The development and evaluation of a baseball coaching technical knowledge scale for the National Coaching Certification Program.

Caroline Ann. Ball

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LA THÈSE A ÉTÉ MICROFILMÉE TELLE QUE NOUS L'AVONS REÇUE
THE DEVELOPMENT AND EVALUATION OF A BASEBALL COACHING
TECHNICAL KNOWLEDGE SCALE FOR THE NATIONAL COACHING
CERTIFICATION PROGRAM

by

Caroline Ann Ball

A Thesis submitted to the Faculty of Graduate Studies and Research through the Faculty of Human Kinetics in Partial Fulfillment of the requirements for the Degree of Master of Human Kinetics at the University of Windsor

Windsor, Ontario, Canada

1986
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ABSTRACT

THE DEVELOPMENT AND EVALUATION OF
A BASEBALL COACHING TECHNICAL KNOWLEDGE SCALE
FOR THE NATIONAL COACHING CERTIFICATION PROGRAM

by

Caroline Ann Ball

The purpose of this study was to develop and evaluate a baseball coaching technical knowledge scale (popularly referred to as the Baseball Coaching Technical Questionnaire, or the BCTQ) as a valid and reliable measure of technical coaching knowledge for NCCP Level II coaches. A secondary concern was the development of a general theoretical and operational model of test construction for evaluation of coaches from other sports in the NCCP. To do this, a sample (N=142) of baseball coaches from southern Ontario communities completed the BCTQ under either a classroom or mail situation.

Content, construct and criterion-related validity measures were used to establish content, construct and criterion validity of the BCTQ. A content analysis of
the NCCP Level II Technical course and an expert panel of coaches (N=11) indicated that the BCTQ exhibited a high degree of content validity. Further support for content validity was obtained from a content analysis of the BCTQ results.

The construct validity of the BCTQ was determined by a factor analysis of the (N=30) dichotomous test items. The thirteen factors extracted closely approximated the underlying dimensions of the Level II Technical baseball coaching course.

A discriminant function analysis on the (N=30) variables identified two discriminant functions ("training vs nontraining" and "degree of training") as valid indicators of the construct "technical coaching knowledge in baseball". The discriminant function analysis also established criterion-related validity by indicating the test items effectively predicted group membership, classifying coaches into their predicted coaching levels. A discriminant function equation illustrated the predicted variables from the BCTQ which were most significant in measuring the criterion of technical coaching knowledge in baseball.

Cronbach's Alpha coefficient of reliability for N=63 (Non-summated) test items was calculated (.6505) indicating a moderate degree of reliability for the initial stages of test development.
The results indicated the BCTQ is both a valid and reliable measure of technical coaching knowledge for baseball. It was recommended that the BCTQ should form the basis for a standardized certification measure for the MCCP and Baseball Canada. Also, the theoretical and operational development model for test construction is recommended for future testing and evaluation of all levels of baseball coaching, and perhaps other sport coaches.
ACKNOWLEDGEMENTS

Endless gratitude is extended to my chairman, Dr. Richard Moriarty, for his guidance and encouragement in every aspect of this thesis. His insight and resourcefulness made the reality of this project much more meaningful and worth the effort expended.

I would like to thank Dr. Jay Powell for offering a good practical approach to the construction of this scale, as well as Dr. Megeed Ragab, for his sound conceptual advice. Thanks also to Dr. P.J. Galasso, for recognizing the merits this study may have for the coaching profession.

Much appreciation is given to the Canadian Federation of Amateur Baseball for endorsing this as a worthwhile project in baseball development.

I also wish to acknowledge my panel of expert baseball coaches for contributing greatly to the initial development of the scale. These people define the true meaning and essence of the sport of baseball.

A special word of thanks goes out to my fellow graduate students in the Faculty of Human Kinetics, especially those with whom I shared "the midnight oil"! In particular, I am indebted to Mr. Fred Blowes, a fellow graduate student and comrade in "scholarly pursuits", for his timely discussions and
encouragement.

Gratefulness is extended to the Human Kinetics secretaries for their tireless patience and understanding, and also to Mr. Malcolm Webster, for his steady hand and reprographic genius.

Finally, I wish to thank my family for their willingness to lend support in all of my endeavours. This was truly one of adventure.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>iv</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>vii</td>
</tr>
<tr>
<td>List of Tables</td>
<td>xi</td>
</tr>
<tr>
<td>List of Figures</td>
<td>xii</td>
</tr>
<tr>
<td>List of Appendices</td>
<td>xiii</td>
</tr>
<tr>
<td>List of Exhibits</td>
<td>xiv</td>
</tr>
<tr>
<td>Chapter</td>
<td></td>
</tr>
<tr>
<td>I. MEASURING BASEBALL COACHING KNOWLEDGE - A CERTIFIABLE SOLUTION</td>
<td>1</td>
</tr>
<tr>
<td>Purpose of the Study</td>
<td>2</td>
</tr>
<tr>
<td>Theoretical Need for the Study</td>
<td>3</td>
</tr>
<tr>
<td>Practical Need for the Study</td>
<td>6</td>
</tr>
<tr>
<td>Research Problems and Hypotheses</td>
<td>8</td>
</tr>
<tr>
<td>Limitations of the Study</td>
<td>11</td>
</tr>
<tr>
<td>Format of the Study Chapters</td>
<td>12</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>13</td>
</tr>
<tr>
<td>II. REVIEW OF RELATED LITERATURE</td>
<td>19</td>
</tr>
<tr>
<td>The NCCP and Development of the Level II</td>
<td></td>
</tr>
<tr>
<td>Technical Component</td>
<td>19</td>
</tr>
<tr>
<td>The Educational Process</td>
<td>23</td>
</tr>
<tr>
<td>Test Construction</td>
<td>32</td>
</tr>
<tr>
<td>III. CONSTRUCTION OF THE BASEBALL COACHING TECHNICAL QUESTIONNAIRE (BCTQ)</td>
<td>46</td>
</tr>
<tr>
<td>Content Analysis of the Level II Technical Program</td>
<td>46</td>
</tr>
<tr>
<td>Determining the Use of the Baseball Coaching Technical Questionnaire</td>
<td>49</td>
</tr>
<tr>
<td>Specifying the Target Population</td>
<td>54</td>
</tr>
<tr>
<td>Attending to Items and Indicators - BCTQ</td>
<td>55</td>
</tr>
<tr>
<td>Item Development</td>
<td>66</td>
</tr>
<tr>
<td>Test Assembly</td>
<td></td>
</tr>
<tr>
<td>IV. METHODOLOGY</td>
<td>71</td>
</tr>
<tr>
<td>Study Description</td>
<td>71</td>
</tr>
<tr>
<td>Identification of Variables</td>
<td>73</td>
</tr>
<tr>
<td>Validity</td>
<td>74</td>
</tr>
<tr>
<td>Reliability</td>
<td>75</td>
</tr>
<tr>
<td>Pre-Test Administration</td>
<td>76</td>
</tr>
</tbody>
</table>
Test Conditions and Procedures ........................................... 79
Scoring Procedures ......................................................... 82
Analysis of the Data ....................................................... 83

V. RESULTS AND DISCUSSION .................................................. 86

Initial Group Differences ................................................... 88
Validity ........................................................................ 90
Reliability .................................................................... 135

VI. CONCLUSIONS AND RECOMMENDATIONS .............................. 139

Conclusions ................................................................ 139
Recommendations for Future Research ............................. 142
Implications for Baseball Coaching Development ............... 146

