & Cooper, 1976; Herrin, Crosby & Hill, 1980). This method is very dependent on the potential of the presented material to provide adequate information for the learner to assume responsibility for self-instruction. It is possible to utilize audio-visual materials in place of an instructor, thus relieving the dependence on personnel, and making the program available on a learner demand schedule. Unfortunately, individual factors may limit the learner population that can acquire the desired knowledge and skill proficiency via self-learning. Some individuals may not be able to identify or retain essential information. They may not be able to efficiently modify their behavior or adequately assess their own performance. Although this may be an economical and expedient approach for some participants, the absence of external evaluation does not provide adequate quality control. However, the approach may be modified to afford quality control by stipulating that a written cognitive test and performance tape be submitted as evidence of sucessfully achieving the course objectives.

The PEOI and Spectrum of Teaching Style are aides to systematic investigation of factors effecting the acquisition of CPR knowledge and skill. In his paper concerning CPR instructor training, Doto (1980) expresses a concern about neglect in providing adequate information about teaching strategies. Dependence on subjective rationale for recommending manikins, curriculums, or techniques is counterproductive to building a knowledge foundation on which the selection of appropriate learning strategies is empirically sound. The development of CPR educational programs with optimal effect is dependent upon empirical validation of the components.

Effect of KR in Acquisition of CPR Proficiency

In numerous studies, KR has been demonstrated as an important variable in motor learning. The results of the present study indicate equivocal merits of precise KR in the acquisition of CPR skill proficiency. Although better performance was associated with precise KR for compression, compression time, and total time components, no significant differences, relative to gross KR were identified in proficiency of ventilation, camping, pressure points, or ventilation time errors. Several factors related to the instructional environment interact to enhance or inhibit the function of KR. These include such things as the time allotted to particular elements of the instruction program, the various skill practice strategies, and the ability of the instructor to interpret perceived feedback. The following discussion will focus on the implications of these parameters, relevant to the evaluation of KR effect.

Time Management

The amount of time available for skill practice is a determinant of ultimate proficiency. CPR course time is divided between basic instruction (introduction, verbal instruction, demonstration, and student interaction) and skill practice activities (CPR skills, other BLS skills). Subjects in this study were assigned to an instructor on a 4:1 ratio, with a minimum of fifteen minutes contact manikin use (a variation in time occurred due to timing errors by the subjects during the taping of the criterion performance). The demonstrated lack of proficiency by all groups indicates that there was insufficient time to develop proficiency; that skill acquisition was inefficient; or that individual performer limitations were involved.

Barranco (1980) describes a creative approach to provide increased practice time through the use of student mimicry and pantomime. An instructor leads the student body in a drill activity in which they pantomime the CPR sequence on an imaginary patient. Students are assigned to groups for manikin practice after becoming familiar with the pantomime activity. While the instructor provides individualized assistance as required, the remainder of the group continues the 'line' drill. This approach could result in mastery of the cognitive and sequencing aspects of CPR, but it does not assure skill proficiency. Unfortunately, no objective data were presented by Barranco to support the suggested effectiveness of this strategy in facilitating skill proficiency.

Effective time management demands a control of the student-instructor ratio, the qualification of didactic information, and the judicious selection of instructional methods. It is possible that different formats may be more beneficial under particular circumstances or for specific learner groups. Although the emphasis will (and should) be placed on improvement of standard mass education programs, small group experimentation should also be encouraged, in order to provide controlled on-going assessment of instructional methods and equipment, or to suit particular group needs.

Practice Strategies

Practice plays a critical role in developing unconscious control of movement. Tasks may be divided into partial or whole units for practice. Generally, the latter is more effective in achieving proficiency of a serial task (Robb, 1972). Partial practice is more useful when specific sub-routines of the sequence require refinement in order to develop precision. To illustrate, in the present study the ventilation phase of the CPR task tended to be too long. This may have been corrected by practicing a few compressions, followed by ventilation and a few more compressions. This breakdown includes the stimului preceding ventilation and compression phase. Therefore, it maintains the continuity of cues and allows concentration on timing, while avoiding unnecessary practice of other task components. As soon as the movement pattern flows together, practice of the whole task should be resumed in order to reinforce the correct sequence and character of the sub-routines.

Bogen (1969) theorized that it is differences in information processing, rather than specific stimuli or tasks, that account for the specialization of cerebral hemisphere function. Lateral eye movement patterns appear to predict the preferred mode of information processing (Day, 1964). Briefly, individuals who tend to look left process information in the right hemisphere, and learn better with holistic presentation and practice. Those tending towards the right prefer sequential presentation and practice, and process information in the left hemisphere (Harnad, 1972; Weiten & Etaugh, 1973). Murray (1979), evaluated the effect of matching or mis-matching practice techniques and preferred cognitive processing mode. She found 12-25% faster skill acquisition ($p < .05$), associated with matching the appropriate practice method with the preferred processing mode. This challenges the suggested role of practice method (Knapp & Dixion, 1952) and task complexity (Briggs & Brogden, 1954) as the major determinants of skill acquisition time, and demonstrates how individualized instruction may promote more efficient use of time.

Information Management

A great abundance and variety of information is involved in the learning experience. The instructor must control her response to inappropriate stimuli, and translate relevant stimuli into feedback that will reinforce or modify behavior as required. It is not possible to attend properly to more than one bit of information at a time (Keele, 1973), unless one of the behaviors has been overlearned, allowing the individual to attend selectively to other pertinent stimuli (Robb, 1972). Miller (1956), found that about seven bits of information could be held in the short term memory for later processing. Fortunately, information can be consolidated into meaningful ' chunks' which enables a larger amount of information to be processed efficiently. Discrete CPR tasks can be lumped into sub-routines in order to reduce the amount of information attended to or given during a performance. To illustrate this concept, the sub-routine of 'compressions' consists of information about landmarking, hand position, compression characteristics, and the rhythm of the movement. The ability to assess the total performance also appeared to depend on the experience of the instructor as reflected by lower error scores in the group with experienced instructors, with the exception of ventilation. The techniques utilized to determine what stimuli are selectively addressed by effective instructors should be identified in order to train instructors to become more efficient.

It appears that precise KR may be particularly valuable with respect to specific sub-routines, and its effect may depend on the degree of congruence between the error information and remedial strategy. Better proficiency levels were associated with groups having precise KR for compression ($p = .001$; Appendix C; Table 37), compression time in groups provided with pKR, ($p = .03$; Appendix G; Table 62), and total time ($p = .02$; Appendix H; Table 69). Ventilation (Appendix B; Table 28), and ventilation time (Appendix F;

Table 53), did not demonstrate a significant difference due to KR type. The congruency between the type of KR provided and the appropriate subsequent remedial instruction is a factor in the significant differences mentioned above. An example of feedback and instruction congruence is that inadequate compression depth errors are corrected simply by increasing the amount of pressure. Correction of ventilation error, on the other hand, requires assessment of performance characteristics for single, multiple, or combined activities. Failure to obtain a green light on a precise KR manikin or an adequate volume tracing may not relate to the learner's ability to provide the criterion volume of air, but rather to errors in performing prerequisite behaviors that would culminate in sucessful ventilation. In order to facilitate improvement knowledge of performance is required, including such things as the learner's body position, the technique used to open the airway, and the ability to secure a seal while ventilating. The emphasis of Gentile (1972), and Martiniuk (1976) on the role of KR in developing skill proficiency, suggests that the provision of KR may interfere with attending to the behavior patterns of performance.

Ventilation and ventilation time error reduction may involve a speed versus accuracy tradeoff in which the lower scores in one aspect are associated with higher scores in the other. Figure 2 illustrates this proposition with respect to AE post-test mean scores for ventilation and ventilation time. The extent of this tradeoff appears to be influenced by the experience of the instructor. Groups with experienced instructors showed less of this trend in error scores. Figure 3 illustrates the AE post-test mean scores for compression and compression time. In this case the effect of a speed/accuracy trade-off appears

Figure 2

Relationship between ventilation time absolute error and ventilation absolute error on the post-test

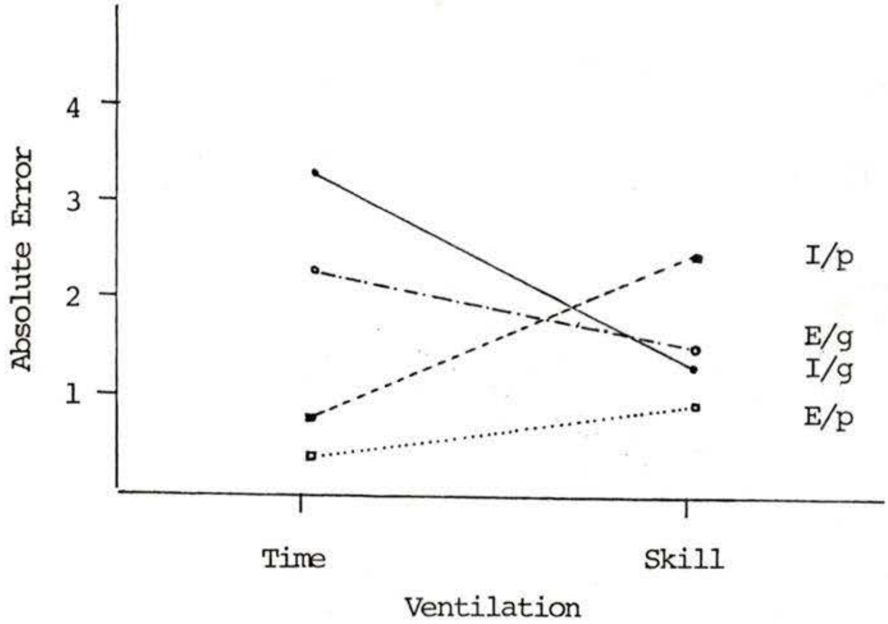


Figure 3

Relation ship between compression time absolute error and compression absolute error on the post-test

to be diminished compared to the ventilation sub-routine results. The possibility of speed/accuracy trade-offs should be further investigated to assess the validity of the hypothesis and to determine the implications relevant to skill acquisition.

Schmidt (1968), identified timing relationships in motor performance as anticipating the stimulus or co-ordinating movements to develop control and accuracy of behavior. CPR skill involves a consistent sequence of sub-routine performance, and therefore should provide a high degree of task coherence. Generally, proficiency is higher in coherent tasks, due to the predictable behavior pattern (Nobel & Trumbo, 1967; Schmidt, 1968). Timing errors, regardless of type, are associated with progressive reduction of cardiac output and profusion pressure. Compression rate errors occurred in all groups, indicating that recital of the mnemonic does not assure correct rhythm. The metronome was not used by instructors in the precise KR treatment groups, therefore no statement regarding the effect of this device can be made. The acquisition of timing accuracy depends on an accurate time reference, and on the ability to perform the task elements within the specified time parameters. This is a complex task requiring more than basic time information to provide adequate corrective instruction to improve performance.

Although KR research demonstrates the motivational value of feedback, CPR instructors have varying opinions about the effect of evaluative information on performance. Success information has been found to motivate performers Bandura, 1967; Feather, 1966; Feather, 1968; Feather & Saville, 1968; Zajonc & Brickman, 1969). Failure feedback can also improve performance (Aronson & Carlsmith, 1962), provided the situation is non-threatening (Iso-Ahola, 1976). Anxiety tends to increase with failure feedback (Gaudry & Poole, 1972), and is associated with inefficient behavior patterns (Weinberg, 1968). Yerke and Dodson (1908) identified levels of arousal ranging from low in sleep to high in anxiety, and concluded that there is an inverted-U relationship between arousal and performance. Arousal, in either extreme, is not conducive to proficient performance. Research findings indicate the importance of controlling stress in the learning situation, utilizing success or failure feedback appropriately, and selecting instructional strategies to meet specific learner characteristics.

Korttilla, Vertio and Savolainen (1979), evaluated the CPR proficiency of two groups of army conscripts after instruction and practice in two conditions. Instruction of the control group was conducted by medical officers, and consisted of a lecture followed by practice using non-recording manikins (gross KR). The test group program consisted of viewing a film, a review of the important aspects of the film, and practice on recording manikins under the supervision of the authors. The results indicated that 62 percent of the test group passed the criteria for lay public (Winchell & Safar, 1966), and 28 percent passed according to the medical personnel criteria of Berkebile, Benson, Ersoz, Barnhill and Safar (1975). In comparison, none of the control group achieved the lay public standard of performance. Unfortunately, independent variables such as the presentation of didactic information, instructor qualification, and the type of manikin were not controlled. Therefore, it is difficult to isolate factors that are related to improved proficiency. This study manipulated instructor experience and precision of KR with no significant differences identified within the treatment groups. The information provided by the precise

KR manikin requires successful mediation either by the learner or instructor to be meaningful. It is probably this factor that predicts the potential to achieve an optimum proficiency level.

CPR Training in Hospitals

Hospitals are required by accreditation standards to have a response system for cardiopulmonary arrest (CPA), Canadian Council of Hospital Accreditation (CCHA, 1977). The CCHA recommends that 'Cardiopulmonary resuscitative training *should* be required for physicians, nurses, and all allied health personnel who work in the emergency services'; 'continuing education programs *should* be considered the responsibility of the hospital'; and 'annual review *should* be required' (CCHA, 1977, page 19). Hospital programs vary, depending on the priority of trainees and standards of performance required. Incorporating a program in the hospital is expensive in terms of labor, time, and equipment. Prudent management demands careful distribution of resources to provide training.

As demand for resuscitative training may depend on hospital size and the sophistication of medical services provided, a survey was designed to provide descriptive information about:

1. The degree of staff involvement in resuscitation attempts;
2. The incidence of CPA involvement by unit; and
3. The resuscitation skills used relative to hospital type (referral or general community).

A questionnaire was assigned to 40 percent of the full time nursing staff working rotating shifts in specific units during the six month period of October 1, 1980 to April 1, 1981.

CPA occurrence, with respect to type of unit (general or critical care sub-divisions) and hospital (referral or general community), is given in Table 23. Critical care units had the highest incidence of CPA due to the concentration of high risk patients. Cardiopulmonary arrests occur on general units because of the inability to identify all potential victims. Tweed (1980), estimated that about one third of all cardiac arrests from coronary artery disease occur in the general unit, and that 27 percent of resuscitation attempts are on patients who have terminal or irreversible disease. In view of the lower survival rates for general unit victims (Berhard, Trundorf, Cottrell, Vew and Basak, 1979; Tweed, Bristow, Donen and Kirk, 1980), and acknowledging the expense of personnel and materials associated with resuscitation attempts, an effort to identify patients who may not benefit from resuscitation is required.

The referral hospital had a higher rate of CPA staff involvement compared to the community hospital. This is probably related to the larger size of the hospital and the increased number of high risk patients requiring cardiovascular surgery, advanced neurological diagnosis or treatment, and dialysis facilities. The apparent differences between emergency departments may reflect reporting errors under-estimating CPR use in the community hospital (Table 23). The CPA occurrence rate and location trends identified within the surveyed hospitals were similar to those in literature reports concerning similar institutions (Bernhard et al., 1979; Mackintosh et al., 1979; Tweed et al., 1980).

CPR skill application in the clinical setting is outlines in Table 24. The use of ventilation devices (bag and mask etc.) may reflect accessibility of such equipment or an aversion to mouth-to-mouth

Table 23

Incidence of Staff Involvement in Resuscitation Attempts,
Number of Staff Reporting Activity and Total Number of Staff Contacted By Type of Unit
In a Referral and Community Hospital

Type of Unit	Referral Hospital			Community Hospital		
	Number[a]	Report[b]	Total[c]	Number	Report	Total
General Units						
Maternity	0	0	4	0	0	2
Pediatrics	2	1	18	1	1	2
Surgery	8	4	19	3	3	17
Medicine	13	9	36	5	3	13
Sub-total	23	14	77	9	7	32
Critical Care Units						
Operating Room	1	1	10	1	1	10
Postanesthetic Recovery	39	5	5	0	0	8
Coronary Care	15	3	3	3	2	2
Intensive Care	58	11	11	14	4	5
Emergency	70	6	6	38[d]	4	5
Sub-total	183	26	35	56	11	30
Total	206	40	112	65	18	62

[a] Number of times staff participated in a resuscitation attempt.
[b] Number of respondents who participate in a resuscitation attempt.
[c] Total number of staff contacted for the unit
[d] Two respondents indicated ten plus rather than a number estimate.

Table 24

Skills Utilized By Staff in Reported Arrest Situations at The Referral and Community Hospital (October 1, 1980 Until April 1, 1981)

Skill	Referral Hospital		Community Hospital		Combined	
	Yes	No	Yes	No	Yes	No
Identify arrest	28 78 %	8 22 %	16 73 %	6 27 %	44 76 %	14 24 %
Mouth-to-mouth ventilation	8 22 %	28 78 %	6 27 %	16 73 %	14 24 %	44 76 %
Ventilation with a device	24 67 %	12 33 %	11 50 %	11 50 %	35 60 %	23 40 %
Compressions	24 67 %	12 33 %	12 55 %	10 45 %	36 62 %	22 38 %

Note Work related activities such as obtaining supplies, participating in definitive treatment and documentation were reported.

respiration. Special training is necessary to ensure adequate volumes are provided when using ventilation devices. The standard CHF programs in Basic Life Support and Advanced Life Support are capable of meeting the clinical needs of hospitals such as those surveyed.

The problem of allocating training services is related to the funding level relative to the learner population, and to the availability of trainers and equipment. Bernhard et al. (1979), demonstrated increased survival rates after extending advanced cardiopulmonary training to medical and paramedical groups, including the cardiac arrest team. Table 25 points out significant changes in performance after extended training (modified from Bernhard et al., 1979). A pilot study to evaluate the impact of BLS training in a community hospital was conducted at Salem Hospital (Salem, Massachusetts). Over an eighteen month period, 1,700 people were trained to perform CPR. During that period 82 patients were resuscitated within five minutes of collapse, and demonstrated an 85 percent survival rate (Tabone, 1980). The desirability of training staff cannot be disputed. However, programs must be cost-effective in terms of labor, time, degree of proficiency achieved, and utilization of resources, before the hospital administration can make a commitment to CPR training.