APPENDICES ..................................................................... 150

BIBLIOGRAPHY ................................................................. 159

VITA AUCTORIS .............................................................. 166
<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Major Content Areas of the NCCP</td>
<td>50</td>
</tr>
<tr>
<td>II.</td>
<td>Table of Test Specifications</td>
<td>58</td>
</tr>
<tr>
<td>III.</td>
<td>Test Items in the BCTQ</td>
<td>96</td>
</tr>
<tr>
<td>IV.</td>
<td>Initial Statistics</td>
<td>107</td>
</tr>
<tr>
<td>V.</td>
<td>Rotated Factor Matrix</td>
<td>114</td>
</tr>
<tr>
<td>VI.</td>
<td>Stepwise Variable Selection - Discriminant Analysis</td>
<td>119</td>
</tr>
<tr>
<td>VII.</td>
<td>Summary Table - Entry and Removal of Variables</td>
<td>120</td>
</tr>
<tr>
<td>VIII.</td>
<td>Fisher's Linear Discriminant Functions</td>
<td>121</td>
</tr>
<tr>
<td>IX.</td>
<td>Unstandardized Discriminant Function Coefficients</td>
<td>122</td>
</tr>
<tr>
<td>X.</td>
<td>Classification Results</td>
<td>123</td>
</tr>
<tr>
<td>XIa.</td>
<td>Canonical Discriminant Functions</td>
<td>129</td>
</tr>
<tr>
<td>XIb.</td>
<td>Canonical Discriminant Functions - Group Means</td>
<td>129</td>
</tr>
<tr>
<td>XII.</td>
<td>Standardized Canonical Discriminant Function Coefficients</td>
<td>133</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Analysis of Learning (Bloom, 1976)</td>
<td>29</td>
</tr>
<tr>
<td>2</td>
<td>Conceptual Model of Test Construction (Green &amp; Lewis, 1986)</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>Common Factor Model Equation</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>Mathematical Model for Discriminant Function</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>Operational Model - Development of the BCTQ</td>
<td>47</td>
</tr>
<tr>
<td>6</td>
<td>Conceptual Model of the Level II Technical Baseball Program</td>
<td>52</td>
</tr>
<tr>
<td>7</td>
<td>Selection Ratio for Level II Technical Item Selection</td>
<td>64</td>
</tr>
<tr>
<td>8</td>
<td>Difficulty Index for Level II Technical Item Selection</td>
<td>64</td>
</tr>
<tr>
<td>9</td>
<td>Model of Research Objectives</td>
<td>87</td>
</tr>
<tr>
<td>10</td>
<td>Scree Plot (Cattell, 1966)</td>
<td>109</td>
</tr>
</tbody>
</table>
LIST OF APPENDICES

A. Baseball Coaching Technical Questionnaire (Key) ........................................ 150
B. Panel of Experts .................................................................................. 151
C. Explanatory Cover Letters (2) ......................................................... 152-153
D. Results of the Item Analysis ................................................................. 154
LIST OF EXHIBITS

Exhibit I - Baseball Coaching Technical Questionnaire
Test Booklet
CHAPTER I

MEASURING BASEBALL
COACHING KNOWLEDGE – A CERTIFIABLE SOLUTION

The National Coaching Certification Program (NCCP) is a comprehensive education program designed to develop coaching across Canada in a systematic and standardized series of theoretical, technical, and practical levels of instruction. It provides a structural framework for the development of progressive coaching techniques, striving to ensure that all sport coaches have the "...necessary fundamental knowledge and skills that are the prerequisites of coaching effectiveness" (Hurren, 1984, p. 10).

The Level II (NCCP) Technical program for baseball is presently the highest level of certification for baseball coaches (Robinson, 1985). It is the most advanced level of technical instruction and requires that its candidates have a good technical knowledge of the game before gaining entrance into the course. Until now (1986), there have been no means developed as a measure for coaching knowledge in a certifiable way (Johnston, 1985; Robinson, 1985).

Currently, for a baseball coach to be certified as a Level III Technical coach, he/she must meet certain criteria which have been specified in the development of this level in the NCCP. These criteria are
considered essential as prerequisites for Level III Technical certification:

1. A greater commitment to coaching, shown in their work over a larger period of time with more committed and experienced athletes.

2. A commitment to upgrading their own knowledge and skills, either through attendance at courses, workshops, and clinics, or through membership in various sport and coaching associations.

3. Advanced skills in planning programs and motivating athletes.

4. A high level of technical expertise within the sport of baseball.

5. Leadership within the sport of baseball.

6. Organizational skills to pull together the development of athletes (Baseball Canada, 1984).

The Level II Technical program is considered a vehicle necessary as a prerequisite for Level III participation in baseball coaching. However, at present there are no means by which coaches can be critically measured in terms of their prerequisite qualities. This concern is felt by those involved in the technical and overall development of Canadian baseball coaches, including individuals in Baseball Canada and the Coaching Association of Canada (Robinson, 1985).

Purpose of the Study

The primary purpose of this study was the
development of a valid and reliable paper-and-pencil test instrument for evaluating the technical knowledge of baseball coaches in the National Coaching Certification Program (NCCP). A baseball coaching technical knowledge scale (popularly referred to as the Baseball Coaching Technical Questionnaire, or BCTQ) was designed for the collection of valuable information concerning coaching development in baseball at all levels of experience and expertise, including coaches who may have never taken an NCCP coaching course (e.g., Non-certified, Level I, and Level II Technical coaches). More specifically, the scale has been constructed as a means for discriminating between different levels of coaching knowledge in baseball.

A secondary purpose of the study involved the development of a general theoretical and operational model of test development for the (technical) evaluation of coaches in all sports within the National Coaching Certification Program.

Theoretical Need for the Study

Learning and the entire realm of education is a dynamic process; continually changing with new information, new methods, and new processes being developed. It is "...the process whereby intentional
direction is given to the full, wholesome development of human beings" (Penman, 1980).

Penman (1980) expresses the educational process as being cyclical in nature. First, goals are established (as influenced by society) and a specific program is identified in order to meet those goals. The program is then implemented and, subsequently should be evaluated and assessed to determine if these goals need to be refined or redefined (Penman, 1980).

The educational process provides for a series of environments which permit the student (or coach) to learn certain new behaviours. It also provides the opportunity to practice these behaviours to consistency at a reasonably satisfactory level of competence and regularity (Thorndike, 1971).

Krathwohl and Payne (1971) note that educational objectives are necessary for the effective delivery of any educational system and are essentially structured on four main levels. The first level includes long-term global goals of an educational system that describe the end product of a complete education. Second level objectives involve the translation of global goals into specific behaviours that form the terminal performance capabilities of students successfully completing an instructional unit. Even more specific, the third level of educational
objectives provides for the description, at the unit or course level, of a succession of "way stations", each of which would be a behaviour more sophisticated than the previous one (Krathwohl and Payne, 1971). A fourth objective reflects the other three objectives, involving their measurement and evaluation through the use of test items and instructional materials and describing the situations in which the behaviours to be learned are actually displayed (Krathwohl and Payne, 1971).

Brennan (1975) identifies the need for testing and evaluation in an instructional system in terms of decision-making. The collection of data serves in making decisions regarding instruction and the assessment of its effects, especially for the purpose of identifying any necessary revisions within the instructional unit. Evaluation is also necessary for decisions regarding student placement and certification (Brennan, 1975).

Glaser (1963) states that testing and achievement data are often required to rank individuals in a program along a relative continuum of capability with regard to a specified group of persons. Similarly, it is necessary in order to rank these persons along an absolute continuum of proficiency with respect to a specified behavioural criterion (Glaser, 1963).
Another need for educational measurement concerns those aspects or components of programs which are not well-received. Often, program participants will identify problems with the complexity of instructional materials, or the instructors may be seen as non-supportive or technically uninformed. Sometimes, the sequencing of certain units may be inefficient and inappropriate.

Through educational measurement and evaluation it is possible to provide feedback on the level of knowledge, skill development, and attitudinal performance of those involved in the instructional program (Lewis and Green, 1986).

Practical Need for the Study

At present, there is no method of standardized measurement which has been developed to measure the technical knowledge of baseball coaches within the Level II baseball component (NCCP), or at any other coaching level in the NCCP. Consequently, there is a need for the development of a content-appropriate written test to assist in the measurement of cognitive behaviours in coaches relative to their technical knowledge of the game of baseball.

A second need for the study concerns the degree to
which the content of the Level II and Level III Advanced Coaching Manual for baseball is translated into actual clinic settings. It is important to know if the instructional objectives outlined in this manual are being interpreted and understood by coaches in the clinical setting. It is also necessary to discover to what extent the material in the manual has been delivered by NCCP course conductors during instructional sessions.

There is a need to determine whether the content of the Level II Technical component differs significantly from that of the Level I Technical component in baseball in terms of the retention and use of that information by baseball coaches who have taken the Level II course. The test instrument (Baseball Coaching Technical Questionnaire) attempts to measure whether Level II baseball coaches are learning any more than their Level I counterparts or even coaches who are not certified.

A further justification for this study relates to proposed changes which are being made to the National Coaches Certification Program coaching model (1985). These changes involve a combination of the Technical and Practical components within each of the five levels in the NCCP, thus precipitating the need for some sort of evaluative technique(s) designed to measure these
interlocking components simultaneously (Robinson, 1985).

The Level II Technical component is a necessary prerequisite for the newly-developed (1985) Level III Technical course, which has been designed for coaches considered more "elite" or top-level within Canadian baseball levels. In order for a coach to be able to continue in this program, he/she must presently be selected by the members of a National Technical Committee (Baseball Canada) to participate in a Level III Technical clinic. There are no objective means that have been developed to assess these coaches with regard to their prerequisite technical knowledge of baseball. Thus, the construction of a valid and reliable written test instrument would serve as an important method of measurement for this selection process.

Research Problems and Hypotheses

The goal of this research study was to develop a written test instrument to measure the construct of technical coaching knowledge in baseball. There were two research objectives to be achieved in this study:

1. To determine if the baseball coaching technical
knowledge scale (i.e., BCTQ) provides a valid measure of NCCP Level II Technical baseball coaching knowledge.

2. To determine if the baseball coaching technical knowledge scale (i.e., BCTQ) is a reliable measure of NCCP Level II Technical baseball coaching knowledge.

Measurement of validity, the first research objective revolved around the following research questions and hypotheses:

1.) How well does the BCTQ reflect the content and objectives of the NCCP Level II Technical baseball course, as contained in resources used in the delivery of the NCCP Level II Technical baseball course (i.e., Advanced Coaching Manual and the Course Conductor's Guide)? Will there be a significant difference between the item content of the BCTQ and the instructional content of the Level II Technical course in baseball?

2.) What underlying dimensions are measured by the BCTQ, as identified by factor analysis?

3.) Does the BCTQ perform effectively in correctly classifying cases into predicted groups of baseball technical coaching expertise (i.e., Non-certified, Level I, and Level II baseball coaches)?
4.) Is there a significant difference in the ability of the BCTQ to discriminate between each of the three levels of technical coaching knowledge in baseball (i.e., Non-certified, Level I, and Level II baseball coaches)?

H01: There will be no significant difference in the ability of the BCTQ to discriminate between each of the three levels of technical coaching knowledge in baseball (p < .05).

H1: There will be a significant difference in the ability of the BCTQ to discriminate between each of the three levels of technical coaching knowledge in baseball (p < .05).

5.) Is there a significant difference in the ability of the 30 items and 13 variables in the BCTQ to discriminate between each of the three levels of technical coaching knowledge in baseball (i.e., Non-certified, Level I, and Level II baseball coaches)?

H02: There will be no significant difference in the ability of the 30 test items and 13 variables in the BCTQ to discriminate between levels of technical coaching knowledge in baseball (p < .05).

H1: There will be a significant difference in the ability of the 30 test items and 13 variables in the BCTQ to discriminate between levels of technical coaching knowledge in baseball (p < .05).

Measurement of reliability, the second research objective, focused on the following two research questions:
1. How reliable is the BCTQ in measuring factors of baseball technical coaching knowledge in the NCCP?

2. What test length provides a reliable estimate of baseball technical coaching knowledge in the BCTQ?

Limitations of the Study

The following limitations were recognized as potentially affecting the outcome of the study:

1. Testing began, in many cases, just after the end of the regular season of baseball play as opposed to during the actual competitive period for baseball.

2. Due to post-seasonal constraints (i.e., leagues were finished until the next season), a certain number of potential subjects were not accessed. The acquisition of a fairly large sample of baseball coaches was difficult.

3. The attendance of coaches at scheduled testing situations was low in comparison to the response rate on mailed-out questionnaires.

4. It was not possible to include an equal number of coaches for each of the three coaching groups without drastically reducing the total size of the
sample.

5. Some coaches may have participated in some other type of coaching education program or technical course prior to completing the BCTQ.

6. It was not possible to determine whether coaches who had completed the mailed questionnaires had used additional instructional materials and/or references to answer some or all of the test items.

Format of the Study Chapters

In the remaining five chapters, the study is described in detail. Chapter II focuses on research and development related to the problem under study. This review of the literature includes developmental aspects of the Level II (NCCP) Technical component in baseball, program evaluation in sport, educational performance and assessment, test construction theory, a general look at factor analysis and discriminant analysis.

Chapter III concentrates on the development and operationalization of a baseball coaching technical knowledge scale (i.e., BCTQ), from its conceptualization to the final assembly of test items (refer to Exhibit I, p. 97).

Chapter IV elaborates on the methods and
procedures of the investigation, including the study description, test administration, and analysis of the quantitative data results.

Chapter V presents the findings of these procedures with regard to the descriptive statistics obtained from the study sample, and results from the factor and discriminant analyses and reliability estimates of the BCTQ.

The final chapter (VI) offers conclusions and recommendations for future research based on the findings of the study and the construction of a baseball coaching technical questionnaire (i.e., BCTQ). In addition, the author offers suggestions for future development in the area of coaching education and evaluation in the NCCP.

**Definition of Terms**

**Achievement test**

A test designed to measure the amount of knowledge and/or skill a person has acquired, usually as a result of classroom instruction; may be either informal or standardized (Lyman, 1978).

**Coaching Association of Canada (CAC)**

A national non-profit (incorporated) organization
dedicated to coaching development and the profession of coaching for the purpose of achieving excellence in amateur sport in Canada (Fisher, 1980).

Concept

An idea of the attributes or relationships common to a class of objects; an abstraction of particulars to a more global idea (Green and Lewis, 1986).

Construct

The specific representation of a concept within a causal explanation or theoretical framework (Green and Lewis, 1986).

Construct Validity

Test validation based on a combination of logical and empirical evidence of the relationship between the test and a related theory; concerned with the psychological meaningfulness of the test (Kerlinger, 1986).

Content Validity

Logical evidence that the item content of a test is suitable for the purpose of which the test is to be used; concept is used principally with achievement tests (Kerlinger, 1986).
Criterion-Referenced Test

Interpretation of test scores follows from the establishment of an absolute standard for each test item. Every test score is measured relative to a criterion or cut-off score (Kerlinger, 1986).

Criterion-Related Validity

Test validity based on data from practical situations; i.e., a correlation coefficient between a set of test scores and a set of criterion values (Kerlinger, 1986).

Discrimination (Value)

Any of several statistics used to express the extent to which a test item shows a difference between high-ability and low-ability examinees (Lyman, 1978).

Education

The process whereby intentional direction is given to the full wholesome development of human beings...it is a dynamic learning process; continually changing, with new information, new methods, and new processes continually being developed (Penman, 1980).
Evaluation

Assesses the effectiveness of an ongoing program in achieving its objectives...and aims at program improvement through a modification of current operations (Wholey, 1971).

Factor

Technically, an element or variable presumed to exist because of its ability to help explain some of the interrelationships noted among a set of tests (Lyman, 1971).

Goals

The clearly defined aims of the organization; what the members intend to accomplish (Katz and Kahn, 1966).

Instructional System

A deliberate, systematic, and replicable organization of a set of resources for the principal purpose of effecting student achievement of clearly stated instructional objectives (Brennan, 1975).

Item Discriminability Index

The degree to which item responses vary with ability level (Lord, 1980). This index determines how well the item segregates persons higher on the scale of the criterion from those lower on the scale (Guilford
and Fruchter, 1978).

Level I and Level II Technical Baseball Coach

A Level I baseball coach is one who is new or inexperienced (generally) as a coach. The major needs of their athletes centre upon learning basic skills, having fun, and developing confidence and self-esteem in playing the game of baseball.

A Level II coach includes coaches working with more experienced players who are beginning a more structured and disciplined approach to the sport of baseball (NCCP Task Listings, 1984).

National Coaching Certification Program (NCCP)

This is a program created by the CAC in order to meet the needs of practising coaches, both male and female, beginner and experienced, in developing knowledge and skills in the profession of coaching. There are five levels of certification, each having a general theory, sport-specific technical, and practical component (CAC, 1984).

Non-Certified Baseball Coach

A coach who may or may not have had experience in the technical areas of baseball and who may have had some other type of coaching training in baseball other
than the NCCP (Author definition).

Program

That vehicle for accomplishing specified goals, as stated in the policies or statements of intent (or non-intent) of the organization (Cameron, 1981).

Selection Ratio (Item Difficulty)

The proportion of respondents to a particular test item who meet the target expectation by whatever means and for whatever reason. The empirical probability that the particular population involved (i.e., baseball coaches) will pass the item (Guilford, 1954).

Taxonomy of Educational Objectives

The division of the universe of educational objectives (behaviours) into three domains, including cognitive, affective, and psychomotor behaviours (Bloom, 1956).

Test of Significance

A statistical procedural rule whereby the probability of an event falls below a pre-specified critical level. Statistical procedures leading to decisions regarding whether the difference between two means may be probably ascribed to sampling error (Ferguson, 1959).
CHAPTER II

REVIEW OF RELATED LITERATURE

A review of the literature was carried out relating to the evaluation of coaching performance. The following sources of information were examined: an overview of the National Coaching Certification Program and the development of the Level II Technical baseball component; studies in educational performance and assessment; literature on factor analysis; and discriminant analysis.