The nurses surveyed, had obtained their CPR training from a variety of agencies (Table 26), with operational expenses supported by government or private funds. Morgan (1982, page 182), states the Loma Linda University Hospital's CPR Training and Education Center, a co-operative program between the hospital and the community, is capable of training 50 participants per day. Advantages of this approach are:

1. Potential to train a large number of participants;

Table 25

Comparison of Cardiopulmonary Arrest Response Factors Between a CPR Team And Expanded Response Group, Adapted from Bernhard et.al. 1979

Factor	Cardiac Arrest Team	Expanded Response Group	Significant
Survival	38.6 %	50.4 %	$p < .005$
Survival by location			
Intensive care	40.7 %	57.5 %	$p < .01$
General unit	30.7 %	54.5 %	$p < .001$
Arrest recognized by:			
Nurse	60.8 %	67.3 %	$p < .05$
CPR started by a Nurse	33.3 %	52.6 %	$p < .005$
Nurse initiation of CPR by unit			
Intensive care	33.3 %	52.6 %	
General	19.8 %	30.2 %	
CPR started within one minute	41.6 %	53.4 %	$p < .0005$
Manual cardiac massage performed	33.7 %	47.9 %	$p < .01$
Palpable pulse	63.7 %	87.1 %	$p < .05$

Table 26

Sources of CPR Training for Nursing Staff in Referral and Community Hospital

Source	Referral Hospital %[a]	Community Hospital %[a]
No Training	3% (3/112)	2% (1/64)
Educational Program only	13% (15/112)	14% (9/64)
Hospital Program only	17% (19/112)	11% (7/64)
Hospital Program		
Orientation	42% (47/112)	69% (44/64)
Refresher	53% (59/112)	52% (33/64)
Community Program	20% (22/112)	27% (17/64)
Two or More Programs	58% (65/112)	70% (45/64)

[a] number in parentheses indicate the number responding out of the total number contacted.

2. Predictable supply of programs;
3. Reduced duplication of staff, equipment and physical facilities;
4. Potential for research on instructor development and CPR instructional methods.

A training center would enable optimal utilization of resources and sharing of training responsibility. It would promote most efficient operation and cost containment practices in the provision of all aspects of life support education.

CONCLUSION

On the basis of research findings concerning the effect of KR on motor skill acquisition it was expected that the provision of precise KR would be associated with superior CPR skill proficiency. Also it seemed likely that an instructor with experience would be capable of producing more proficient learners than inexperienced instructors. Both of these expectations failed to achieve overall support when the performance of assigned subjects was analyzed, therefore it is necessary to attempt to identify possible factors that may account for this course of events.

The instructors employed in the study taught the program in accordance with their personal preference in instructional techniques. The lack of control over the selection of an instructional strategies may have resulted in a broad distribution of proficiency scores thus weakening the effect of the experience variable. In addition experience is a difficult variable to control since the performance of individual instructors may vary greatly within a defined time and incidence of involvement in teaching CPR programs. A superior approach would be to identify instructor proficiency based on the CPR skill proficiency demonstrated by her students. This would enable the researcher to isolate instructional strategies that are associated with increased proficiency.

The role of precise KR in overall CPR proficiency, appeared to be weak as evidenced by the results but this finding may be the result of several factors. First, the congruence between the feedback and corrective behavior. Second, the ability of the instructor to implement remedial instruction on the basis of performance feedback. Third, inattention to feedback resources such as the carotid pulse simulator and metronome. The results indicate the effectiveness of precise KR within the context of current application but may not be a definitive measure of the potential to facilitate skill acquisition under conditions in which the instructor recognizes pertinent information and implements appropriate instructional strategies.

Error analysis proved to be an effective approach to providing descriptive information about the level of proficiency observed in terms of the degree of approximation to the criterion, the directional bias of the error and the consistency of performance. The data obtained from selected groups could be used to determine performance characteristics by age, size, or gender, thus standards of performance may be set on the basis of potential of the group to achieve desired performance characteristics.

This study failed to demonstrate an overall advantage of either instructor experience or precise KR in the development of CPR skill proficiency in learners. From the analysis of skill acquisition, it was apparent that the sub-routines had different characteristics in terms of magnitude of error, proficiency development and effect of KR. This raises questions concerning:

1. The amount of information necessary to modify behavior;
2. The role of selective attention to information;
3. The threshold of perception for identifying criterion performance.

As further research is required to provide answers to these questions five recommendations follow.

Recommendation One

CPR skill acquisition was characterized by a graded response with reduced variation over the learning experience. In order to analyze proficiency, it is necessary to utilize measurement techniques that are sensitive to increments of change. Therefore, it is recommended that absolute, constant, and variable error analysis be adopted as standard practice.

Recommendation Two

In view of the possibility of individual physical limitations to the acquisition of AHA standard performance, and respective influences on proficiency and retention evaluations, it is recommended that research be conducted to identify performer limitations relative to size, sex, and other physical characteristics. Should a difference be identified, it would be possible to develop a scale of criteria relative to the sub-groups within the general population (based on age, six, body weight, etc.). Valid standards would encourage a broader range of individuals to participate in the by-stander rescue program. Such standards would also provide legal protection and guidelines for CPR certification as an occupational requirement.

Recommendation Three

In order to improve instructor training programs it is necessary to isolate the most efficient techniques utilized by instructors. The development of a conceptual framework for systematic investigation of CPR instruction would facilitate the identification of critical variables. The PEIO should be tested in the CPR instruction situation. This would provide information concerning the instructor and student behaviors presented relative to skill proficiency demonstrated.

Recommendation Four

Research concerning the efficacy of specific strategies should be developed on a process-product paradigm (Doyle, 1978; Kimble, 1961), so that the merit of particular strategies may be interpreted with reference to CPR skill proficiency. In view of the voluntary nature of the lay public CPR education movement and the positive impact of by-stander rescue, it is essential that future programs are evaluated in terms of expedient skill development. To accomplish this goal it is necessary to develop instructional material and methods that are succinct and effective.

Recommendation Five

Manikins should be evaluated in terms of their effect on CPR proficiency and ease of interpretation of information provided, relative to cost. This study suggests a complex relationship between the utilization of information, the instructor's ability to interpret information, and the individual performer's potential to achieve the standard performance. Therefore, further research is required to accurately define relationships that correlate with proficiency.

In conclusion, optimal proficiency may be achieved through selective implementation of appropriate strategies. Given objective methods for evaluating proficiency, educators can develop an empirical knowledge foundation, rather than depend on inefficient trial and error approaches based on personal preference and speculation.

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APPENDIX A

PROCEDURE INFORMATION

BASIC LIFE SUPPORT

CARDIOPULMONARY RESUSCITATION PERFORMANCE TEST FOR ONE AND TWO RESCUER CPR

Elapsed Time (Seconds) Min.	Max.	Activity and Time (Seconds)	Critical Performance
6	10	Establish unresponsive and call out for help. Allow 6-10 seconds if face down and turning is required. Open Airway.	Shake shoulder, shouting "Are you OK?" Turn if necessary. Call for HELP. Designate individual. Give local emergency number. Adequate time.
10	15	Establish breathlessness. (Look, Listen, and Feel). (4 - 5 seconds).	Kneel properly. Head tilt with one hand on forehead and neck lift or chin lift with other hand. Ear over mouth and nose, observe chest.
13	20	Four Ventilations (3 - 5 seconds).	Ventilate properly four times and observe chest rise.
20	30	Establish pulse. (7 - 10 seconds).	Fingers palpate for carotid pulse on near side (other hand on forehead maintains head tilt). Adequate time.
74	96	Four cycles of 15 compressions two ventilations.	Proper body position. Landmark check each time and position of hands. Vertical compression. Say mnemonic out loud. Proper rate. Proper ratio. No bouncing. Ventilates properly.

Comparison of Acquisition of CPR Skill

Using Different Training Devices

The purpose of this research is to measure the effectiveness of training devices currently used to teach CPR skills. The results of the study may be used to make decisions about the purchase of training devices.

It is essential to the study that volunteers not have previous practice with CPR skills as this would change the rate of learning the skill. All subjects will be taught by certified instructors. The collection of research data will take place during the scheduled CPR program planned by the College.

INFORMATION OBTAINED IS FOR RESEARCH PURPOSES ONLY AND WILL NOT BE USED TO EVALUATE STUDENTS.

The following information is necessary for me to plan the study.

Thank you,

Noreen Campbell, RN, BSN

****

NAME ____

PHONE NUMBER _______________ BEST TIME TO CALL _______________

SESSION DESIRED (Circle choice and indicate order of choice if possible)

January 21   February 18   March 18

* source: original consent form

** used only for the volunteer student nurses

Record of Subject Identification

and

Random Number Assignment

	Knowledge of Results	
	gKR	pKR
Experienced Instructor	948	320
	081	779
	254	148
	048	310
	529	880
	274	993
	555	775
	123	919
	067	017
	959	352
	670	173
	647	248
Inexperienced Instructor	344	768
	360	558
	448	570
	633	579
	799	092
	941	392
	584	627
	526	569
	795	863
	692	338
	546	307
	065	742

APPENDIX B

Ventilation Sub-routine:

Tables and Figures

Table 27

Absolute Error Mean Scores of the Ventilation Sub-routine

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	4.45	2.50	2.24	1.74	1.55
Instructor[a]						
Inexperienced	24	4.28	1.90	1.71	0.96	1.39
Experienced	24	4.68	3.11	2.77	2.51	1.70
KR[b]						
gKR	24	4.78	3.34	2.95	2.23	1.88
pKR	24	4.12	1.67	1.54	1.25	1.21
Treatment Groups[c]						
I/gKR	12	5.03	2.34	2.22	0.76	1.28
E/gKR	12	3.52	1.46	1.21	1.17	1.50
I/pKR	12	4.53	4.34	3.67	3.69	2.48
E/pKR	12	4.72	1.87	1.87	1.32	0.92

[a] See Figure 4

[b] See Figure 5

[c] See Figure 6

Figure 4

Absolute error mean scores
for ventilation for inexperienced (I)
and experienced (E) instructors

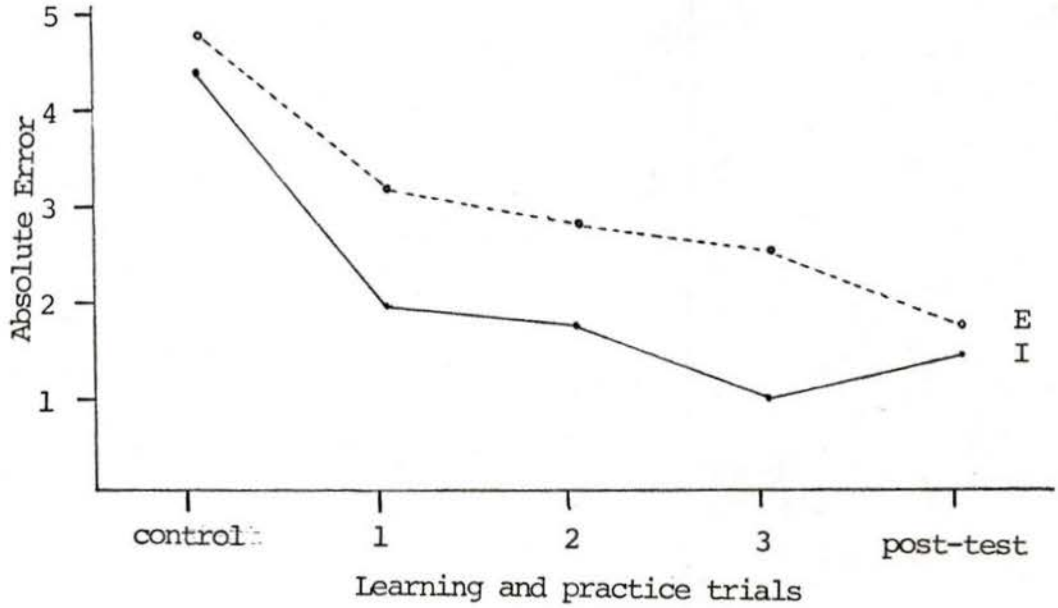

Figure 5

Absolute error mean scores
for ventilation for gKR (g) and pKR (p)

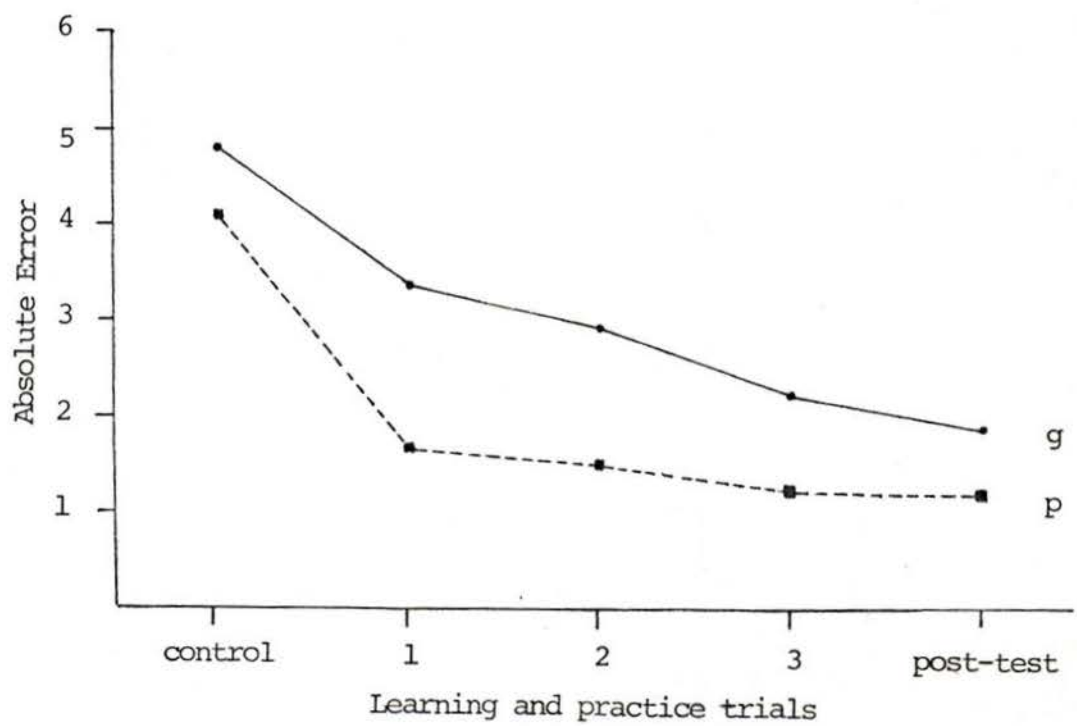

Figure 6

Absolute error mean scores
for ventilation for treatment groups

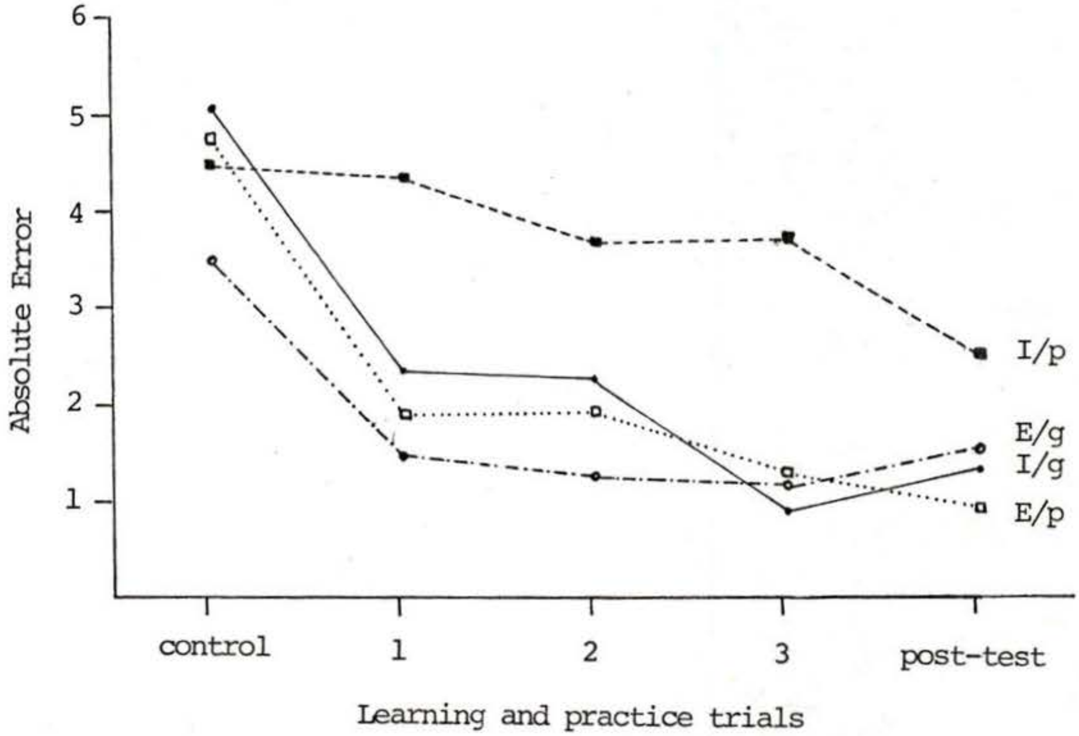

Table 28

Two-way ANOVA for Absolute Error for Ventilation Sub-routine Between Instructor Experience and KR

Sources of Variation	df	MS	F	Probability
		Control		
Instructor	1	1.470	0.251	ns
KR	1	5.201	0.888	ns
I/KR	1	8.670	1.481	ns
Error	44	5.854		
		Trial 1		
Instructor	1	17.521	4.270	0.045
KR	1	33.668	8.206	0.006
I/KR	1	7.521	1.833	ns
Error	44	4.103		
		Trial 2		
Instructor	1	13.547	4.151	0.048
KR	1	23.660	7.250	0.010
I/KR	1	1.880	0.576	ns
Error	44			
		Trial 3		
Instructor	1	28.675	11.647	0.001
KR	1	11.505	4.673	0.036
I/KR	1	23.101	9.383	0.004
Error	44	2.462		
		Post-test		
Instructor	1	1.172	0.459	ns
KR	1	5.400	2.113	ns
I/KR	1	9.452	3.699	ns
Error	44	2.555		

Table 29

Constant Error Mean Scores for Ventilation

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	-4.45	-2.45	-2.13	-1.63	-1.26
Instructor[a]						
Inexperienced	24	-4.27	-1.81	-1.48	-0.75	-0.83
Experienced	24	-4.63	-3.10	-2.77	-2.50	-1.70
KR [b]						
gKR	24	-4.78	-3.33	-2.94	-2.21	-1.85
pKR	24	-4.12	-1.57	-1.32	-1.05	-0.67
Treatment Groups[c]						
I/gKR	12	-5.02	-2.34	-2.20	-0.74	-1.22
E/gKR	12	-3.52	-1.27	-0.76	-0.77	-0.43
I/pKR	12	-4.53	-4.32	-3.67	-3.67	-2.48
E/pKR	12	-4.72	-1.87	-1.87	-1.32	-0.91

[a] See Figure 7

[b] See Figure 8

[c] See Figure 9

Figure 7

Constant error mean scores
for ventilation for inexperienced (I)
and experienced (E) instructors

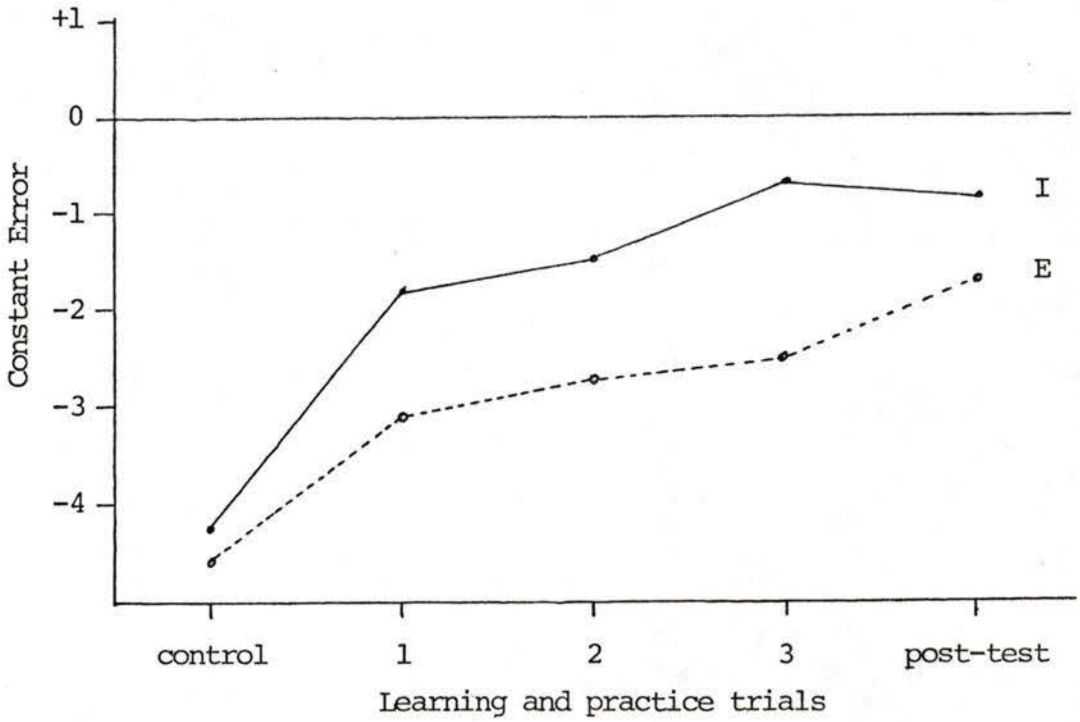

Figure 8

Constant error mean scores
for ventilation for gKR (g) and pKR (p)

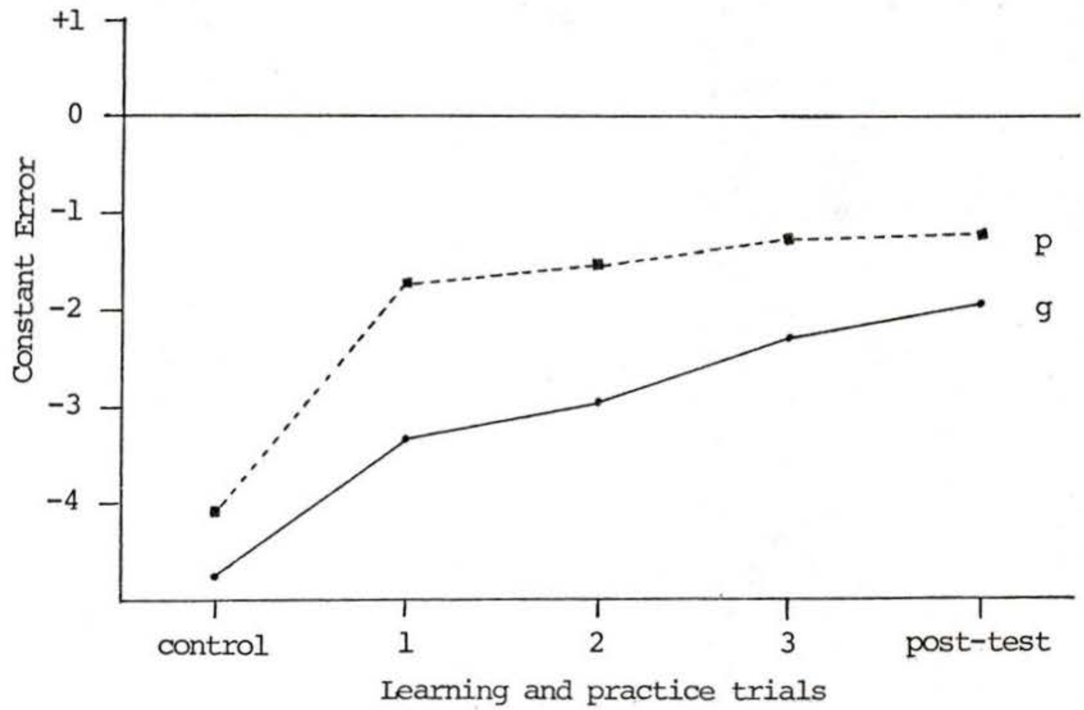

Figure 9

Constant error mean scores
for ventilation for treatment groups

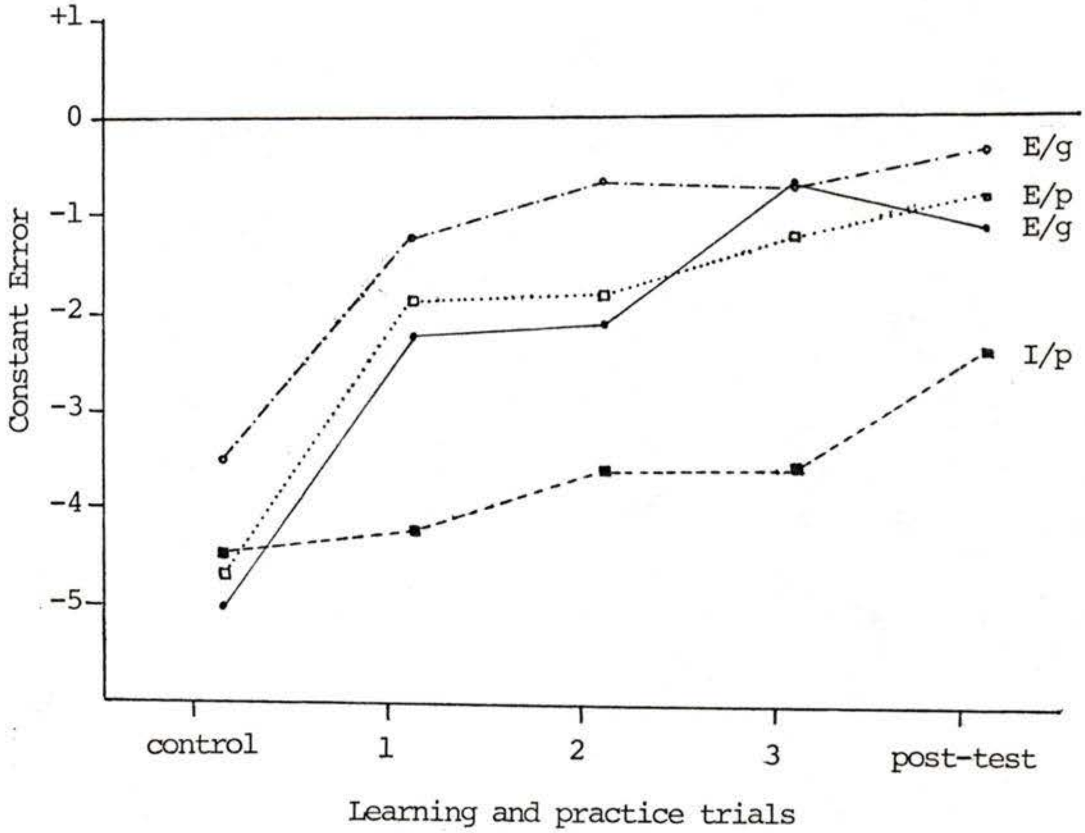

Table 30

Two-way ANOVA for Constant Error for Ventilation Sub-routine Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	1.541	0.261	ns
KR	1	5.070	0.860	ns
I/KR	1	8.501	1.442	ns
Error	44	5.893		
		Trial 1		
Instructor	1	20.021	4.685	0.04
KR	1	37.101	8.682	0.005
I/KR	1	5.741	1.343	ns
Error	44	4.274		
		Trial 2		
Instructor	1	20.150	5.740	0.02
KR	1	31.525	8.981	0.004
I/KR	1	0.385	0.110	ns
Error	44	3.510		
		Trial 3		
Instructor	1	36.575	13.521	0.001
KR	1	16.217	5.995	0.02
I/KR	1	16.922	6.252	0.02
Error	44	2.705		
		Post-test		
Instructor	1	9.100	2.980	ns
KR	1	16.685	5.464	0.02
I/KR	1	1.880	0.616	ns
Error	44	3.053		

Table 31

Variable Error Mean Scores for Ventilation

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	1.40	1.57	1.61	1.38	1.59
Instructor[a]						
Inexperienced	24	1.21	1.53	1.40	1.03	1.68
Experienced	24	1.58	1.60	1.81	1.73	1.49
KR[b]						
gKR	24	1.44	1.81	1.71	1.58	1.53
pKR	24	1.35	1.32	1.50	1.19	1.64
Treatment Groups[c]						
I/gKR	12	1.13	1.92	1.85	1.14	1.34
E/gKR	12	1.29	1.15	0.96	0.92	2.03
I/pKR	12	1.74	1.70	1.58	2.01	1.73
E/pKR	12	1.41	1.49	2.05	1.45	1.25

[a] See Figure 10

[b] See Figure 11

[c] See Figure 12

Figure 10

Variable error mean scores
for ventilation for inexperienced (I) and experienced (E) instructors

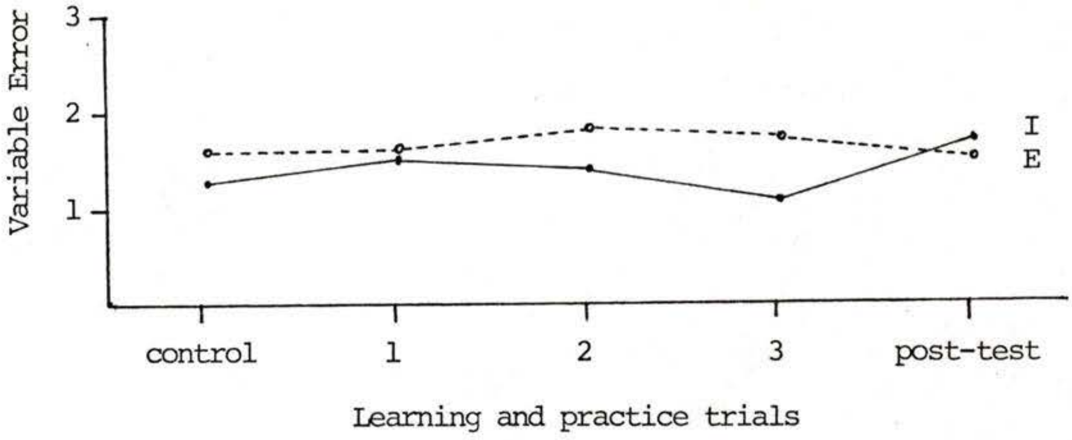

Figure 11

Variable error mean scores
for ventilation for gKR (g) and pKR (p)

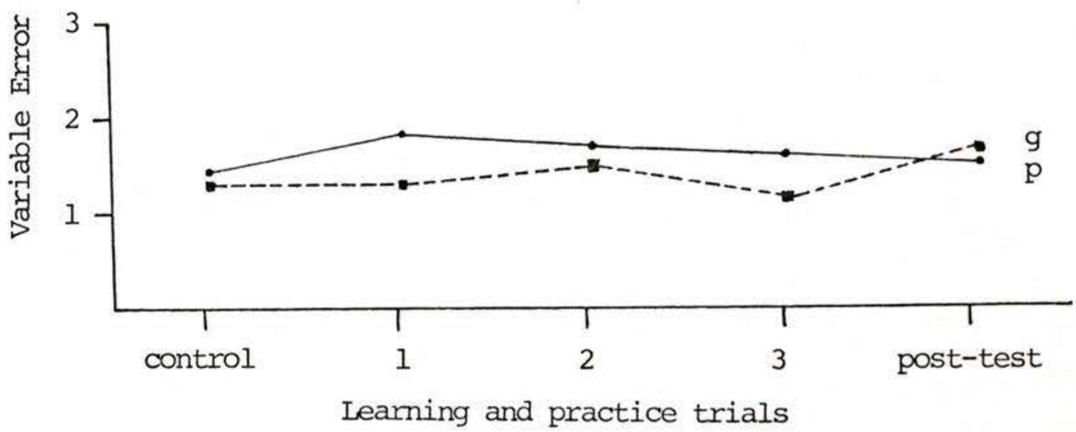

Figure 12

Variable error mean scores
for ventilation for treatment groups

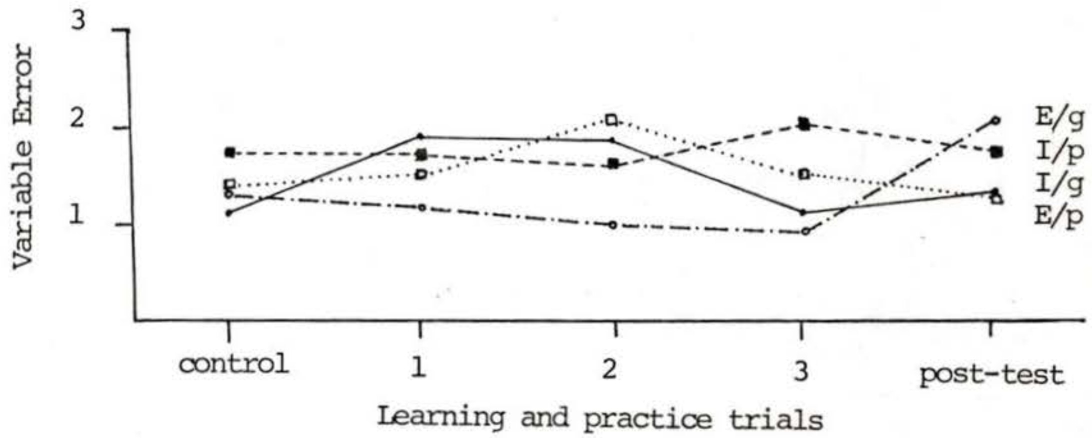

Table 32

Two-way ANOVA for Variable Error for Ventilation Sub-routine Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	1.606	1.067	ns
KR	1	0.085	0.057	ns
I/KR	1	0.715	0.475	ns
Error	44	1.505		
		Trial 1		
Instructor	1	0.051	0.049	ns
KR	1	2.861	2.791	ns
I/KR	1	0.924	0.901	ns
Error	44	1.025		
		Trial 2		
Instructor	1	1.997	1.826	ns
KR	1	0.531	0.486	ns
I/KR	1	5.583	5.105	0.03
Error	44	1.094		
		Trial 3		
Instructor	1	5.978	9.360	0.004
KR	1	1.825	2.858	ns
I/KR	1	0.337	0.527	ns
Error	44	0.639		
		Post-test		
Instructor	1	0.443	0.207	ns
KR	1	0.142	0.066	ns
I/KR	1	4.124	1.924	ns
Error	44	2.144		

Table 33

Three-way ANOVA of Absolute Error
for Ventilation Sub-routine
Between Instructor Experience (I), KR and Time

Source of Variation	df	MS	F	Probability
Between Subjects				
Instructor	1	48.150	4.64	0.04
KR	1	69.659	6.71	0.01
I/KR	1	16.380	1.58	ns
Error	44	10.388		
Within Subjects				
Time	4	64.505	32.87	0.000*
I/Time	4	3.558	1.81	ns
KR/Time	4	2.444	1.25	ns
I/KR/Time	4	8.560	4.36	0.002
Error	176	1.962		

* p 0.0000000

Table 34

Three-way ANOVA of Constant Error
for Ventilation Sub-routine
Between Instructor Experience (I), KR and Time

Source of Variation	df	MS	F	Probability
Between Subjects				
Instructor	1	74.259	6.37	0.02
KR	1	97.410	8.36	0.006
I/KR	1	6.239	0.54	ns
Error	44	11.657		
Within Subjects				
Time	4	74.095	38.10	0.000*
I/Time	4	3.282	1.69	ns
KR/Time	4	2.297	1.18	ns
I/KR/Time	4	6.796	3.50	0.009
Error	176	1.944		

* p 0.0000000

Table 35

Three-way ANOVA of Variable Error
for Ventilation Sub-routine
Between Instructor Experience (I), KR and Time

Source of Ventilation	df	MS	F	Probability
Between Subjects				
Instructor	1	4.390	1.99	ns
KR	1	2.718	1.23	ns
I/KR	1	0.003	0.00	ns
Error	44	2.205		
Within Subjects				
Time	4	0.582	0.55	ns
I/Time	4	1.420	1.35	ns
KR/Time	4	0.681	0.65	ns
I/KR/Time	4	2.920	2.78	0.03
Error	176	1.050		

APPENDIX C

Compression Sub-routine (Compression):

Tables and Figures

Table 36

Absolute Error Mean Scores
for Compression

Group	N	Trials				
		Control	1	2	3	Post-trial
Total Population	48	2.74	1.79	1.68	1.60	1.27
Instructor [a]						
Inexperienced	24	2.95	2.43	1.65	1.62	1.70
Experienced	24	2.54	1.15	1.71	1.59	0.85
KR [b]						
gKR	24	3.43	2.32	2.64	2.57	2.02
pKR	24	2.05	1.27	0.72	0.64	0.52
Treatment Groups [c]						
I/gKR	12	3.96	2.89	2.20	2.26	2.54
E/gKR	12	1.93	1.97	1.09	0.98	0.86
I/pKR	12	2.90	1.74	3.07	2.88	1.50
E/pKR	12	2.17	0.56	0.36	0.29	0.19

[a] See Figure 13

[b] See Figure 14

[c] See Figure 15

Figure 13

Absolute error mean scores for compression for inexperienced (I) and experienced (E) instructors

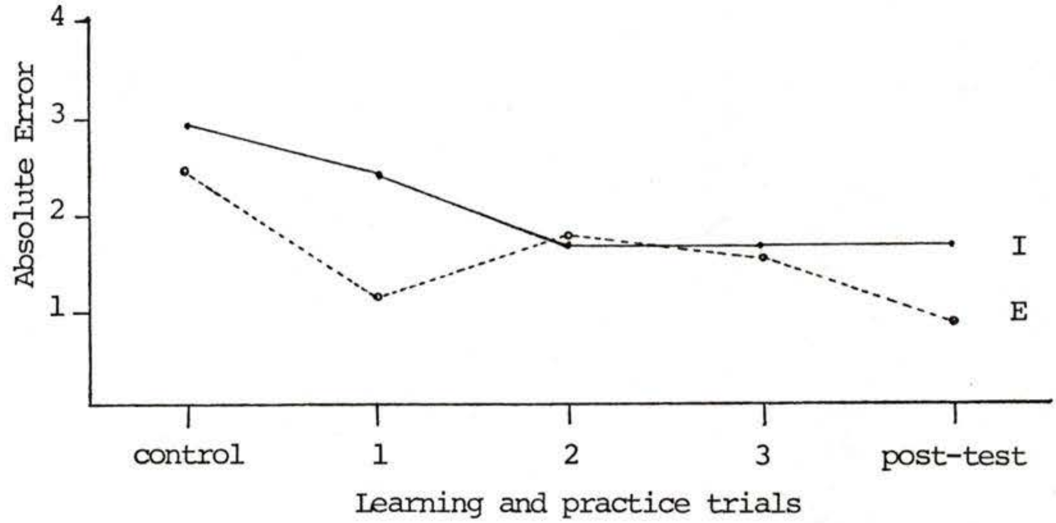

Figure 14

Absolute error mean scores for compression for gKR (g) and pKR (p)