The National Coaching Certification Program and Development of the Level II Technical Component

In 1971, the National Coaching Certification Program (NCCP) was initiated, based on a framework within which sports could develop technical and practical programs while maintaining a common theoretical base of coaching principles applicable to all coaching levels (Johnston, 1985).

Gowan (1984) discussed a working rationale for the development of coaching education programs in amateur sport. It was to strive to ensure that all coaches would have the "necessary fundamental knowledge and
skills that are the prerequisites of coaching effectiveness” (Hurden, 1984).

The NCCP is structured on five levels of coaching certification each including theoretical, technical, and practical components. Levels I, II, and III incorporate common sport science theory courses, covering topics in exercise physiology, sport psychology, and skill analysis. Sport-specific technical courses are developed by each national sport governing body (NSGB), as well as the requirements for the completion of practical coaching experiences (CAC, 1984a). Levels IV and V combine theory, technical, and practical components into a course extending over two years. This includes sport specific technical courses, take-home study, and practical coaching experience with a Master Coach, for example, a National or Provincial team coach (CAC, 1984a).

Johnston (1985) notes that participation and basic skill instruction comprise Levels I and II. The NCCP has endeavoured to replace more traditional attitudes of competition, intimidation, and recognition of the “star” with those of cooperation, respect, and team recognition (Johnston, 1985).

The development of Level I and II laid the groundwork for coaching standards that governed the future development of Levels III, IV, and IV. Gowen
(1984) states that, initially, the thrust of the NCCP was toward firm establishment of a base of competent coaches. Since 1982, the emphasis has shifted more toward developing high performance or "elite" coaches. In 1985, completion of the lower three levels (i.e., Levels I, II, and III) was to be accomplished for each sport in order that further development of Levels IV and V could be initiated (Hurren, 1984).

Robinson (1985) states that NCCP coaches are coordinated by the provincial sport governing bodies (PSGB) responsible for each sport. Technical courses are the responsibility of the national sport body in cooperation with the Coaching Association of Canada (CAC), which annually allocates up to $18,000 for technical course development and $6,000 for the training of course conductors (Robinson, 1985).

The NCCP and Baseball Canada


The specific goals of the baseball program are congruent with those of the NCCP: (1) The program will
assist in the overall development of coaches in Canada through recruitment, improvement, maintenance, and delivery of clinics; (2) The standardized format will assist provinces in the development of their own (baseball) coaching program(s); (3) The program will improve communication between the national, provincial, regional, and local associations; (4) The program will promote the visibility and credibility of the national and provincial associations (Baseball Canada, 1984).

Baseball Canada (1984) states that the Level II Technical component focuses on coaches involved with athletes who may be beginning a more technically structured and disciplined approach to sport participation. Level II Technical introduces coaches to more advanced technical material, involving strategy and complex skill development. In addition, the Level II Technical component is a prerequisite for entry into the Level III Technical component, which is, at present, under development (Baseball Canada, 1984). Baseball Canada considers Level III to be the most advanced level of technical instruction in baseball and requires that its candidates have an adequate technical knowledge of baseball to gain entrance to this level (Baseball Canada, 1984).

The Level III Technical target group is comprised of coaches having: (1) A greater commitment to
coaching, shown in their work over a larger period of time with more committed and experienced athletes; (2) A commitment to upgrading their own knowledge and skills, whether through attendance at courses, workshops, and clinics, or through membership in various sport and coaching associations; (3) Advanced skills in planning programs and motivating athletes; (4) A high level of technical expertise within the sport; (5) Leadership within the sport; and, (6) Organizational skills to pull together the development of athletes (Baseball Canada-NCCP Task Listings, 1984).

The Educational Process

Thorndike (1971) describes the educational process as providing a series of environments that permit the student to learn new behaviours or modify or eliminate existing behaviours, practicing them to a point where he/she displays a satisfactory level of competence and regularity (Thorndike, 1971). These behaviours are displayed as a means for attaining prescribed educational system.

Brennan (1975) defines an educational system as,

...a deliberate, systematic, and replicable organization of a set of resources for the principal purpose of effecting student achievement of clearly stated instructional objectives" (Brennan, 1975, p. 289).
Brennan (1975) also theorizes that it is useful and practical to view an educational system as consisting of a discrete number of "objective-related modules", referring to all of those factors in an instructional system that are directly related to a particular instructional objective (Brennan, 1975).

In a study by Penman (1980) education is defined as "the process whereby intentional direction is given to the full, wholesome development of human beings" (p. 25). Education is a dynamic learning process which involves factors for establishing goals as influenced by society; identifying specific programs to meet these stated goals; implementing and assessing specified programs, and reviewing goals and re-establishing them if change is necessary (Penman, 1980).

Models of Learning

Lewin's (1963) general equation of behaviour (B) as a function (f) of personality (P) and environment (E) has been used by many researchers in estimating the function of learning behaviour and is written as B=f(P,E). Learning can thus be formulated more specifically as a function of individual aptitude and instructional treatment, or L=f(A,T), where L constitutes the function of learning, A is the aptitude
of the individual, and \( T \) is the type or level of instructional treatment (Levin, 1963).

In addition, Levin (1963) postulated that certain psychological-environmental factors may also be included as an estimate of the weight of non-manipulated factors that are associated with learning outcomes. That is, learning is a function of individual aptitude (A) instructional environment (T) and psychological environment (E) and can be conceptualized as \( L = f(A, T, E) \) (Levin, 1963).

Carroll (1963) first proposed a model of school learning in which major constructs were defined in terms of time (e.g., time spent learning or time needed to learn). This model specifies that the quality of instruction and the student's ability to understand the instruction would, when both are optimal, make the time needed minimal for each student. This model was based on five main constructs, the first three relating to entering behaviours of students and the latter two relating to an analysis of instruction (Carroll, 1963).

Bruner (1966) proposed a normative theory of instruction, organized around four requirements. The first requirement involves implanting a predisposition or motivation toward learning. Second, a body of knowledge to be taught dependent upon learner characteristics, previous instruction, and the nature
of the subject matter must be structured. Third, the presentation of learning materials must be sequenced. The fourth requirement specifies the nature and spacing of rewards and punishments, involving the use of intrinsic and extrinsic rewards and the provision of immediate and deferred gratification. Bruner's (1966) theory also discusses the importance of providing feedback just at the point when learners must compare their performance to some criterion (Haertel, 1983).

Cooley and Leinhardt (1975) focused on the relationship between instructional practices and school performance. The criterion predicted included both academic achievement and attitudes toward school, peers, and instructors. School performance was found to be a function of the constructs of initial abilities, opportunity, motivators, structure, and instructional events (Haertel, 1985). In the form of an equation, the function is \( P = f(A, O, M, S, I) \), where \( P \) is the function of school performance, \( A \) is the initial ability of the student, \( O \) represents opportunities for learning, \( M \) constitutes motivators for learning, \( S \) is the educational structure, and \( I \) represents one or a series of instructional events occurring in the educational process.

The Harnischfeger and Wiley model (1975) discusses teaching-learning processes and outcomes, but
only the teaching-learning process is considered extensively. This model recognizes that all learner outcomes are directly mediated through time-based learner pursuits. The amount and quality of learning is dependent upon the particular learning setting and the time spent in each (Haertel, 1985).

The Glaser model (1976) is based upon four basic components: analysis of the competence and skill to be achieved, description of the initial state, with which learning begins, conditions that have to be implemented to produce change from the learner’s initial state to a state of competence, and assessment procedures to determine the short and long term outcomes of the conditions implemented (Glaser, 1976).

Gagne (1977) described eight types of learning, their products and the conditions necessary to produce them, arranged in a hierarchy, from simple associations to complex higher order processes. This model focuses more narrowly upon specific intended outcomes for individual learners. Little attention is given to overall time allocation or to the larger social context of instruction (Gagne, 1977).

Bloom (1974) describes two prerequisites for learning: the cognitive entry behaviours and the learner’s affective entry characteristics. Cognitive entry behaviours can be considered as specific
prerequisites to accomplishing individual learning tasks. Affective entry characteristics include relatively task-specific attributes, such as attitude toward the subject matter and more general attributes, such as attitude toward school and self-concept as a learner (Haertel, 1985).

Roid and Haladyna (1982) interpret Bloom's analysis of learning in terms of quality of instruction. In this analysis, the test scores are expected to represent the amount of learning that has occurred in an educational course. This pattern of learning can potentially be changed by improving the quality and quantity of instruction (Roid and Haladyna, 1982).