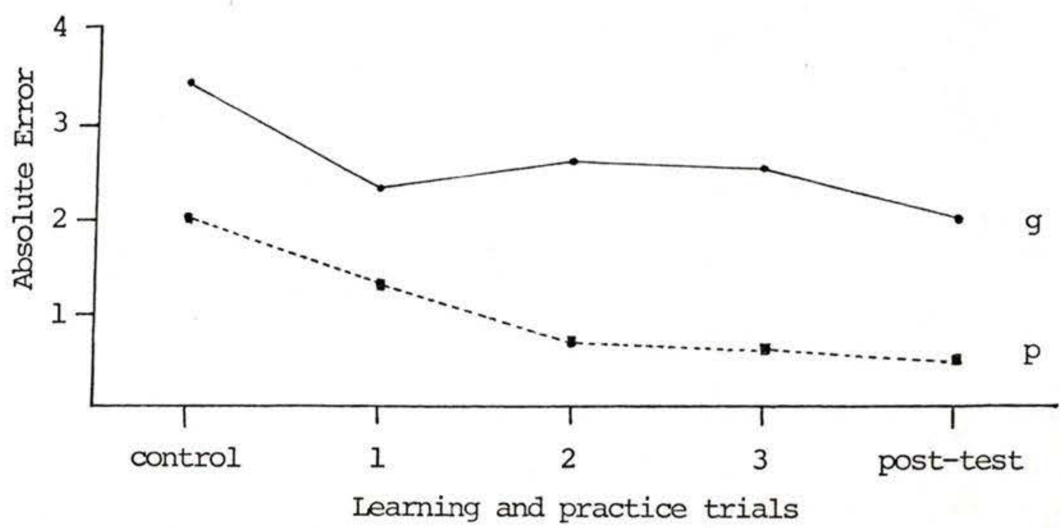

Figure 15

Absolute error mean scores
for compression for treatment groups

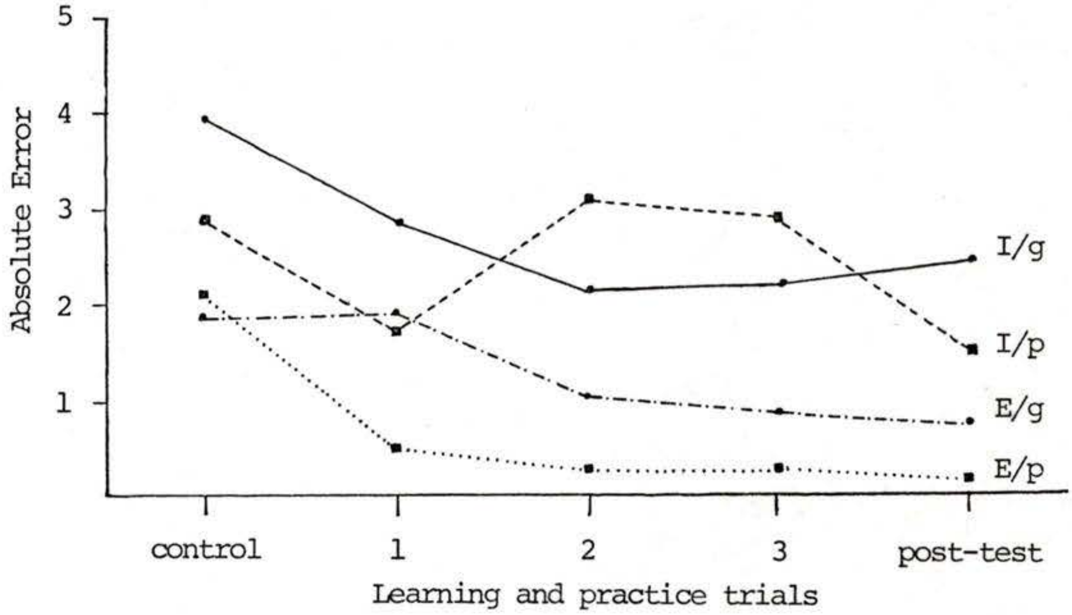

Table 37

Two-way ANOVA for Absolute Error

for Compression Sub-routine Between Instructor Experience (I) and KR

Source of Variantion	df	MS	F	Probability
		Control		
Instructor	1	2.013	0.225	n.s
KR	1	22.978	2.564	n.s
I/KR	1	5.051	0.564	n.s
error	44	8.960		
		Trial 1		
Instructor	1	16.403	3.997	0.03
KR	1	19.533	4.760	0.04
I/KR	1	0.187	0.046	n.s
error	44	4.104		
		Trial 2		
Instructor	1	0.057	0.014	n.s
KR	1	43.930	10.955	0.002
I/KR	1	7.632	1.903	n.s
error	44			
		Trial 3		
Instructor	1	0.015	0.004	n.s
KR	1	44.815	13.181	0.001
I/KR	1	5.253	1.545	n.s
error	44			
		Post-test		
Instructor	1	8.738	3.768	n.s
KR	1	26.910	11.604	0.001
I/KR	1	0.392	0.169	n.s
error	44			

Table 38

Constant Error Mean Scores
for Compression

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	-2.46	-1.37	-1.50	-1.47	-1.19
Instructor[a]						
Inexperienced	24	-2.70	-2.21	-1.61	-1.58	-1.65
Experienced	24	-2.21	-0.53	-1.39	-1.37	-0.73
KR[b]						
gKR	24	-3.33	-1.96	-2.46	-2.38	-1.98
pKR	24	-1.59	-0.78	-0.54	-0.57	-0.40
Treatment Groups[c]						
I/gKR	12	-3.75	-2.78	-2.20	-2.25	-2.53
E/gKR	12	-1.65	-1.63	-1.01	-0.90	-0.76
I/pKR	12	-2.90	-1.14	-2.71	-2.52	-1.42
E/pKR	12	-1.52	-0.08	-0.07	-0.23	-0.03

[a] See Figure 16

[b] See Figure 17

[c] See Figure 18

Figure 16

Constant error mean scores for compression
for inexperienced (I) and experienced (E) instructors

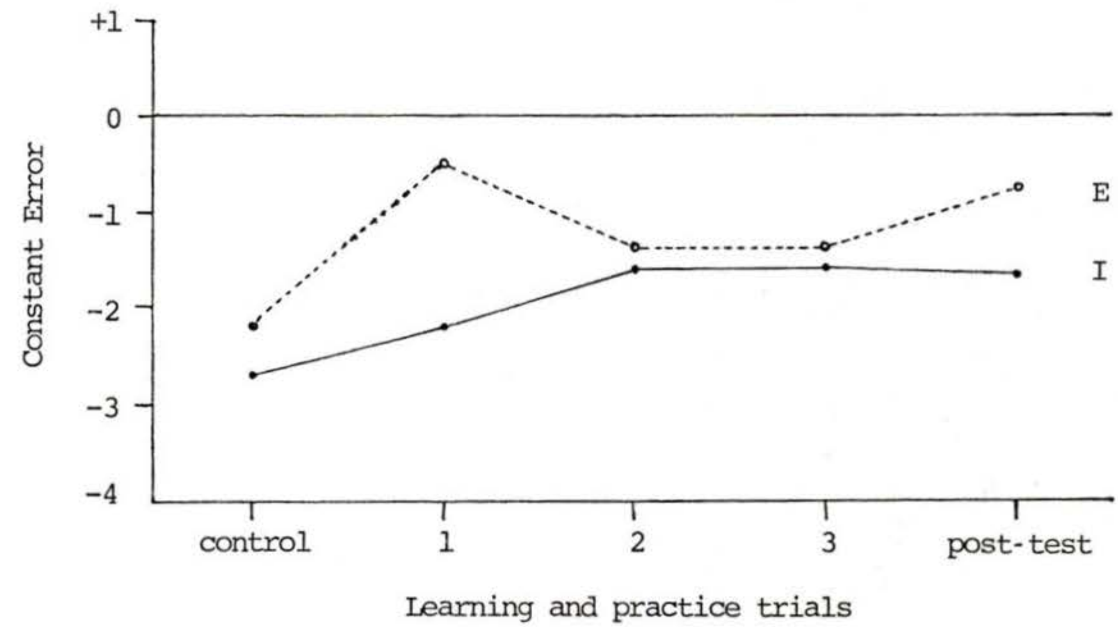

Figure 17

Constant error mean scores for compression
for gKR (g) and pKR (p)

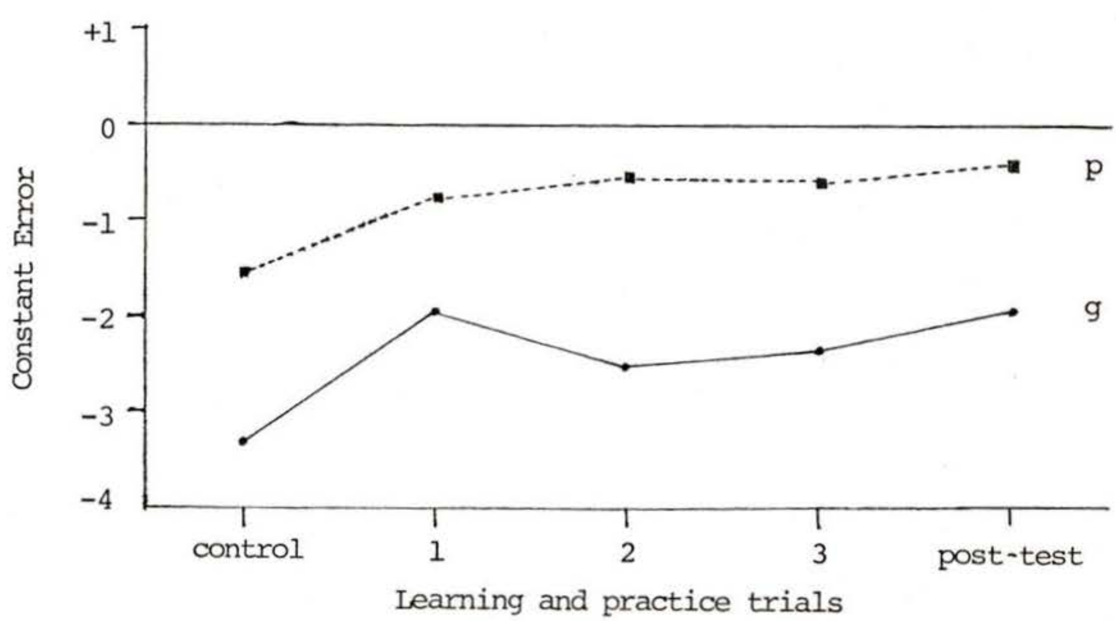

Table 39

Two-way ANOVA for Constant Error for Compression Sub-routine Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	2.837	0.280	ns
KR	1	36.349	3.582	ns
I/KR	1	1.523	0.150	ns
Error	44	10.148		
		Trial 1		
Instructor	1	33.701	6.802	0.01
KR	1	16.898	3.411	ns
I/KR	1	0.015	0.003	ns
Error	44	4.955		
		Trial 2		
Instructor	1	0.581	0.148	ns
KR	1	43.930	11.177	0.002
I/KR	1	6.307	1.605	ns
Error	44	3.930		
		Trial 3		
Instructor	1	0.504	0.156	ns
KR	1	39.567	12.212	0.001
I/KR	1	2.660	0.821	ns
Error	44	3.240		
		Post-test		
Instructor	1	10.139	4.212	0.05
KR	1	29.862	12.406	0.001
I/KR	1	0.418	0.174	ns
Error	44	2.407		

Table 40

Variable Error Mean Scores for Compression

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	1.81	1.71	1.48	1.38	0.88
Instructor[a]						
Inexperienced	24	1.80	1.34	0.91	1.07	0.98
Experienced	24	1.81	2.08	2.05	1.71	0.79
KR [b]						
gKR	24	2.28	2.34	1.73	1.83	1.05
pKR	24	1.33	1.08	1.23	0.95	0.72
Treatment Groups[c]						
I/gKR	12	2.28	1.37	0.91	1.16	1.01
E/gKR	12	1.33	1.31	0.90	0.99	0.95
I/pKR	12	2.29	3.32	2.55	2.50	1.09
E/pKR	12	1.34	0.85	1.56	0.92	0.48

[a] See Figure 19

[b] See Figure 20

[c] See Figure 21

Figure 18

Constant error mean scores
for compression for treatment groups

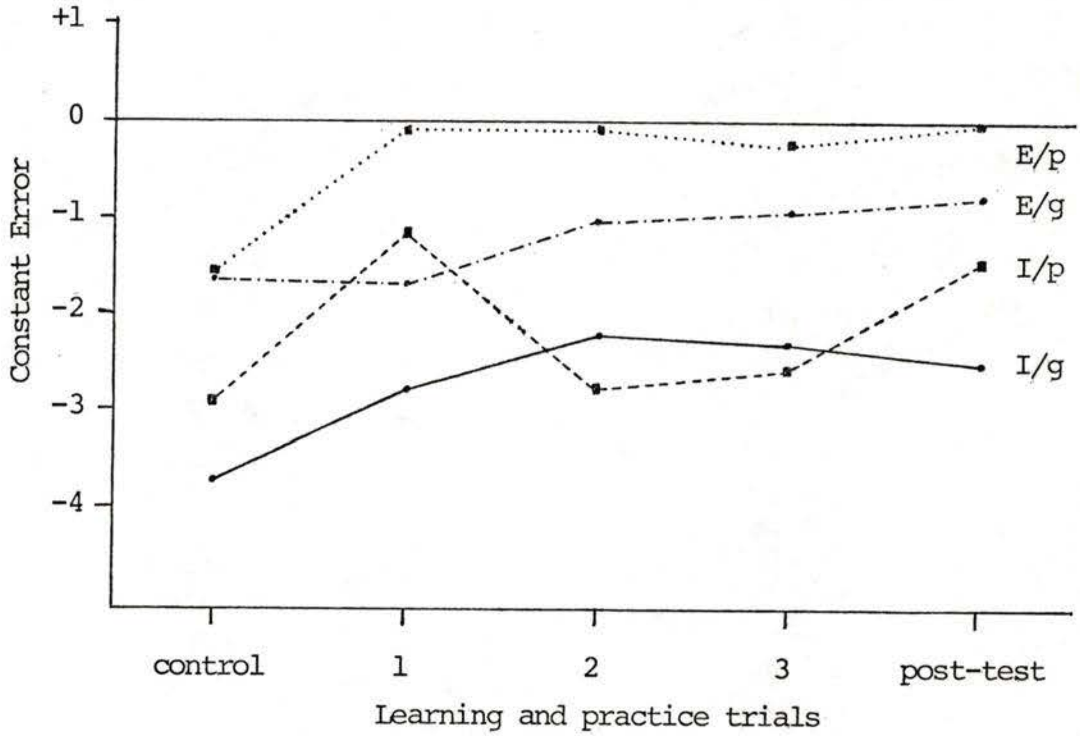

Figure 19

Variable error mean scores for compression
for inexperienced (I) and experienced (E) instructors

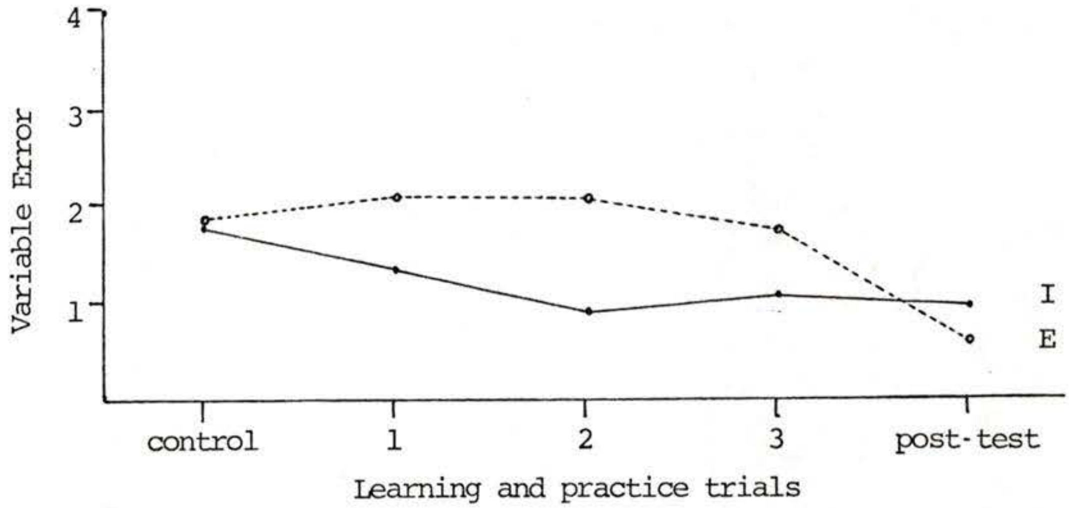

Figure 20

Variable error mean scores for compression
for gKR (g) and pKR (p)

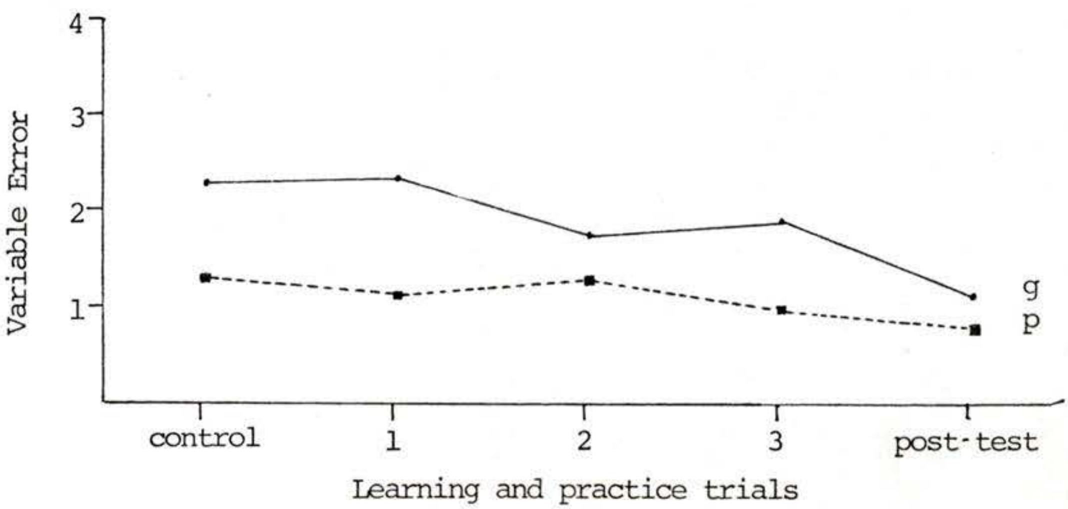

Figure 21

Variable error mean scores
for compression for treatment groups

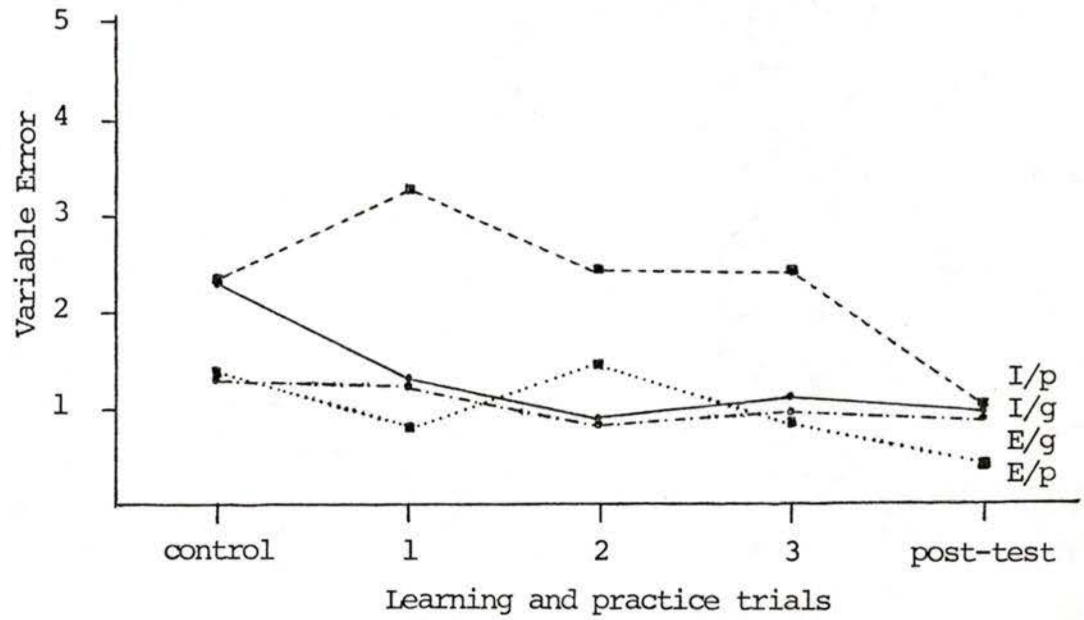

Table 41

Two-way ANOVA for Variable Error for Compression Sub-routine Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	0.001	0.000	ns
KR	1	10.716	3.713	ns
I/KR	1	0.000	0.000	ns
Error	44	2.886		
		Trial 1		
Instructor	1	6.586	0.455	ns
KR	1	19.102	1.320	ns
I/KR	1	17.448	1.206	ns
Error	44	14.471		
		Trial 2		
Instructor	1	15.801	2.415	ns
KR	1	2.970	0.454	ns
I/KR	1	2.920	0.446	ns
Error	44	6.542		
		Trial 3		
Instructor	1	4.788	0.861	ns
KR	1	9.153	1.647	ns
I/KR	1	5.992	1.078	ns
Error	44	5.559		
		Post-test		
Instructor	1	0.443	1.034	ns
KR	1	1.337	3.123	ns
I/KR	1	0.916	2.139	ns
Error	44	0.428		

Table 42

Three-way ANOVA of Absolute Error
for Compression Sub-routine
Between Instructor Experience (I), KR and Time

Source of Variation	df	MS	F	Probability
Between Subjects				
Instructor	1	15.055	1.09	ns
KR	1	145.220	10.56	0.002
I/KR	1	1.366	0.10	ns
Error	44	13.753		
Within Subjects				
Time	4	14.614	6.47	0.000*
I/Time	4	3.825	1.69	ns
KR/Time	4	1.670	0.74	ns
I/KR/Time	4	4.287	1.90	ns
Error	176	2.259		

* p 0.00007

Table 43

Three-way ANOVA of Constant Error
for Compression Sub-routine
Between Instructor Experience (I), KR and Time

Source of Variation	df	MS	F	Probability
Between Subjects				
Instructor	1	29.505	1.94	ns
KR	1	162.707	10.68	0.002
I/KR	1	1.135	0.07	ns
Error	44	15.231		
Within Subjects				
Time	4	11.782	4.99	0.000*
I/Time	4	4.563	1.93	ns
KR/Time	4	0.974	0.41	ns
I/KR/Time	4	2.446	1.04	ns
Error	176	2.362		

* p 0.0008

APPENDIX D

Compression Sub-routine (Camping):

Tables

Table 44

Absolute Error Mean Scores for Camping

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	0.38	0.53	0.54	0.66	0.66
Instructor						
Inexperienced	24	0.34	0.50	0.50	0.77	0.59
Experienced	24	0.42	0.55	0.59	0.60	0.72
KR						
gKR	24	0.40	0.46	0.50	0.47	0.59
pKR	24	0.36	0.59	0.58	0.84	0.72
Treatment Groups						
I/gKR	12	0.41	0.31	0.20	0.24	0.26
E/gKR	12	0.28	0.69	0.79	1.17	0.92
I/pKR	12	0.39	0.61	0.81	0.69	0.93
E/pKR	12	0.45	0.49	0.37	0.52	0.52

Table 45

Two-way ANOVA of Absolute Error for Camping
Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	0.069	0.182	ns
KR	1	0.015	0.041	ns
I/KR	1	0.095	0.252	ns
Error	44	0.379		
		Trial 1		
Instructor	1	0.037	0.047	ns
KR	1	0.202	0.258	ns
I/KR	1	0.728	0.931	ns
Error	44	0.782		
		Trial 2		
Instructor	1	0.100	0.129	ns
KR	1	0.071	0.092	ns
I/KR	1	3.240	4.171	0.05
Error	44	0.777		
		Trial 3		
Instructor	1	0.127	0.081	ns
KR	1	1.721	1.095	ns
I/KR	1	3.603	2.293	ns
Error	44	1.571		
		Post-test		
Instructor	1	0.201	0.173	ns
KR	1	0.189	0.162	ns
I/KR	1	3.429	2.947	ns
Error	44	1.164		

Table 46

Variable Error Mean Scores for Camping

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	0.43	0.51	0.54	0.48	0.55
Instructor						
Inexperienced	24	0.41	0.50	0.51	0.50	0.56
Experienced	24	0.46	0.51	0.56	0.47	0.55
KR						
gKR	24	0.48	0.53	0.58	0.47	0.63
pKR	24	0.38	0.48	0.50	0.50	0.47
Treatment Groups						
I/gKR	12	0.45	0.40	0.39	0.36	0.49
E/gKR	12	0.37	0.59	0.63	0.64	0.62
I/pKR	12	0.52	0.67	0.76	0.58	0.77
E/pKR	12	0.40	0.36	0.36	0.35	0.33

Table 47

Two-way ANOVA of Variable Error for Camping Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	0.076	0.326	ns
KR	1	0.029	0.123	ns
I/KR	1	0.002	0.010	ns
Error	44	0.232		
		Trial 1		
Instructor	1	0.003	0.007	ns
KR	1	0.038	0.096	ns
I/KR	1	0.752	1.910	ns
Error	44	0.394		
		Trial 2		
Instructor	1	0.027	0.103	ns
KR	1	0.074	0.289	ns
I/KR	1	1.206	4.684	0.04
Error	44	0.258		
		Trial 3		
Instructor	1	0.015	0.042	ns
KR	1	0.009	0.026	ns
I/KR	1	0.768	2.166	ns
Error	44	0.354		
		Post-test		
Instructor	1	0.001	0.005	ns
KR	1	0.288	1.251	ns
I/KR	1	0.975	4.229	0.05
Error	44	0.230		

APPENDIX E

Compression Sub-routine (Pressure Points):

Tables

Table 48

Absolute Error Mean Scores for Pressure Points

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	0.03	0.02	0.02	0.04	0.03
Instructor						
Inexperienced	24	0.05	0.01	0.04	0.05	0.05
Experienced	24	0.00	0.03	0.00	0.04	0.01
KR						
gKR	24	0.00	0.04	0.00	0.04	0.02
pKR	24	0.05	0.00	0.04	0.05	0.05
Treatment Groups						
I/gKR	12	0.00	0.01	0.00	0.00	0.03
E/gKR	12	0.10	0.00	0.07	0.10	0.08
I/pKR	12	0.01	0.06	0.00	0.07	0.01
E/pKR	12	0.00	0.00	0.00	0.00	0.02

Table 49

Two-way ANOVA of Absolute Error for Pressure Points
Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	0.026	1.508	ns
KR	1	0.026	1.508	ns
I/KR	1	0.036	2.095	ns
Error	44	0.017		
		Trial 1		
Instructor	1	0.005	0.851	ns
KR	1	0.014	2.288	ns
I/KR	1	0.007	1.225	ns
Error	44	0.006		
		Trial 2		
Instructor	1	0.015	2.121	ns
KR	1	0.015	2.121	ns
I/KR	1	0.015	2.121	ns
Error	44	0.007		
		Trial 3		
Instructor	1	0.002	0.106	ns
KR	1	0.002	0.106	ns
I/KR	1	0.087	3.806	ns
Error	44	0.023		
		Post-test		
Instructor	1	0.021	1.881	ns
KR	1	0.011	0.975	ns
I/KR	1	0.012	1.052	ns
Error	44	0.011		

Table 50

Variable Error Mean Scores of Pressure Points

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	0.12	0.11	0.09	0.25	0.17
Instructors						
Inexperienced	24	0.22	0.07	0.18	0.22	0.26
Experienced	24	0.02	0.16	0.00	0.27	0.08
KR						
gKR	24	0.02	0.21	0.00	0.27	0.09
pKR	24	0.22	0.02	0.18	0.22	0.25
Treatment Groups						
I/gKR	12	0.00	0.11	0.00	0.00	0.16
E/gKR	12	0.43	0.03	0.36	0.44	0.37
I/pKR	12	0.04	0.32	0.00	0.54	0.02
E/pKR	12	0.00	0.00	0.00	0.00	0.13

Table 51

Two-way ANOVA of Variable Error for Pressure Points Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	0.466	1.733	ns
KR	1	0.466	1.733	ns
I/KR	1	0.665	2.473	ns
Error	44	0.269		
		Trial 1		
Instructor	1	0.095	0.603	ns
KR	1	0.458	2.924	ns
I/KR	1	0.174	1.110	ns
Error	44	0.157		
		Trial 2		
Instructor	1	0.382	2.060	ns
KR	1	0.382	2.060	ns
I/KR	1	0.382	2.060	ns
Error	44	0.185		
		Trial 3		
Instructor	1	0.028	0.035	ns
KR	1	0.028	0.035	ns
I/KR	1	2.901	3.606	ns
Error	44	0.805		
		Post-test		
Instructor	1	0.409	1.510	ns
KR	1	0.293	1.082	ns
I/KR	1	0.035	0.128	ns
Error	44	0.271		

APPENDIX F

Time (Ventilation Phase):

Tables and Figures

Table 52

Absolute Error Mean Scores for Time (Ventilation Phase)

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	2.31	2.39	2.16	1.99	1.69
Instructor [a]						
Inexperienced	24	2.83	3.64	3.39	3.01	2.81
Experienced	24	1.79	1.14	0.93	0.97	0.58
KR [b]						
gKR	24	2.21	2.71	2.13	2.40	2.03
pKR	24	2.42	2.07	2.19	1.58	1.36
Treatment Groups [c]						
I/gKR	12	2.47	4.20	3.22	3.56	3.28
E/gKR	12	3.19	3.08	3.55	2.47	2.33
I/pKR	12	1.95	1.22	1.03	1.25	0.78
E/pKR	12	1.64	1.06	0.83	0.69	0.39

[a] See Figure 22

[b] See Figure 23

[c] See Figure 24

Figure 22

Absolute error mean scores
for time (ventilation phase) for inexperienced (I)
and experienced (E) instructors

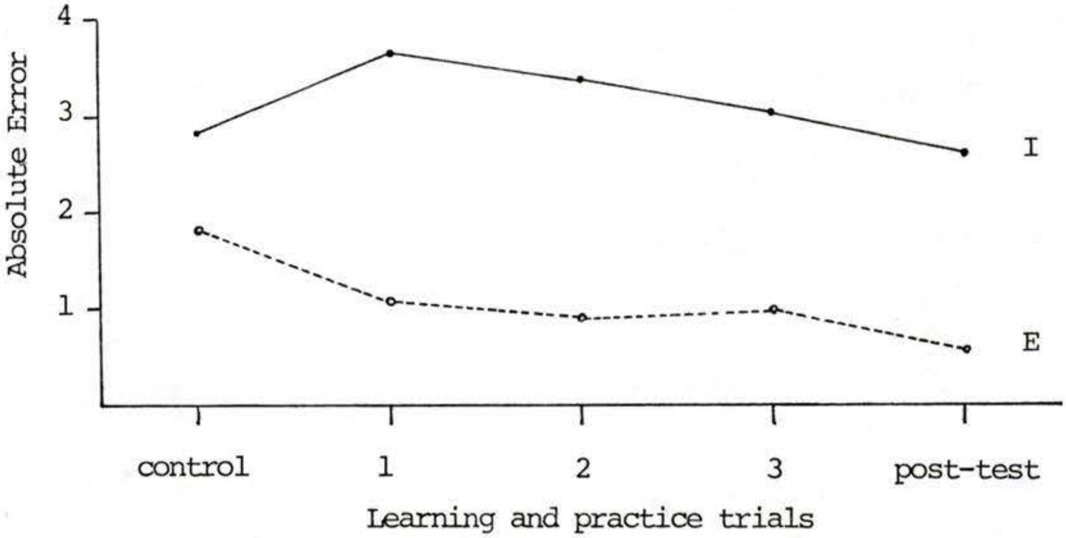

Figure 23

Absolute error mean scores
for time (ventilation phase) for gKR (g) and pKR (p)

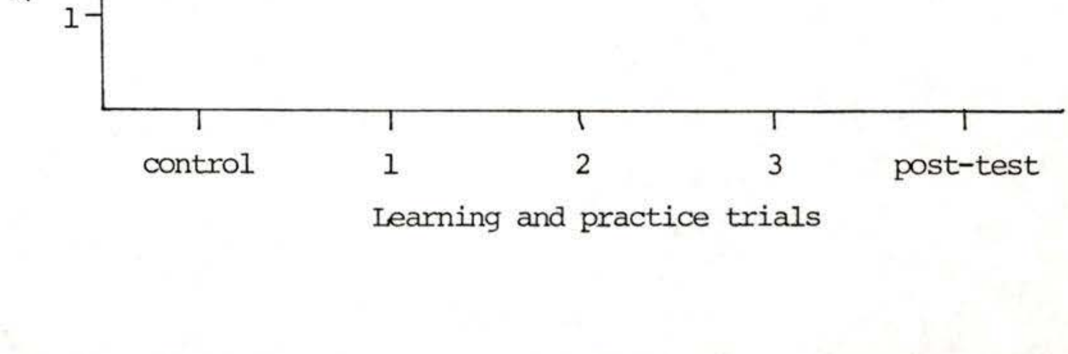

Figure 24

Absolute error mean scores
for ventilation time for treatment groups

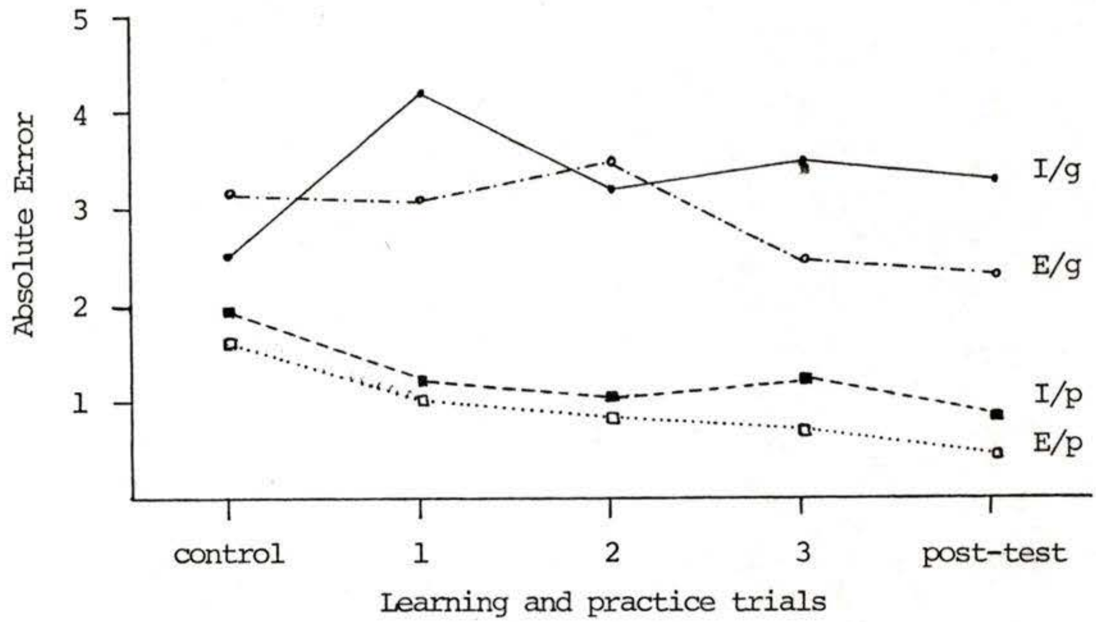

Table 53

Two-way ANOVA for Absolute Error for Time (Ventilation Phase)
Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	13.031	4.444	0.04
KR	1	0.515	0.175	ns
I/KR	1	3.188	1.087	ns
Error	44	2.933		
		Trial 1		
Instructor	1	75.050	21.561	0.000
KR	1	4.890	1.405	ns
I/KR	1	2.679	0.770	ns
Error	44	3.481		
		Trial 2		
Instructor	1	72.595	23.895	0.000
KR	1	0.057	0.019	ns
I/KR	1	0.829	0.273	ns
Error	44	3.038		
		Trial 3		
Instructor	1	50.062	15.776	0.000
KR	1	8.102	2.553	ns
I/KR	1	0.843	0.266	ns
Error	44	3.173		
		Post-test		
Instructor	1	59.274	32.170	0.000
KR	1	5.333	2.895	ns
I/KR	1	0.919	0.499	ns
Error	44	1.843		

Table 54

Constant Error Mean Scores for Time (Ventilation Phase)

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	2.27	2.39	2.09	1.90	1.65
Instructor[a]						
Inexperienced	24	2.83	3.64	3.28	2.82	2.72
Experienced	24	1.71	1.14	0.90	0.97	0.58
KR[b]						
gKR	24	2.13	2.71	2.01	2.26	2.03
pKR	24	2.42	2.07	2.17	1.53	1.28
Treatment Groups[c]						
I/gKR	12	2.47	4.20	3.00	3.28	3.28
E/gKR	12	3.19	3.08	3.55	2.36	2.17
I/pKR	12	1.78	1.22	1.03	1.25	0.78
E/pKR	12	1.64	1.06	0.78	0.69	0.39