Bloom (1976) posits that when quality of instruction is improved, both cognitive and affective entry characteristics (i.e., characteristics which are present prior to training or the introduction of a learning unit) are improved. Thus, as a result of their modified learning history, students who originally might have been predicted as low-achievers may achieve satisfactorily. Central to Bloom's schema is test development, since achievement must be assessed for learning units and outcomes (Bloom, 1976) (refer to Figure 1, p. 29).

Dual consideration of entry characteristics and
Figure 1: Analysis of Learning (Garm, 1976)

- Level of Achievement
- Rate of Learning
- Affective Outcomes
- Learning Unit(s)
- Quality of Instruction
- Cognitive Entry Characteristics
- Affective Entry Characteristics
quality of instruction in this model provide a good theoretical basis from which to view the Level II Technical course. This suggests that achievement in the Level II Technical course is dependent upon all three elements (i.e., cognitive entry characteristics, affective entry characteristics, and quality of instruction) as contributors to learning.

In a study by Parkerson, Lomax, Schiller, and Walberg (1984), it was determined that the educational process is characterized by several causal models of learning that characterize the process in terms of the simultaneous effects of several variables in the form of production functions or mathematical equations that estimate levels of achievement from measured input factors (Parkerson, Lomax, Schiller, and Walberg, 1984).

#### Developing a Taxonomy of Educational Objectives

Bloom (1956) developed a taxonomy of educational objectives concerned with the holistic nature of learning. The universe of these objectives was divided into three domains, including: (1.) cognitive, (2.) affective, and (3.) psychomotor areas.

Within the taxonomy, the cognitive domain is arranged in an ascending, hierarchical order. The
first classification, "knowledge", involves the retention, recall, and recognition of an appropriate context of learned material. The second level, "comprehension", involves understanding and individual ability to paraphrase knowledge accurately; to explain or summarize it in his/her own words, or to show logical extensions in terms of implications or corollaries. "Application", the third level, requires the ability to select a given abstraction appropriate for a new situation and to correctly apply it. "Analysis" follows application and is classified as the ability to break down a communication or concept into its constituent elements to show a hierarchy or other internal relations of ideas; to show the basis for organization, and to indicate how it conveys its effects. "Synthesis" involves the arrangement and combination of pieces, parts, etc., in such a way as to constitute a pattern or structure which was not there before. The level of classification is "evaluation", wherein qualitative and quantitative judgement about the extent to which material and methods satisfy criteria are determined by either the instructor or student (Bloom, 1956).

McGuire (1963), and Scannell and Stellwagon (1960) state that the cognitive domain taxonomy is useful in analyzing whether or not a formulated set of objectives
includes objectives at all levels of the taxonomy appropriate to the curriculum under consideration.

Nitko (1983) attempts to explain the importance of specifying objectives. First, planning of test procedures is made easier if the researcher has knowledge of the specific behaviors which need to be observed. The selection and/or development of certain test procedures depend on knowledge of which specified behaviors are expected to be elicited by students and observed by evaluators.

Test Construction

Cronbach (1970) defines the term "test" as a "...systematic procedure for observing a person's behaviour and describing it with the aid of a numerical scale or category system" (Cronbach, 1970).

Recent test item writing theory and technology has centred on the earlier work of researchers such as Bormouth (1970), Guttman (1969), and Hively et al. (1968).

Glaser (1963) was the first researcher to use the term "criterion-referenced" to designate a type of test that is designed to measure and describe student achievement relative to a standard defined by the intent of instruction (Roid and Haladyna, 1982). This
research also proposed that any form of systematic instruction has three common elements: (1) statements describing the intent of instruction, (2) instruction that is designed to help the student achieve these intended outcomes, and (3) criterion-referenced tests that are explicitly related to both intent of instruction and instruction (Roid and Haladyna, 1982).

Glaser (1963) suggested that the results of an achievement test can be used to rank individuals in an instructional unit along a relative continuum of ability with respect to a specified group of persons (norm-referencing) or along an absolute continuum of proficiency with respect to a specified behavioural criterion (criterion-referencing) (Brennan, 1975).

Glaser also notes that achievement test scores provide two kinds of information. The first is the degree to which the student has attained criterion performance and the second involves a relative ordering of individuals with respect to their test performance (Brennan, 1975).

Powell (1986) lists a number of functions related to testing, including:

1. Placement—putting each learner into a certain position relative to an instructional sequence.
2. Tracking — following each learner's progress through the instructional sequence.

3. Certification — acknowledging when each learner has achieved a predetermined set of minimum competencies.

4. Quality Checking — determining whether particular modules of the program met the expectations set for them.

5. Delivery Checking — determining whether the delivery of particular instructors met the standards set for them.

6. Program Evaluation — determining whether the overall program met the specifications for it.

7. Resource Allocation — determining which components of a program require more or less resources to meet program specifications. (Powell, 1986).

Popham and Husek (1969) noted that a problem in testing lies not only in the summarization of a student's performance on a test, but also in insuring that a test is constructed and judged in a manner appropriate for its use. The former situation calls
for a "norm-referenced" testing procedure, while the latter situation concerns "criterion-referenced" testing (Popham and Husek, 1982).

Norm-referenced measures are those which are used to ascertain an individual's performance in relationship to the performance of other individuals on the same measuring device. Criterion-referenced measures are those which can be used to ascertain an individual's status on some criterion, (i.e., a performance standard). The meaningfulness of an individual score is not dependent on a comparison with other testees (Popham and Husek, 1982). Popham and Husek state that in situations where one is only interested in whether an individual possesses a particular competence, and there are no restraints placed on how many individuals can possess that skill, criterion-referenced measures are suitable.

Bloom (1974) discusses mastery learning studies and notes that at the end of a group-based instructional unit, a formative criterion based test should be used to determine which students have reached a criterion of mastery. These studies also suggest that if a second learning unit follows the first and the units are sequential (as with the NCCP), that is, the first unit is a prerequisite to the second unit, it will be found that at the end of group instruction some students will
have attained mastery of the second unit while others may be in need of more time and help (Bloom, 1974).

In a study by Roid and Haladyna (1982), an "effective" criterion-referenced test is described as being built from items which logically reflect the intent of instruction. The test must be made up of items that cover all important aspects of the instructional domain upon which the test is based (Roid and Haladyna, 1982).

In summary, when instruction is systematic and tests have been planned to logically represent instructional intent, there will be a substantial increase in the amount learned, as well as the time taken for learning, incidental learning, and a number of positive effects on student attitudes (Block, 1971; Bloom, 1976; Hartley and Davies, 1976; Kulik, Kulik, and Cohen, 1979; Robin, 1976; Walberg, 1980; and Roid and Haladyna, 1982).

**Scale Construction**

In recent years, a number of behavioural test scale construction techniques have been developed based on the construction of a valid and reliable scale which follows this procedure: 1. a definition of the constructs to be scaled and the generation of
statements for inclusion in an item pool. 2. selection of the type of scaling procedure to be used. 3. selection of items for testing of scale properties. 4. reliability testing of scale properties.

This procedural framework is suggested in the literature by Gullikson (1950), Guilford (1954), Torgerson (1956), Horst (1966), Shaw and Wright (1967), and Hughes (1971), (in Lundstrom and Lamont, 1976).

Kerber (1967) focused on four factors to be considered in knowledge test construction. First, the length of the test instrument should be considered as longer tests tend to be more reliable than shorter ones if they contain items of equal difficulty. The study posited that this decreases the opportunity for guessing and increases the measurement of true ability.

A second consideration involves the range of difficulty of the test instrument, stating that the instrument should be balanced in its proportion of simple to difficult items.

The third consideration centres on the format of the instrument stating that the test must include clear directions, be legible, and arranged according to difficulty (Kerber, 1967).

Tinkelman (1971) states that the construction of any test first requires a definition of the emphasis and specific scope of the test expressed in an outline
or test blue print. Appropriate item types and construction of items should then be initiated dependent upon the level of ability of the intended users of the test instrument (e.g., NCCP baseball coaches) and distribution of item difficulties. Following this, an appropriate number of items and item sections should be devised and assembled for the format of the final test instrument. A final step involves an analysis of these items to determine their relative difficulty, discriminability, and usefulness for the proposed test measures.

Lien (1976) developed a similar list of steps for test construction which focused on preliminary and actual test considerations (Lien, 1976). Similarly, Kirkendall, Gruber, and Johnson (1980) constructed a model for construction of knowledge tests which included: planning the examination, preparing the examination, administering the examination, determining its quality, revising test items, and developing norms and criteria measures for intended test use.

Green and Lewis (1986) adapted a conceptual overview model for test development procedures, originally devised by Lindeman (1976a, 1976b). This model is based upon seven stages of test development, including: selecting a conceptual framework (Stage I), determining the use of the instrument (Stage II),
specifying the target population (Stage III), paying attention to items or indicators (Stage IV), quantifying selected items (Stage V), testing reliability (Stage VI), and testing validity (Stage VII) (Green and Lewis, 1986) (Figure 2, p. 40).