[a] See Figure 25

[b] See Figure 26

[c] See Figure 27

Figure 25

Constant error mean scores
for ventilation time for inexperienced (I)
and experienced (E) instructors

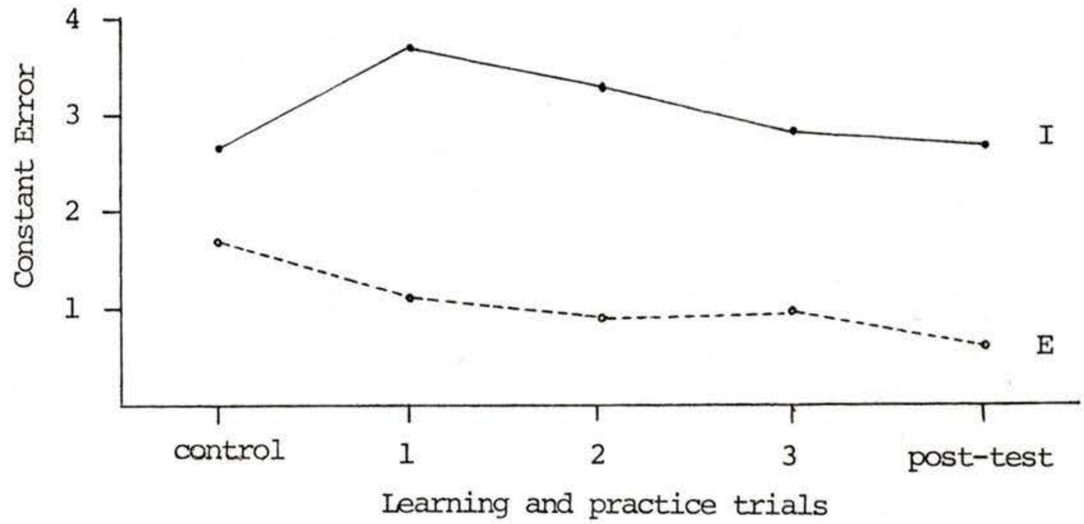

Figure 26

Constant error mean scores
for ventilation time for gKR (g) and pKR (p)

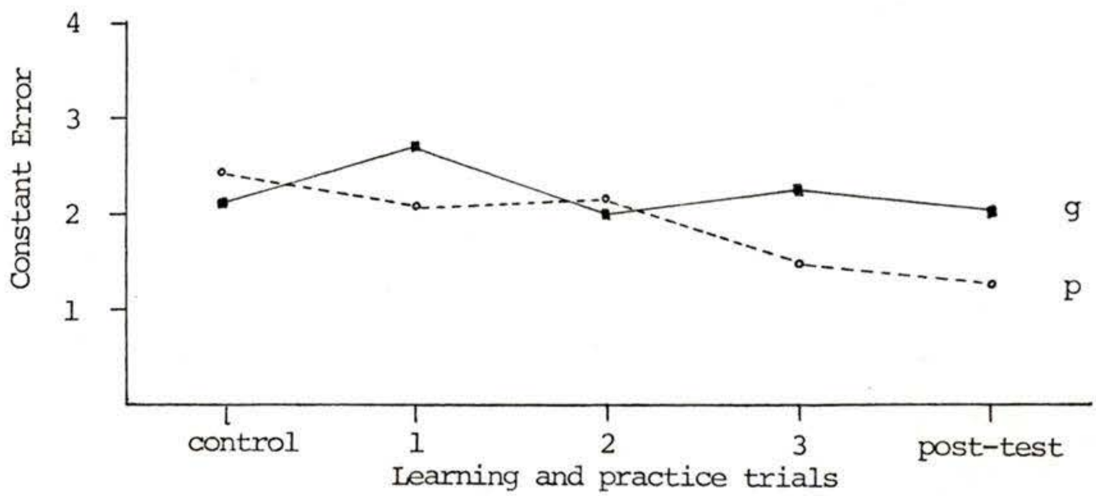

Figure 27

Constant error mean scores
for ventilation time for treatment groups

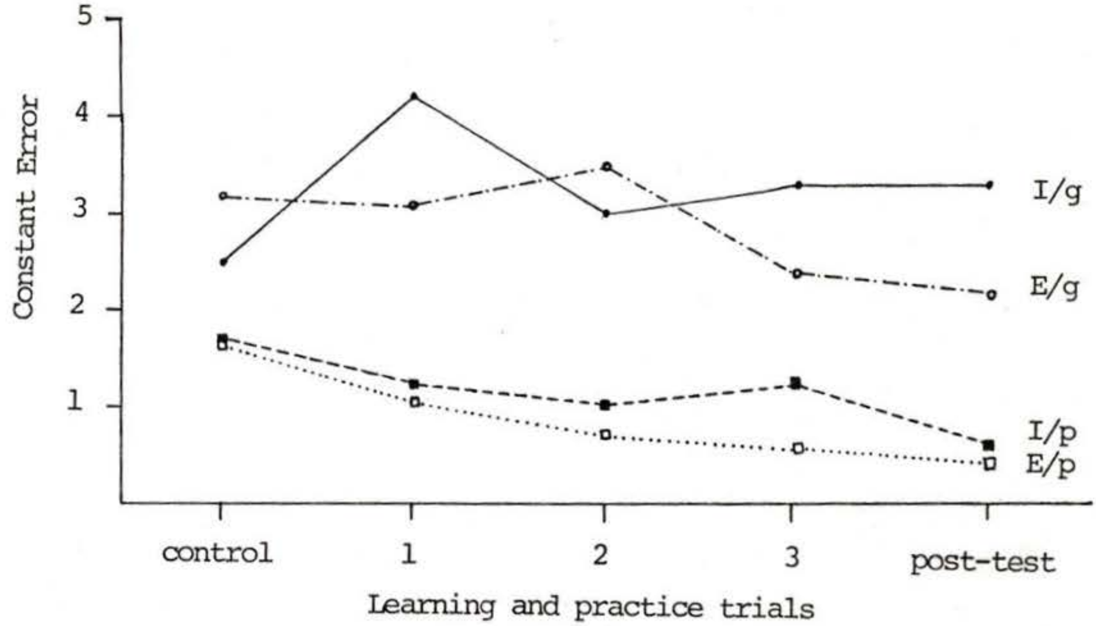

Table 55

Two-way ANOVA of Constant Error for Time (Ventilation Phase)
Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	15.199	4.900	0.03
KR	1	1.012	0.326	ns
I/KR	1	2.240	0.722	ns
Error	44	3.102		
		Trial 1		
Instructor	1	75.050	21.561	0.000
KR	1	4.890	1.405	ns
I/KR	1	2.679	0.770	ns
Error	44	3.481		
		Trial 2		
Instructor	1	67.735	20.164	0.000
KR	1	0.279	0.083	ns
I/KR	1	1.936	0.576	ns
Error	44	3.359		
		Trial 3		
Instructor	1	40.978	13.396	0.001
KR	1	6.534	2.136	ns
I/KR	1	0.394	0.129	ns
Error	44	3.059		
		Post-test		
Instructor	1	54.912	26.824	0.000
KR	1	6.750	3.297	ns
I/KR	1	1.555	0.760	ns
Error	44	2.047		

Table 56

Variable Error Mean Scores for Time (Ventilation Phase)

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	0.83	0.95	0.81	0.66	0.34
Instructor[a]						
Inexperienced	24	0.90	1.31	1.11	0.98	0.52
Experienced	24	0.76	0.59	0.50	0.34	0.15
KR[b]						
gKR	24	0.90	1.12	0.66	0.75	0.32
pKR	24	0.77	0.78	0.96	0.57	0.36
Treatment Groups[c]						
I/gKR	12	0.80	1.57	0.83	1.07	0.41
E/gKR	12	1.00	1.06	1.40	0.88	0.64
I/pKR	12	0.99	0.67	0.49	0.42	0.22
E/pKR	12	0.54	0.51	0.51	0.26	0.08

[a] See Figure 28

[b] See Figure 29

[c] See Figure 30

Figure 28

Variable error mean scores
for ventilation time for inexperienced (I)
and experienced (E) instructors

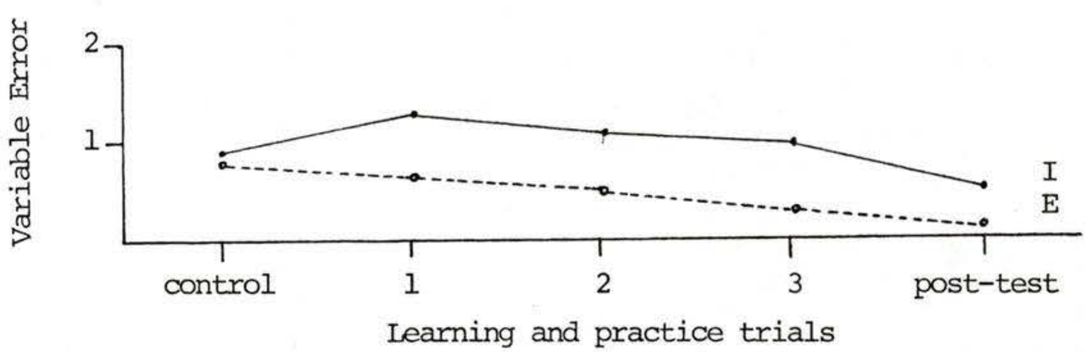

Figure 29

Variable error mean scores
for ventilation time for gKR (g) and pKR (p)

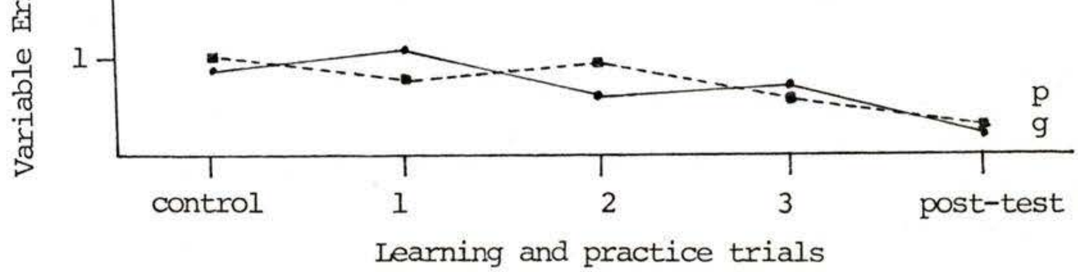

Figure 30

Variable error mean scores
for ventilation time for treatment groups

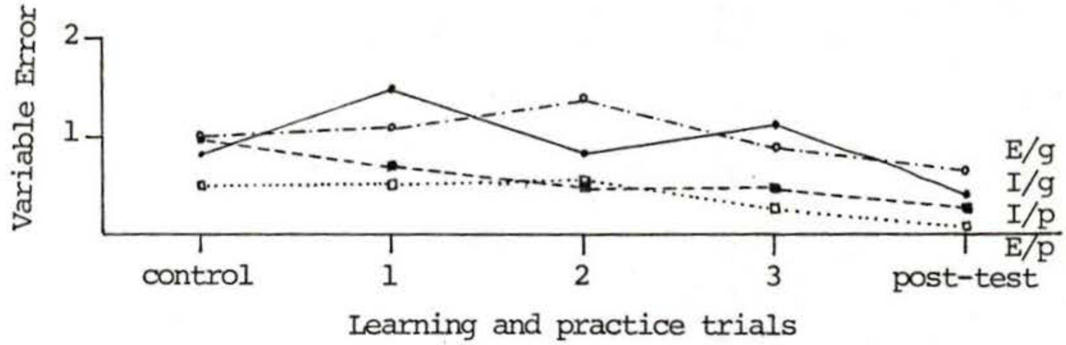

Table 57

Two-way ANOVA of Variable Error for Time (Ventilation Phase) Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	0.232	0.581	ns
KR	1	0.188	0.469	ns
I/KR	1	1.261	3.153	ns
Error	44	0.400		
		Trial 1		
Instructor	1	6.257	5.197	0.03
KR	1	1.350	1.121	ns
I/KR	1	0.376	0.313	ns
Error	44	1.204		
		Trial 2		
Instructor	1	4.576	7.809	0.008
KR	1	1.074	1.833	ns
I/KR	1	0.913	1.558	ns
Error	44	0.586		
		Trial 3		
Instructor	1	4.820	5.897	0.02
KR	1	0.369	0.452	ns
I/KR	1	0.004	0.005	ns
Error	44	0.817		
		Post-test		
Instructor	1	1.658	7.316	0.01
KR	1	0.022	0.096	ns
I/KR	1	0.429	1.895	ns
Error	44	0.227		

Table 58

Three-way ANOVA of Absolute Error
for Time (Ventilation Phase)
Between Instructor Experience (I), KR and Time

Source of Variation	df	MS	F	Probability
Between Subjects				
Instructor	1	253.010	29.69	0.000*
KR	1	8.221	0.96	ns
I/KR	1	0.132	0.02	ns
Error	44	8.522		
Within Subjects				
Time	4	3.693	2.49	0.05
I/Time	4	4.249	2.89	0.02
KR/Time	4	2.668	1.80	ns
I/KR/Time	4	2.081	1.40	ns
Error	176	1.486		

* p 0.000002

Table 59

Three-way ANOVA of Constant Error
for Time (Ventilation Phase)
Between Instructor Experience (I), KR and Time

Source of Variation	df	MS	F	Probability
Between Subjects				
Instructor	1	239.479	27.28	0.000*
KR	1	6.800	0.77	ns
I/KR	1	0.077	0.01	ns
Error	44	8.779		
Within Subjects				
Time	4	4.158	2.65	0.03
I/Time	4	3.598	2.30	ns
KR/Time	4	3.165	2.02	ns
I/KR/Time	4	2.182	1.39	ns
Error	176	1.567		

* p 0.000005

Table 60

Three-way ANOVA of Variable Error
for Time (Ventilation Phase)
Between Instructor Experience (I), KR and Time

Source of Variation	df	MS	F	Probability
Between Subjects				
Instructor	1	14.810	16.59	0.000*
KR	1	207.641	0.23	ns
I/KR	1	844.863	0.95	ns
Error	44	0.892		
Within Subjects				
Time	4	2.688	4.59	0.001
I/Time	4	0.682	1.17	ns
I/KR/Time	4	0.698	1.19	ns
Error	176	0.585		

* p 0.0002

APPENDIX G

Time (Compression Phase):

Tables and Figures

Table 61

Absolute Error Mean Scores of Time (Compression Phase)

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	1.76	1.18	1.35	1.06	1.24
Instructor [a]						
Inexperienced	24	1.74	1.27	1.61	1.34	1.59
Experienced	24	1.77	1.09	1.08	0.77	0.90
KR [b]						
gKR	24	2.02	1.40	1.52	1.42	1.83
pKR	24	1.49	0.97	1.18	0.70	0.66
Treatment Groups [c]						
I/gKR	12	2.00	1.23	1.46	1.60	2.44
E/gKR	12	1.48	1.31	1.77	1.08	0.75
I/pKR	12	2.04	1.56	1.58	1.23	1.23
E/pKR	12	1.50	0.63	0.58	0.31	0.56

[a] See Figure 31

[b] See Figure 32

[c] See Figure 33

Figure 31

Absolute error mean scores
for compression time for inexperienced (I)
and experienced (E) instructors

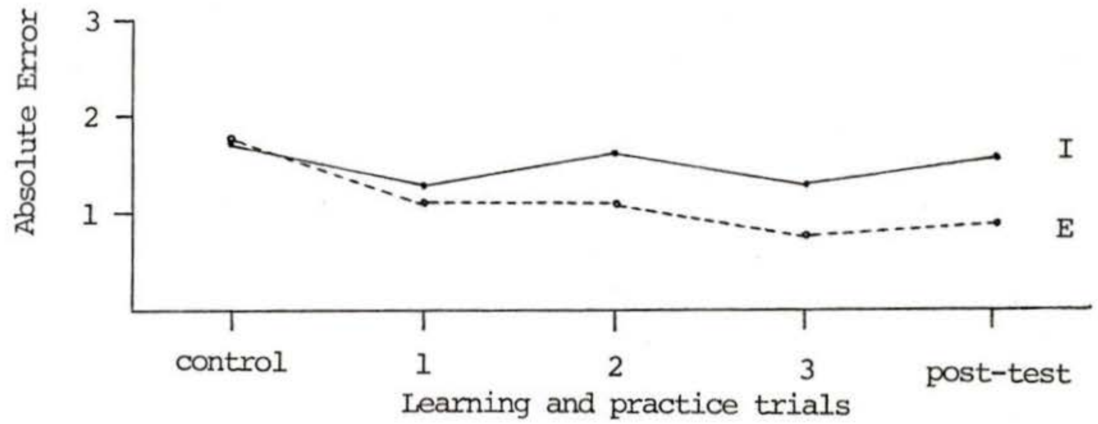

Figure 32

Absolute error mean scores
for compression time for gKR (g) and pKR (p)

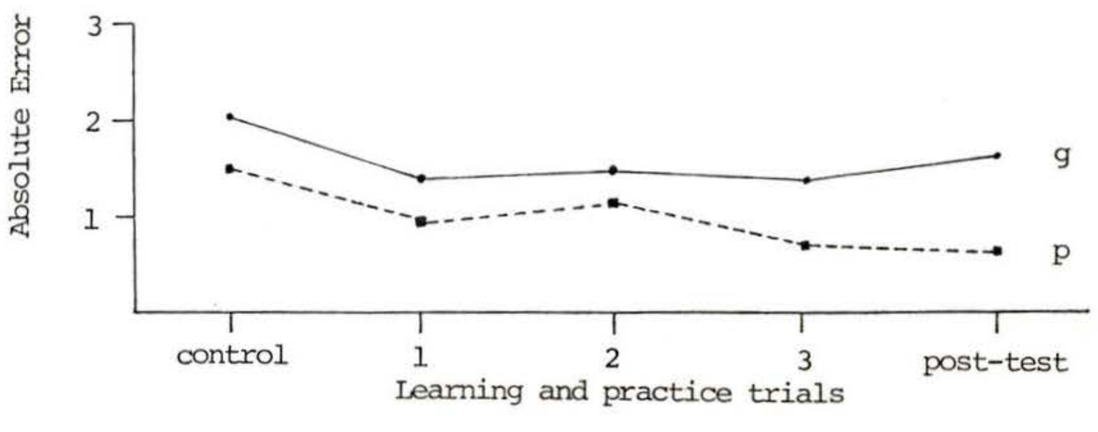

Figure 33

Absolute error mean scores

for compression time for treatment groups

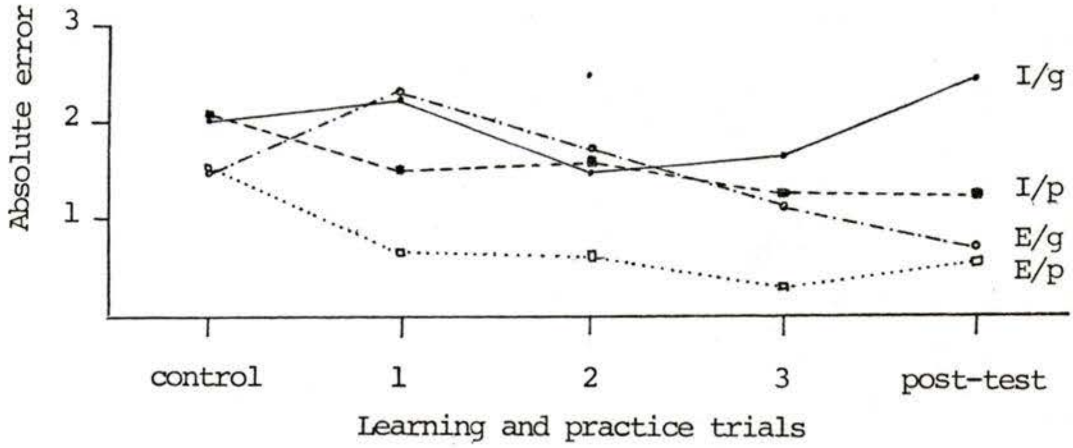

Table 62

Two-way ANOVA of Absolute Error for Time (Compression Phase)