**Factor Analysis**

In introducing the concept of factor analysis, Spearman (1904) hypothesized that exam grades, for an individual, were related to one another, and suggested that the link to a test subject's grades was a latent one and not directly measurable. The test grades for one person were not completely correlated with one another. On the other hand, this hypothesis also suggested that grades in all of the subject areas would depend to some degree on general intelligence, which could be considered a factor common to all of the tests (Bond-Jackson, 1983).

Kass and Tinsley (1979) describe factor analysis as a mathematical technique which permits the reduction of a large number of interrelated variables to a smaller number of latent dimensions or factors (Kass and Tinsley, 1979).

Bond-Jackson (1983) states that factor analysis is a technique for analyzing the internal structure of a
STAGE I
SELECTING A
CONCEPTUAL FRAMEWORK

STAGE II
DETERMINING USES

STAGE III
TARGET POPULATION

STAGE IV
ATTENDING TO
ITEMS/INDICATORS

STAGE V
QUANTIFYING
SELECTED ITEMS

STAGE VI
RELIABILITY

STAGE VII
VALIDITY

FIGURE 2
CONCEPTUAL MODEL OF TEST CONSTRUCTION
(GREEN AND LEWIS, 1986; ADAPTED FROM LINDEMAN, 1976A, 1976B)
set of variables, each of which has been observed or measured for a number of observations, and have some, but not all, of their structure determined by certain underlying unobservable common constructs or factors (Bond-Jackson, 1983).

A study by Stewart (1981) defines factor analysis as a multivariate statistical technique that is concerned with the identification of structure within a set of observed variables. It involves the study of interrelationships among variables in an effort to find a new set of variables, fewer in number than the original variables, which express that which is common among the original variables (Stewart, 1981).

Muthen (1978) proposed a new method for factor analyzing dichotomous variables. The method uses information from first and second order proportions to fit a multiple factor model. Through a transformation into a new set of sample characteristics, the estimation is considerably simplified (Muthen, 1978).

Muthen and Christofferson (1981) further proposed a method for the simultaneous analysis of dichotomous responses from several groups of individuals. This method made it possible to compare factor patterns, variances covariances, and factor means over groups. The new method used information from first and second order proportions and estimated the factor model by
generalized least squares. Figure 3 (p. 45) illustrates the basic mathematical equation.

In the context of this research study, the use of a factor analytic method was necessary in order to determine the construct validity of the test instrument. By utilizing a modified version of the generalized least-squares method of factor analysis, (i.e., unweighted least-squares factor analysis), it was possible to extract factors from the test instrument and better understand the underlying dimensions being measured. The generalized least-squares method was appropriate as a factor analytic procedure since the Baseball Coaching Technical Questionnaire used dichotomous variables in its measurement schema.

**Discriminant Analysis**

The development of classical discriminant analysis took place in the 1930's as a result of research by R.A. Fisher (Rabb, 1980). Its principal uses have been in the fields of anthropology, psychology, biology, medicine, and education. A statistical discrimination or classification problem consists of assigning or classifying an individual or group of individuals to one of several known alternative populations on the
basis of measurements on the individuals (Rabb, 1980).

In the area of coaching, discriminant analysis has been used effectively in a number of studies. Examples of such studies include: "An assessment tool for athletes to judge coaching effectiveness" (Wiznuk, 1984), "What coaches do - behavioural evidence on coaching effectiveness" (Rushall, 1983), and "A system for the behavioural assessment of athletic coaches" (Smith, Smoll, and Hunt, 1977).

Rushall and Wiznuk (1985) developed an assessment tool to judge coaching performance appropriate for completion by athletes. The tool was shown to demonstrate discriminability and provoke accurate responses from subjects. Responses on the developed scale were weighted to reflect the desirable coaching characteristics of a good coach. The final assessment of the utility of the questionnaire was to evaluate whether the data generated for different coaches was sufficiently sensitive to discriminate between the individual characteristics of those coaches.

Brown and Tinsley (1979) defined discriminant analysis as a combination of scores resulting in a weighted linear composite (i.e., a discriminator score), called a discriminant. This score is calculated for each person in each group under study, using a discriminant function formula:
\[ Y = (B_1)(X_1) + (B_2)(X_2) + \ldots + (B_p)(X_p) \]

where, \( Y \) is the discriminant score, \( p \) is the number of discriminator variables, \( B_1, \ldots, B_p \) equals the standardized (or unstandardized) discriminant function coefficients (i.e., weights) for variables 1 through \( p \), and \( X_1, \ldots, X_p \) equals the individual's scores on variables 1 through \( p \) (Brown and Tinsley, 1979) (Figure 4, p. 45).

Discriminant analysis is designed to measure which dimension(s) is/are most important in representing multivariate group differences. It also functions to interpret and describe each dimension and estimate the contribution of variables to these underlying dimensions. In addition, discriminant analysis assigns new or unclassified persons to the group which they are most similar (Brown and Tinsley, 1983).
$$X_i = A_{i1}F_1 + A_{i2}F_2 + \ldots + A_{iK}F_K + U_i$$

**Figure 3**
COMMON FACTOR MODEL EQUATION

$$Y = (B_1)X_1 + (B_2)X_2 + \ldots + (B_p)X_p$$

**Figure 4**
MATHEMATICAL MODEL FOR DISCRIMINANT FUNCTION
CHAPTER III

CONSTRUCTION OF THE BASEBALL COACHING TECHNICAL QUESTIONNAIRE (BCTQ)

The following chapter discusses the actual construction of the Baseball Coaching Technical Questionnaire. An operational model was developed by the author as a means for guiding the construction of the test instrument in a step-by-step process (Figure 5, p. 47). Each of these steps is outlined in this chapter.

It is important, in the development of any test instrument, that a conceptual framework be structured in order to illustrate the underlying dimensions of the proposed test instrument. Conceptualization determines the scope of the measures, specifies the main concepts of interest, offers a structure in which to organize the sets of measures, and specifies the ways in which (education) program components may affect the impact or outcome variables (Green and Lewis, 1986).

Formation of concepts and constructs measuring factors related to the baseball coaching program requires that some sort of technical content analysis also be carried out.

Step 1: Content Analysis of the Level II Technical Baseball Program
**Figure 5**

Operational Model - Development of the BCTQ

- **Step 1**
  - Conceptual Framework
  - Content Analysis
  - Expert Panel
  - Construct Development

- **Step 2**
  - Determine Instrument Uses Type of Measure Who Will Administer?

- **Step 3**
  - Specify the Target Population Level II Baseball Coaches

- **Step 4**
  - Secondary Item Rating Selection of Items

- **Step 5**
  - Attending to Items and Indicators
  - Test Assembly
  - Dimensions Scoring Key Test Procedures

- **Step 6**
  - Quantification
  - Reliability Validity
The primary reference used in developing the Baseball Coaching Technical Questionnaire was the Baseball Canada Advanced Coaching Manual (1984b), which is the prescribed written material for the Level II Technical Baseball Program.

In addition, the Baseball Canada Course Conductor's Manual was consulted as a secondary source of technical information for developing the BCTQ.

The Advanced Coaching Manual is designed to provide technical information for coaches and is aimed at meeting the technical objectives of the Level II Baseball program. These objectives include the following:

1. To communicate with athletes.
2. To learn to analyze and correct errors.
3. To learn to teach sport skills using "effective" teaching principles.
4. To learn to organize a basic seasonal program (for baseball).
5. To learn methods of selecting facilities, equipment, and training aids.
6. To be able to implement drills for the level of athlete coached.
7. To be able to teach appropriate strategies and tactics.
8. To be able to implement appropriate game modifications as they are required (CAC, 1984b).

Content analysis of the Advanced Coaching Manual revealed twelve underlying dimensions, including: infielding, pitching, batting, catching, offensive strategy, defensive strategy, baserunning, outfielding, practice sessions, coaching philosophy, physical conditioning, and facilities (Table I, pp. 50-51).

Following the content analysis, a conceptual model of the Level II Technical program was constructed as an illustration of the major constructs and concepts involving course materials of the Level II program (Figure 6, p. 52).

Step 2: Determining the Use of the Baseball Coaching Technical Questionnaire

The BCTQ has been designed to serve a number of purposes related to measuring technical knowledge of Level II Technical baseball coaches.

The total test score represents an overall assessment of the baseball coach, in terms of baseball knowledge, which is relevant to the Level II Technical course and relevant to other coaches at the same level of expertise.
<table>
<thead>
<tr>
<th>NCCP LEVEL II CONTENT AREA</th>
<th>COURSE PERCENT</th>
<th>NCCP LEVEL II CONTENT SUB-AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>INFIELDING</td>
<td>23%</td>
<td>BODY POSITION, FIELDING, FLY BALLS, POP-UPS, BASE DUTIES</td>
</tr>
<tr>
<td>PITCHING</td>
<td>13%</td>
<td>MECHANICS, TYPES OF PITCHES, MEN ON BASE, FIELDING RESPONSIBILITIES, WARM UPS, CONDITIONING</td>
</tr>
<tr>
<td>BATTING</td>
<td>14%</td>
<td>GRIP/STANCE, BATTING ACTION, TYPES OF HITTERS, FAULTS &amp; CORRECTIONS, MENTAL ASPECTS</td>
</tr>
<tr>
<td>CATCHING</td>
<td>8%</td>
<td>PRE GAME PREPARATION, GIVING A SIGN, RECEIVING THE BALL, POP-UPS, THROWING TO BASES, FIELDING BUNTS, INTENTIONAL WALKS, PITCH OUTS, TAGGING RUNNERS</td>
</tr>
<tr>
<td>OFFENSIVE STRATEGY</td>
<td>6%</td>
<td>BATTING ORDER, HIT AND RUN, RUN AND HIT, BASE STEALING, COACHING THE BASES, SITUATIONS, STRATEGIES</td>
</tr>
<tr>
<td>DEFENSIVE STRATEGY</td>
<td>8%</td>
<td>SITUATIONAL DEFENSE, RELAYS AND CUT-OFFS, BUNTS, DEFENDING THE STEAL, HIT AND RUN, RUN AND HIT, FIRST AND THIRD SITUATIONS, RUN DOWNS, POP-UPS</td>
</tr>
<tr>
<td>BASERUNNING</td>
<td>6%</td>
<td>MENTAL ASPECTS, PHYSICAL TECHNIQUE, TAKING SIGNALS, LEADING OFF THE BASES, STEALING, SLIDING</td>
</tr>
<tr>
<td>OUTFIELDING</td>
<td>5.5%</td>
<td>FLY BALLS, GROUND BALLS, PRINCIPLES OF THROWING, COMMUNICATION, BACK UP FOR BASES</td>
</tr>
<tr>
<td>FACILITIES</td>
<td>5%</td>
<td>UTILIZATION, MAINTENANCE, AND PREPARATION OF BASEBALL PARKS AND FACILITIES</td>
</tr>
</tbody>
</table>

TABLE I
MAJOR CONTENT AREAS OF THE NCCP ADVANCED COACHING MANUAL
<table>
<thead>
<tr>
<th>NCCP LEVEL II CONTENT AREA</th>
<th>COURSE PERCENT</th>
<th>NCCP LEVEL II CONTENT SUB-AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>COACHING PHILOSOPHY</td>
<td>4%</td>
<td>ESTABLISHING A PHILOSOPHY, PLAYER/COACH/umpire RELATIONSHIP, BECOMING MORE KNOWLEDGEABLE AS A COACH</td>
</tr>
<tr>
<td>PRACTICE SESSIONS</td>
<td>3.5%</td>
<td>INDOOR PRACTICES, PRE-SEASON, OUTDOOR WORKOUTS, GENERAL PRACTICE OUTLINES</td>
</tr>
<tr>
<td>PHYSICAL CONDITIONING</td>
<td>3.5%</td>
<td>PRINCIPLES OF ATHLETIC TRAINING, GENERAL WARM UPS, SCIENTIFIC BASES FOR CONDITIONING AND TRAINING</td>
</tr>
</tbody>
</table>

TABLE I-cont'd
LEVEL II TECHNICAL BASEBALL PROGRAM

TECHNICAL
- PRACTICES
- GAMES

PHILOSOPHICAL
- PERSONAL DEVELOPMENT
- SOCIAL RELATIONS

ADMINISTRATIVE
- TEAM
- FACILITIES

INDOORS
- OUTDOORS

SKILLS
- STRATEGY

PLAYERS
- COACHES
- UMPIRES
- PARENTS

FIELD
- OTHER

FIGURE 6
CONCEPTUAL MODEL OF THE LEVEL II TECHNICAL BASEBALL PROGRAM
The instrument also functions as a method for placement of baseball coaches who may be new to the NCCP program, without any past coaching training. Likewise, coaches who do have coaching experience in baseball, but who have not taken an NCCP course in baseball, can be placed into an appropriate level, based on their ability to meet set criteria for a specified coaching level (e.g., Level II Technical course requirements).

In addition, the BCTQ functions as a method for verification of placement within a NCCP Technical coaching level in baseball. That is, if a coach has attained a certain technical level in the NCCP, the BCTQ serves to verify his/her ability to meet the prescribed criteria for that level.

Another use for the BCTQ is that, by considering each set of test data individually, it is possible to provide specific technical feedback to the baseball coach regarding his/her coaching expertise.

A final use for the BCTQ is that item scores for the group of examinees can serve a diagnostic role by indicating strengths and weaknesses of technical program areas in baseball. For example, a low score for a particular factor may indicate a characteristic of the program which needs to be improved.
Step 3: Specifying the Target Population

Two target populations were considered in the development of the BCTQ, the immediate study population (for use in constructing the test instrument) and the eventual intended users of the BCTQ, (i.e., non-certified, Level I, and Level II baseball coaches).

The immediate study population consisted of baseball coaches ranging in age from 16 to 73 years from three baseball communities in southern Ontario (i.e., Ajax, Hamilton, and Windsor) and N=28 baseball coaches acquired in a—convenient sample from communities across Canada.

The intended users of the BCTQ will be baseball coaches involved in the NCCP Technical component in baseball. The BCTQ is intended for the placement of baseball coaches into the Level III Technical course in baseball. Thus, the author suggests that the primary intended users of the BCTQ should be Level II Technical baseball coaches intent on moving up to the Level III Technical program. A second set of intended users will be coaches who are just entering the NCCP program and who have had past coaching experience in baseball.

In this respect, the test instrument will be used to determine whether or not the coach has sufficient technical knowledge and expertise to be immediately
placed in a more advanced coaching level, (e.g., Level II or Level III).

More generally, the BCTQ has been designed as a model for test instrument development which can be used by other sports and sporting organizations in technically evaluating their sport coaches.

Step 4: Attending to Items and Indicators: Developing BCTQ Items

In May, 1985 a NCCP Level III Technical pilot clinic for baseball was held in Oshawa, Ontario and provided the author an opportunity to participate in an advanced technical clinic setting as well as make contact with a number of baseball coaches and instructors from across Canada. These individuals were considered to be at the highest possible NCCP level for baseball. From this group, a panel of 11 raters was recruited by the author to participate in the study as item assessors (Appendix B - Level III Baseball Expert Rating Panel). Appendix B gives the names of each panel member and their address to indicate a fairly broad cross-section of expert raters. The panel of experts was formed as a means for assessing the relative difficulty, complexity, and discriminability of a large pool of test items, in order that this pool might be lessened to a smaller number of valid items.
for inclusion in the BCTQ.

In addition, members of the panel were asked to provide their input, in terms of the relevance of the items to a subsequent test instrument for Level II baseball coaches, (i.e., the BCTQ).

**Item Generation**

Factors which were considered in creating test items included the following:

1. **A taxonomy of cognitive behaviours** *(Bloom, 1956)*

   Within this taxonomy, cognitive learning is arranged in an ascending, hierarchical order. Thus, items were based partially on their relative ability in eliciting certain cognitive behaviours from the coaches.

2. **Construct areas.**

   As mentioned previously, each construct area was identified and broken down into its various components. In this way, the researcher had a better understanding of the vast number of new items which could be constructed. Use of the NCCP conceptual model for
baseball was helpful in this respect (refer to Figure 6, p. 52).

3. Table of specifications

A table of test specifications (Nikko, 1980; Lien, 1976) was developed to incorporate the cognitive behaviours and construct areas into a detailed graphical representation of potential item areas (Table II, p. 58).

4. Item pool generation.

Using the table of specifications, it was possible to develop a large pool of 104 potential test items (Table II, p. 58).