Between Instructor Experience (I) and KR

Sources of Variation	df	MS	F	Probability
		Control		
Instructor	1	0.012	0.004	ns
KR	1	3.387	1.097	ns
I/KR	1	0.001	0.000	ns
Error	44	3.086		
		Trial 1		
Instructor	1	0.376	0.104	ns
KR	1	2.189	0.605	ns
I/KR	1	3.126	0.864	ns
Error	44	3.617		
		Trial 2		
Instructor	1	3.387	0.832	ns
KR	1	1.418	0.348	ns
I/KR	1	5.168	1.269	ns
Error	44	4.071		
		Trial 3		
Instructor	1	3.939	1.165	ns
KR	1	6.199	1.833	ns
I/KR	1	0.470	0.139	ns
Error	44	3.382		
		Post-test		
Instructor	1	5.845	1.751	ns
KR	1	16.626	4.982	0.03
I/KR	1	3.126	0.937	ns
Error	44	3.337		

Table 63

Constant Error Mean Scores of Time (Compression Phase)

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	0.24	0.23	0.21	0.40	0.81
Instructor [a]						
Inexperienced	24	0.76	1.04	0.89	1.11	1.45
Experienced	24	-0.27	-0.57	-0.46	-0.31	0.17
KR [b]						
gKR	24	-0.10	-0.23	0.10	0.38	1.35
pKR	24	0.59	0.70	0.32	0.43	0.26
Treatment Groups [c]						
I/gKR	12	0.54	0.81	1.00	1.19	2.27
E/gKR	12	0.98	1.27	0.77	1.04	0.63
I/pKR	12	-0.75	-1.27	-0.79	-0.44	0.44
E/pKR	12	0.21	0.13	-0.13	-0.19	-0.10

[a] See Figure 34

[b] See Figure 35

[c] See Figure 36

Figure 34

Constant error mean scores
for compression time for inexperienced (I)
and experienced (E) instructors

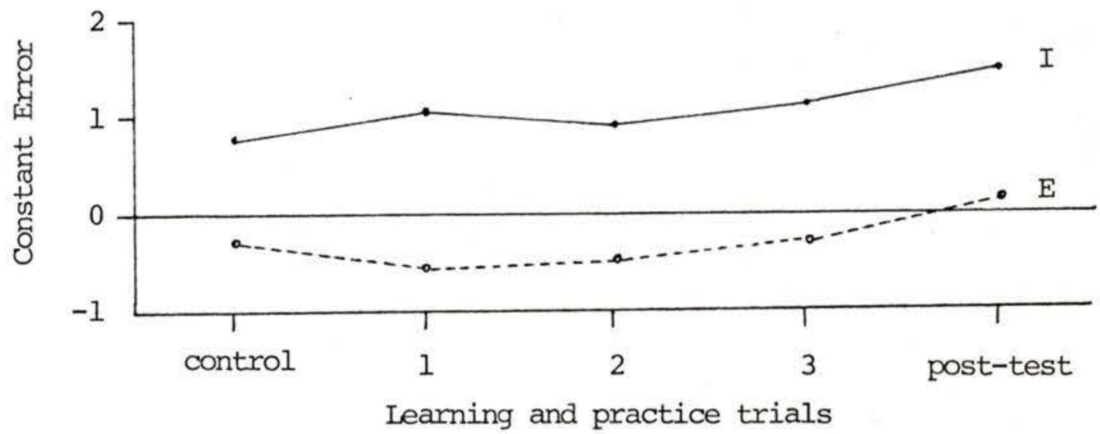

Figure 35

Constant error mean scores
for compression time for gKR (g) and pKR (p)

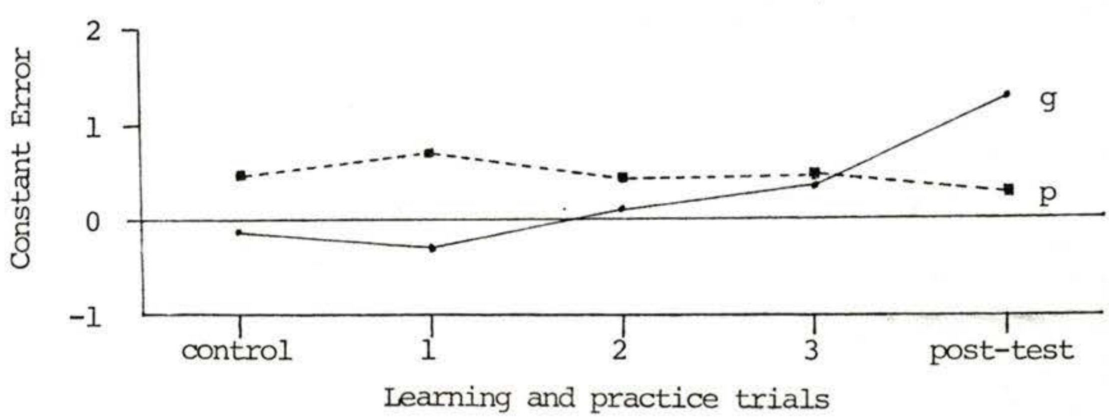

Figure 36

Constant error mean scores
for compression time for treatment groups

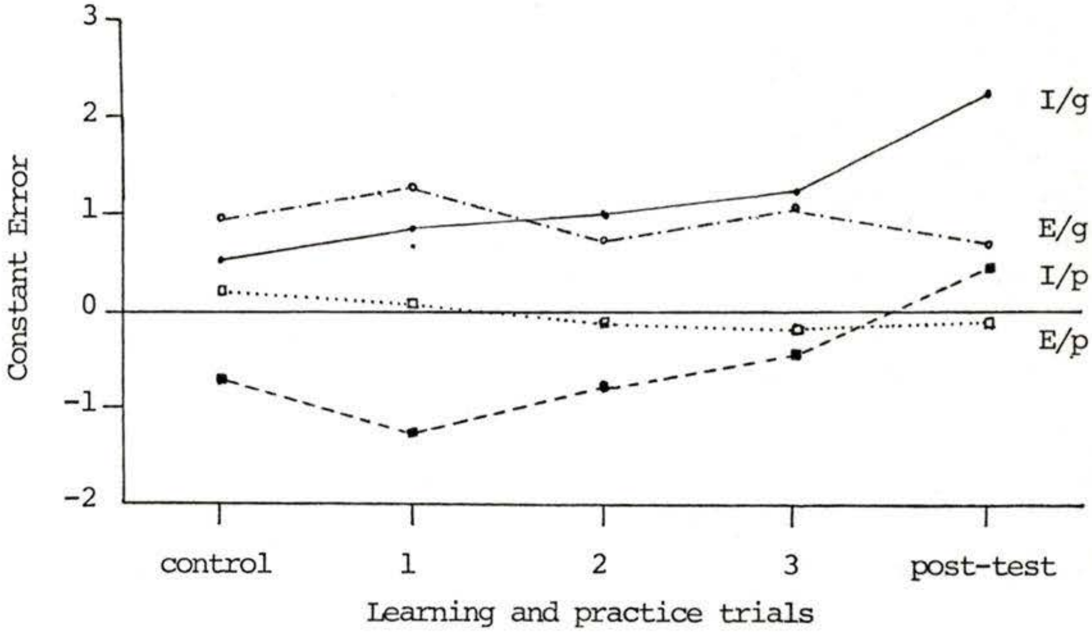

Table 64

Two-way ANOVA of Constant Error for Time (Compression Phase) Between Instructor Experience (I) and KR

Sources of Variation	df	MS	F	Probability
		Control		
Instructor	1	12.762	3.218	ns
KR	1	5.846	1.474	ns
I/KR	1	0.814	0.205	ns
Error	44	3.966		
		Trial 1		
Instructor	1	31.283	8.141	0.007
KR	1	10.314	2.684	ns
I/KR	1	2.637	0.686	ns
Error	44	3.842		
		Trial 2		
Instructor	1	21.668	5.992	0.02
KR	1	0.574	0.159	ns
I/KR	1	2.408	0.666	ns
Error	44	3.616		
		Trial 3		
Instructor	1	24.439	7.421	0.009
KR	1	0.033	0.010	ns
I/KR	1	0.470	0.143	ns
Error	44	3.293		
		Post-test		
Instructor	1	19.699	6.563	0.01
KR	1	14.355	4.783	0.03
I/KR	1	3.658	1.219	ns
Error	44	3.002		

Table 65

Variable Error Mean Scores of Time (Compression Phase)

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	1.20	0.86	1.13	0.67	0.65
Instructor [a]						
Inexperienced	24	1.14	0.76	1.14	0.60	0.62
Experienced	24	1.25	0.96	1.13	0.74	0.68
KR [b]						
gKR	24	1.23	1.21	1.40	1.01	0.82
pKR	24	1.16	0.51	0.87	0.34	0.47
Treatment Groups [c]						
I/gKR	12	1.11	0.94	0.84	0.80	0.82
E/gKR	12	1.17	0.59	1.43	0.41	0.41
I/pKR	12	1.34	1.49	1.95	1.21	0.83
E/pKR	12	1.16	0.43	0.31	0.26	0.53

[a] See Figure 37

[b] See Figure 38

[c] See Figure 39

Figure 37

Variable error mean scores
for compression time for inexperienced (I)
and experienced (E) instructors

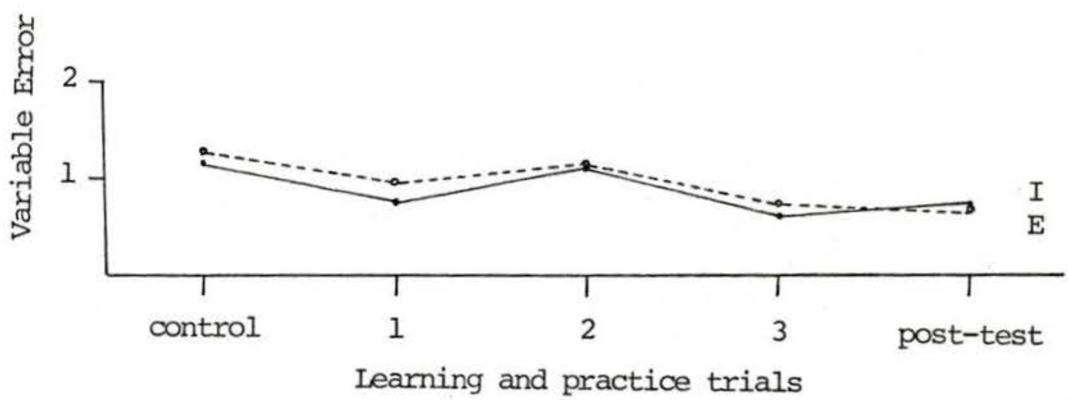

Figure 38

Variable error mean scores
for compression time for gKR (g) and pKR (p)

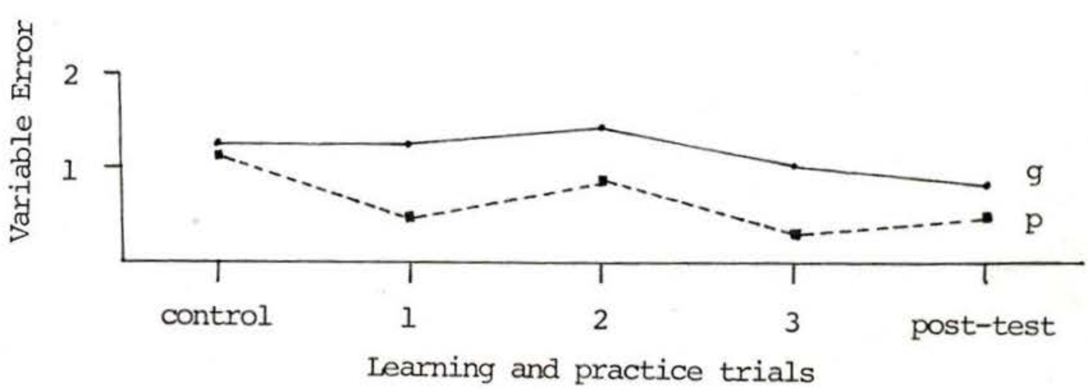

Figure 39

Variable error mean scores
for compression time for treatment groups

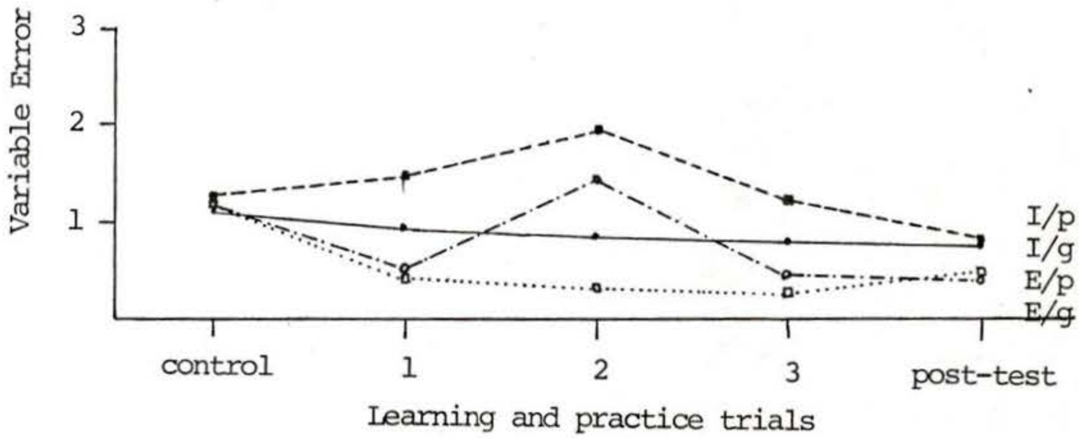

Table 66

Two-way ANOVA of Variable Error for Time (Compression Phase) Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	0.130	0.047	ns
KR	1	0.047	0.017	ns
I/KR	1	0.178	0.064	ns
Error	44	2.793		
		Trial 1		
Instructor	1	0.458	0.131	ns
KR	1	5.915	1.692	ns
I/KR	1	1.509	0.432	ns
Error	44	3.496		
		Trial 2		
Instructor	1	0.001	0.000	ns
KR	1	3.302	0.613	ns
I/KR	1	14.818	2.751	ns
Error	44	5.387		
		Trial 3		
Instructor	1	0.224	0.053	ns
KR	1	5.387	1.284	ns
I/KR	1	0.952	0.227	ns
Error	44	4.194		
		Post-test		
Instructor	1	0.042	0.036	ns
KR	1	1.491	1.289	ns
I/KR	1	0.039	0.033	ns
Error	44	1.157		

Table 67

Three-way ANOVA of Constant Error
for Time (Compression Phase)
Between Instructor Experience (I), KR and Time

Source of Variation	df	MS	F	Probability
Between Subjects				
Instructor	1	107.669	9.01	0.004
KR	1	1.544	0.13	ns
I/KR	1	8.912	0.75	ns
Error	44	11.954		
Within Subjects				
Time	4	3.002	2.08	ns
I/Time	4	0.545	0.38	ns
KR/Time	4	7.394	5.13	0.000*
I/KR/Time	4	0.268	0.19	ns
Error	176	1.441		

* p 0.0006

APPENDIX H

Time (Total):

Tables and Figures

Table 68

Absolute Error Mean Scores for Time (Total)

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	1.99	1.70	1.70	1.46	1.44
Instructors [a]						
Inexperienced	24	2.21	2.29	2.38	2.06	2.11
Experienced	24	1.78	1.11	1.02	0.86	0.76
KR [b]						
gKR	24	2.10	1.96	1.78	1.84	1.92
pKR	24	1.89	1.44	1.61	1.08	0.96
Treatment Groups [c]						
I/gKR	12	2.20	2.50	2.22	2.44	2.80
E/gKR	12	2.21	2.07	2.54	1.68	1.43
I/pKR	12	2.00	1.42	1.34	1.24	1.04
E/pKR	12	1.56	0.81	0.69	0.48	0.49

[a] See Figure 40

[b] See Figure 41

[c] See Figure 42

Table 69

Two-way ANOVA of Absolute Error for Time (Total)

Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	2.215	1.216	ns
KR	1	0.548	0.301	ns
I/KR	1	0.614	0.337	ns
Error	44	1.821		
		Trial 1		
Instructor	1	16.497	8.736	0.005
KR	1	3.214	1.702	ns
I/KR	1	0.095	0.051	ns
Error	44	1.888		
		Trial 2		
Instructor	1	22.141	9.201	0.004
KR	1	0.337	0.140	ns
I/KR	1	2.862	1.189	ns
Error	44	2.406		
		Trial 3		
Instructor	1	17.364	7.361	0.009
KR	1	6.954	2.948	ns
I/KR	1	0.000	0.000	ns
Error	44	2.359		
		Post-test		
Instructor	1	21.884	11.034	0.002
KR	1	11.069	5.581	0.02
I/KR	1	2.021	1.019	ns
Error	44	1.983		

Figure 40

Absolute error mean scores

for total time for inexperienced (I)
and experienced (E) instructors

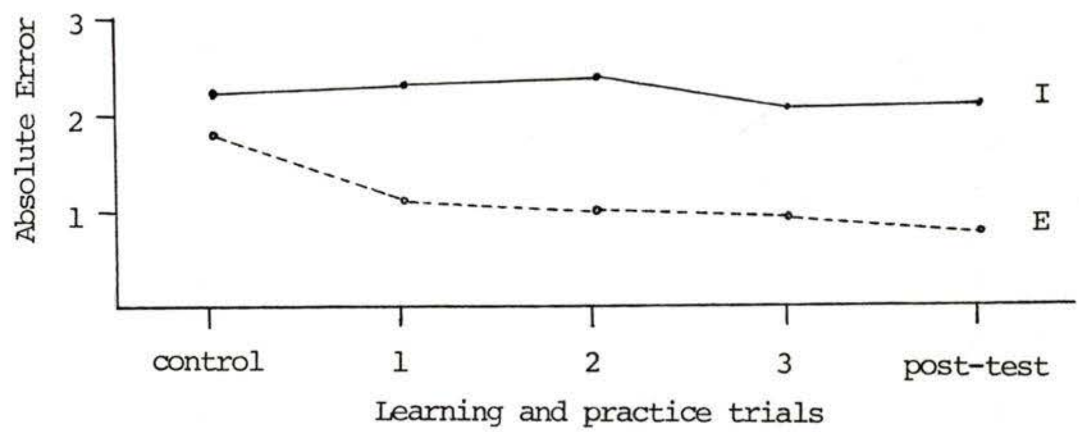

Figure 41

Absolute error mean scores
for total time for gKR (g) and pKR (p)

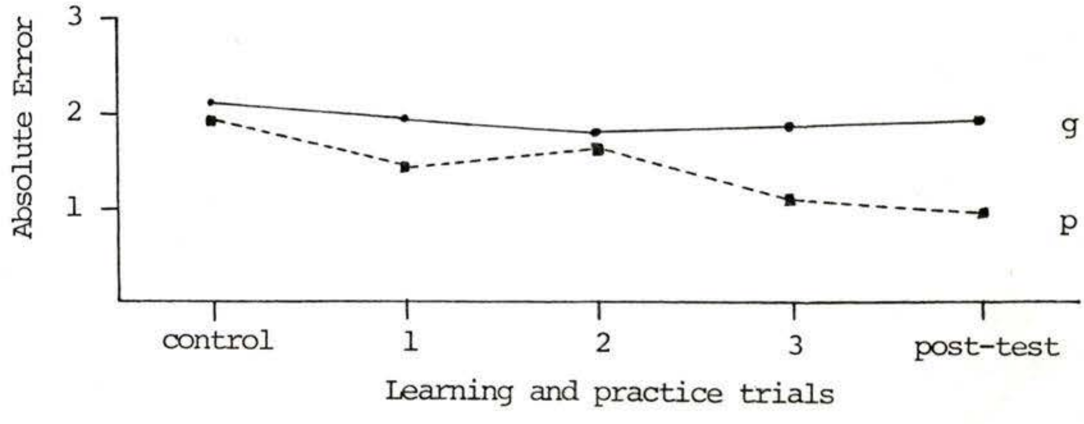

Figure 42

Absolute error mean scores
for time (total) for treatment groups

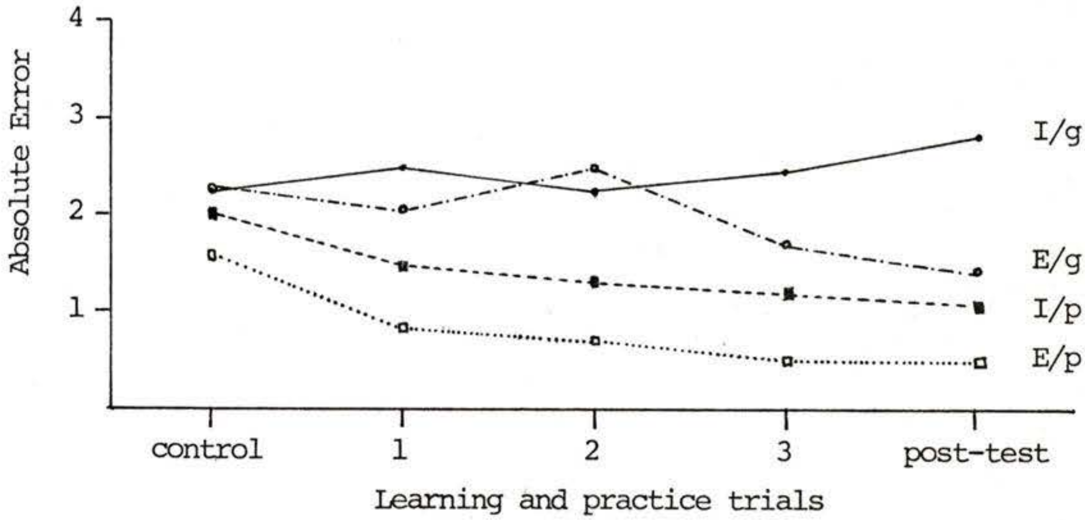

Table 70

Constant Error Mean Scores for Time (Total)

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	1.11	1.16	1.02	1.04	1.17
Instructor[a]						
Inexperienced	24	1.65	2.15	1.91	1.85	1.99
Experienced	24	0.58	0.16	0.12	0.24	0.35
KR[b]						
gKR	24	0.85	1.03	0.92	1.18	1.64
pKR	24	1.38	1.29	1.11	0.90	0.70
Treatment Groups[c]						
I/gKR	12	1.37	2.26	1.86	2.08	2.70
E/gKR	12	1.93	2.05	1.96	1.61	1.28
I/pKR	12	0.33	-0.20	-0.01	0.28	0.58
E/pKR	12	0.82	0.52	0.26	0.19	0.11

[a] See Figure 43

[b] See Figure 44

[c] See Figure 45

Figure 43

Constant error mean scores
for time (total) for inexperienced (I)
and experienced (E) instructors

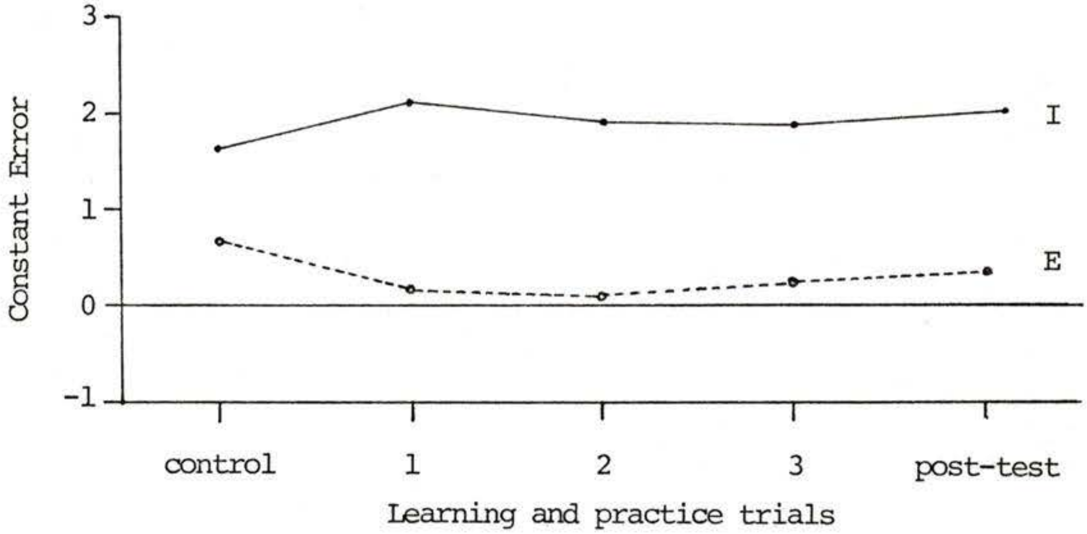

Figure 44

Constant error mean scores
for time (total) for gKR and pKR (p)

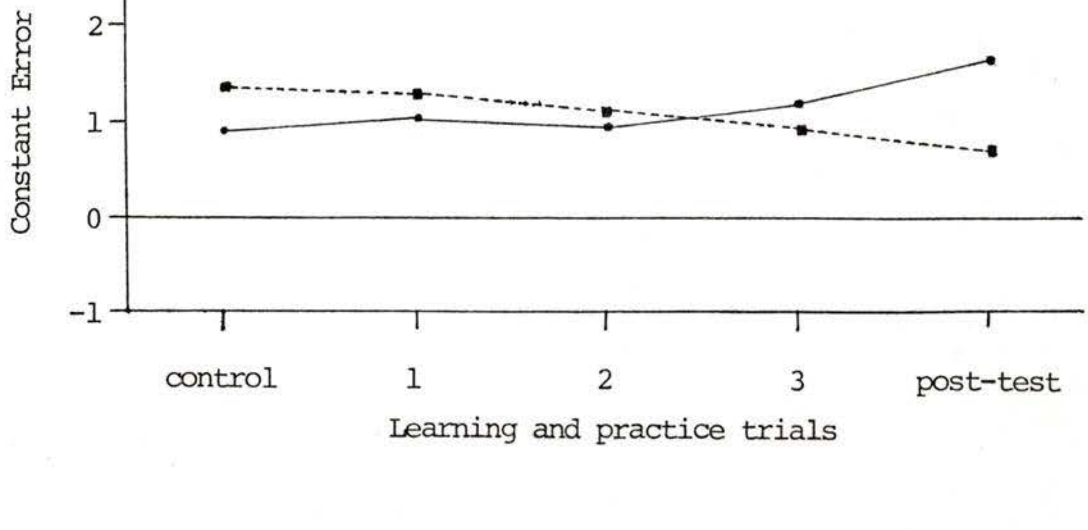

Figure 45

Constant error mean scores
for total time for treatment groups

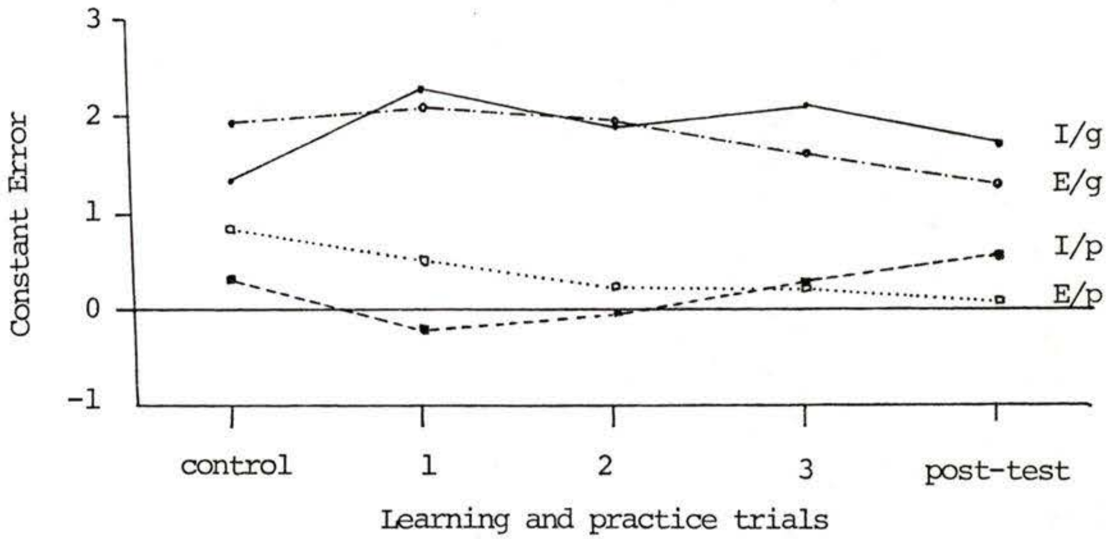

Table 71

Two-way ANOVA of Constant Error for Time (Total)
Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	13.760	6.398	0.02
KR	1	3.297	1.533	ns
I/KR	1	0.016	0.007	ns
Error	44	2.151		
		Trial 1		
Instructor	1	47.700	21.536	0.000
KR	1	0.783	0.353	ns
I/KR	1	2.656	1.199	ns
Error	44	2.215		
		Trial 2		
Instructor	1	19.370	8.452	0.001
KR	1	38.306	16.715	0.000
I/KR	1	0.083	0.036	ns
Error	44	2.292		
		Trial 3		
Instructor	1	16.011	7.244	0.002
KR	1	31.041	14.044	0.001
I/KR	1	0.437	0.198	ns
Error	44	2.210		
		Post-test		
Instructor	1	21.685	11.164	0.000
KR	1	32.588	16.777	0.000
I/KR	1	2.665	1.372	ns
Error	44	1.942		

Table 72

Variable Error Mean Scores for Time (Total)

Group	N	Trials				
		Control	1	2	3	Post-test
Total Population	48	1.88	1.72	1.71	1.33	1.03
Instructor[a]						
Inexperienced	24	1.87	2.01	2.02	1.55	1.26
Experienced	24	1.89	1.43	1.40	1.11	0.80
KR[b]						
gKR	24	2.00	2.10	1.85	1.74	1.19
pKR	24	1.77	1.34	1.57	0.91	0.87
Treatment Groups[c]						
I/gKR	12	1.83	2.26	1.63	1.85	1.40
E/gKR	12	1.92	1.77	2.40	1.25	1.12
I/pKR	12	2.17	1.94	2.07	1.63	0.97
E/pKR	12	1.62	0.92	0.73	0.58	0.62

[a] See Figure 46

[b] See Figure 47

[c] See Figure 48

Figure 46

Variable error mean scores
for total time for inexperienced (I)
and experienced (E) instructors

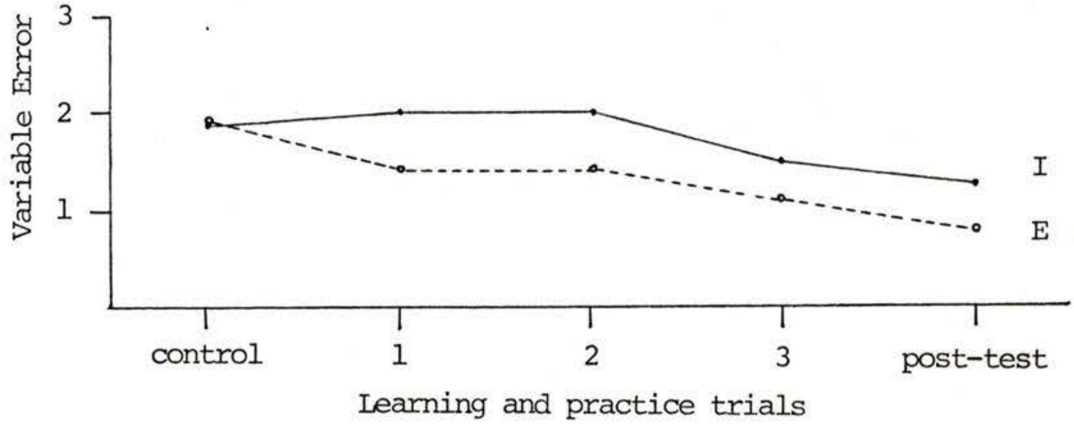

Figure 47

Variable error mean scores
for total time for gKR (g) and pKR (p)

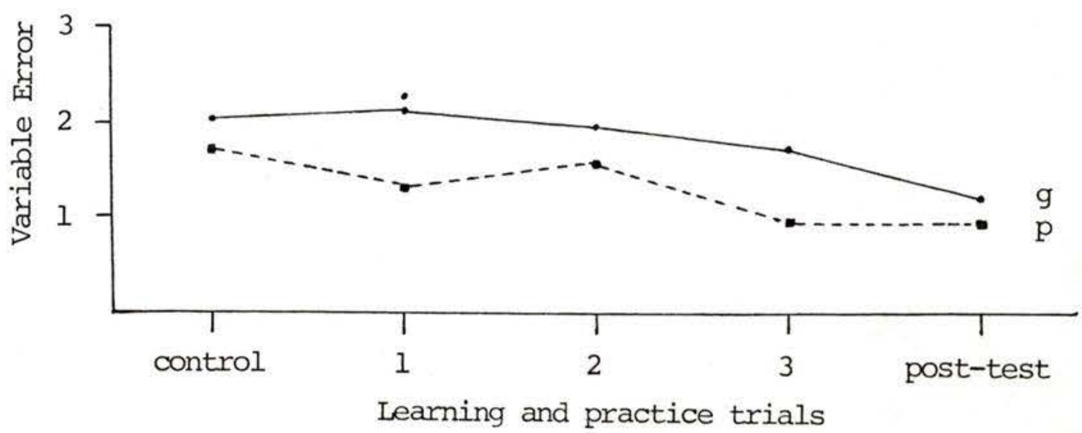

Figure 48

Variable error mean scores
for total time for treatment groups

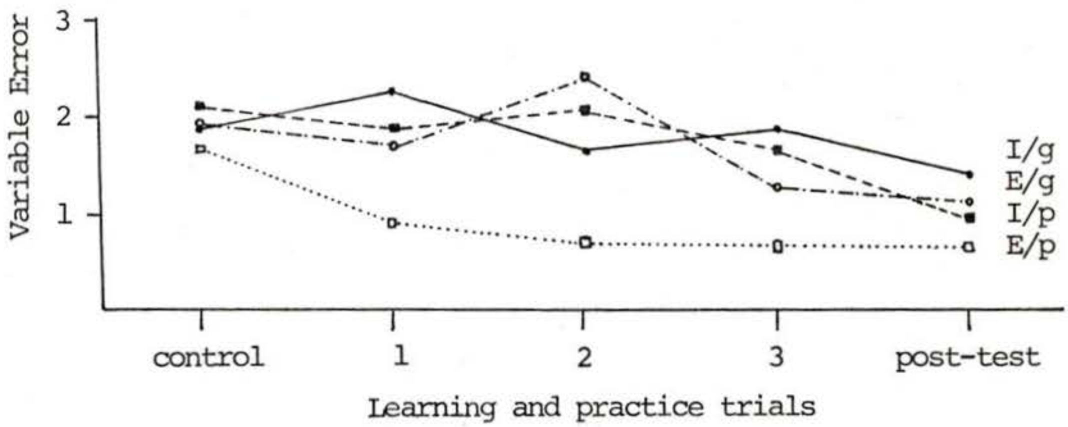

Table 73

Two-way ANOVA of Variable Error for Time (Total)
Between Instructor Experience (I) and KR

Source of Variation	df	MS	F	Probability
		Control		
Instructor	1	0.004	0.003	ns
KR	1	0.644	0.385	ns
I/KR	1	1.203	0.719	ns
Error	44	1.673		
		Trial 1		
Instructor	1	4.078	1.360	ns
KR	1	6.893	2.299	ns
I/KR	1	0.867	0.289	ns
Error	44	2.999		
		Trial 2		
Instructor	1	4.539	1.339	ns
KR	1	0.958	0.283	ns
I/KR	1	13.398	3.953	0.05
Error	44	3.389		
		Trial 3		
Instructor	1	2.350	0.833	ns
KR	1	8.234	2.920	ns
I/KR	1	0.594	0.211	ns
Error	44	2.820		
		Post-test		
Instructor	1	2.553	3.278	ns
KR	1	1.232	1.582	ns
I/KR	1	0.016	0.021	ns
Error	44	0.779		

VITA

Surname: Campbell   Given Names: Noreen Agnes Anne

Place of Birth: Edmonton, Alberta   Date of Birth: February 11, 1945

Educational Institutions Attended, with Dates of Entering and Leaving:

University of Alberta, Edmonton	1968 to 1970
University of Victoria, Victoria	1980 to 1983

Degrees, Diplomas, Etc., Awarded, with Dates and Names of Institutions:

R.N.	1966	Royal Alexandra Hospital School of Nursing
B.Sc.N.	1970	University of Alberta

Honors and Awards:

Publications:

Nursing Assessment (Videotape Course) University of Victoria, 1981