Item Construction

Items were constructed, based on the degree of complexity and difficulty, as statements which were to receive responses on an agree-undecided-disagree scale. Item content was derived directly from the content of the Advanced Coaching Manual (MacKenzie, 1984). Additional items, based on this same material, were considered from tests of baseball skills which had been
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<td>4</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
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<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td>Application</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
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<td>2</td>
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<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>Synthesis</td>
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<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
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<td>-</td>
<td>1</td>
<td>-</td>
<td>11</td>
</tr>
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<td>2</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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<td><strong>16</strong></td>
<td><strong>7</strong></td>
<td><strong>11</strong></td>
<td><strong>11</strong></td>
<td><strong>9</strong></td>
<td><strong>10</strong></td>
<td><strong>12</strong></td>
<td><strong>13</strong></td>
<td><strong>2</strong></td>
<td><strong>2</strong></td>
<td><strong>-</strong></td>
<td><strong>104</strong></td>
</tr>
</tbody>
</table>

**Table 11**

Test Specifications
previously constructed (Waglow and Stephens, 1954; Kay, 1984), as well as test forms created for use by other sports (Ontario Badminton Association, 1984; NCCP, 1984; and Level I Canoe Coach Manual, 1985).

**Format**

The original pool of 104 potential test items consisted of statements which were to be rated and selected by the expert panel members for use in the instrument. The items were presented as statements intended to be rated by coaches as: 1 = agree, 2 = undecided, and 3 = disagree. Thus, the items approximated a Likert-type scale of responses.

**Formation of Item Rating Scales**

A total of N=104 potential test items were constructed, based on the contents of the Advanced Coaching Manual (MacKenzie, 1984) and presented to the panel of baseball experts to be rated on item difficulty and complexity as perceived by the raters. These items were based on the objectives of each instructional unit in the manual and the level of cognitive behaviour required to successfully answer the
item. Panel members were requested to respond to each item and return the pool of questions to the author by mail.

Each of the items was analyzed in relation to its perceived difficulty and complexity and placed into a table of test specifications for later item selection (see Chapter V, Table of Test Specifications, Table II).

**Secondary Item Rating**

Following initial item rating, the items (N=104) were transformed from an original interrogative and short-answer format to a series of positional statements which required the test respondent to respond to a statement based on a 3 point likert scale, 1 = agree with the statement, 2 = undecided about the statement, and 3 = disagree with the statement. It was felt by the author that this new test format would allow for the inclusion of more criterion-referenced test items in the test booklet, since the original short answer items would have required more time and space for completion. The addition of more items would provide for a greater potential internal consistency in the test instrument, as well as increase the potential for content, construct, and criterion-related validity,
since a larger number of content-appropriate items could now be included in the test booklet.

Further validation and selection of preliminary test items was facilitated through a table of test specifications (Table II, Table of Specifications, refer to p. 58). This table was designed to indicate how many items related to each area of the Level II Technical program for baseball in terms of content and complexity of items relative to cognitive learning behaviours (Bloom, 1956). The number of items in each cell was proportional to the percentage of content in each area of the Advanced Coaching Manual for baseball (MacKenzie, 1984).

Using the table of test specifications, two separate preliminary forms were constructed, based on the N=104 3-point likert scaled items. Each preliminary form was comprised of N=55 test items, representing approximately half of the potential test items. Of the N=104 test items, 3 items were included in both of the preliminary test forms in order to maintain a balance in the proportion of representation in item content areas between the forms. The author determined that a total of N=55 test items was based upon a sum of the proportion of content areas in the Advanced Coaching Manual for baseball (Baseball Canada, 1984) relative to the number of items per cell
indicated in the table of test specifications (Table II p.58).

Panel members were asked to respond to each statement without referring to any related materials. An item analysis was then carried out on each of the responses of the panel members, including the calculation of a difficulty index and a selection ratio for discriminability for each item relative to the Level II Technical course.

Gronlund (1976) states that item analysis is useful in determining: (1) if the items function as intended (i.e., are they good discriminators of Level II Technical coaching knowledge in baseball?); (2) if the test items are of appropriate difficulty; and, (3) if the test items are free of defects. These factors are considered to be of value in selecting or revising items for future use in scale development (Gronlund, 1976).

Gronlund (1976) also notes that it is sometimes desirable to obtain a more precise estimate of item difficulty and discriminating power. This can be done by applying relatively simple formulas to the item analysis data (refer to Figures 7 and 8, p. 64).

On the basis of these indices, items were to be selected if they had a discrimination ratio of >.25, and if they fell into one of three distinct regions of
difficulty:

0.00 - 43.00 (high difficulty)
44.00 - 66.00 (medium difficulty)
67.00 - 100.00 (low difficulty)

Selection ratios were based on a ratio of the sum of the respondents answering the item correctly from each of the highest and lowest scoring groups in the sample (N=11) divided by the total number of respondents in both the highest half and lowest half scoring groups (N=11). Figure 7 illustrates this selection ratio, where R is the number of respondents answering correctly to each item and N is the total number of respondents for both the low and high scoring groups (N=11).

Discrimination ratios were calculated by subtracting the number of correct cases in the lowest scoring half of the N=11 subjects from the number of correct cases in the highest scoring half of the subjects and dividing this total by the total number of N=11 subjects. Figure 8 (p.64) illustrates the discrimination ratio, where R is the number of respondents answering the item correctly and N is the total number of respondents for both the low and high scoring groups (N=11).
\[ \text{SELECTION} = \frac{R_{\text{low}} + R_{\text{high}}}{N_{\text{low}} + N_{\text{high}}} \]

**Figure 7**
Selection ratio for Level II technical item selection.

\[ \text{DISCRIMINATION} = \frac{R_{\text{high}}}{N_{\text{high}}} - \frac{R_{\text{low}}}{N_{\text{low}}} \]

**Figure 8**
Discrimination index for Level II technical item selection.
Selection of Test Items

After all data had been collected from the preliminary test forms, the author examined the selection and discrimination ratios, as well as qualitative comments, which had been given by each of the panel members, in order to make any revisions to the test items prior to selection for inclusion in the BCTQ.

Items were selected in terms of their relative difficulty, readability, and discriminability as defined by the following:

Readability: ease of reading, brevity, clarity, and simplicity, as expressed by each of the panel members.

Difficulty: items of high difficulty had difficulty ratios of 0.00 - 43.00, items of medium difficulty had difficulty ratios of 44.00 - 66.00, and items of low difficulty had difficulty ratios of 67.00 - 100.00.

Discriminability: the ability of the item to discriminate between levels of performance. Any item having a discrimination ratio of >.25 was considered a 'selectable' item.
Step 5: Test Assembly

Based on difficulty and discriminability, a total of 43 items were selected as potential items, as a result of obtaining a selection ratio of >.25 on the preliminary test forms. For the purposes of test administration, a total of N=30 test items were chosen for inclusion in the instrument from the stratified random N=43 sample, by means of a two part process of content analysis and use of difficulty ratios.

Selection of Items by Content Area

The number of items per content area was reduced by first considering the "ideal" number of items, derived from multiplying component area proportional percentages by the original N=104 items in the item pool. Then, the actual number of items on each preliminary item form was multiplied by the same proportional weightings and these scores were compared proportionately to the original scale. This was accomplished by subtracting the actual number of items from the original number of items for each content area item total. Based on these calculations, it was determined that 30 items would be used in the BCTQ.
Selection of Items by Item Difficulty

The second step in the item selection process involved determining the proportion of items delegated to each level of difficulty (i.e., low, medium, and high). In consultation with research committee members, it was decided that the three levels of item difficulty would be broken into:

- Low Difficulty = .67 - 1.00 (50%)
- Medium Difficulty = .44 - .66 (30%)
- High Difficulty = 0.00 - .43 (20%)

It was predicted that this distribution of item difficulties would closely resemble a more negative skew in terms of item response functions for each item, which is desirable in a test instrument to measure abilities (Lord, 1980).

Item difficulty level totals were corrected by a factor of 0.7 (30 items/43 items = 0.7) to result in a final proportion of items:

1. Number of items with low difficulty = 15
2. Number of items with medium difficulty = 9
3. Number of items with high difficulty = 6

The author calculated the proportion of item
content areas for each construct area, as well as the proportion of item difficulty levels.

An additional final step in the item selection procedure involved a stratified random sampling procedure in which final test items were selected with regard to the previously calculated content and difficulty proportions. Items were placed into groups based first upon their level of difficulty and second, on their content. Within each group, items of similar content and difficulty were randomly selected to be included in the instrument.

**Dimensions of the Instrument**

The Baseball Coaching Technical Questionnaire was constructed in a booklet format, containing three primary sections: 1. directions to the respondent, 2. a NCCP Coach Profile form (CAC, 1984b), and 3. the 30 test items (Exhibit I, p. 97).

The directions explained the importance of supplying the requested demographic information, age, sex, level of education, level of coaching experience, community, years as a coach, athletes' sex, athletes' age, coaching status, and the existence of a related sport degree, as well as responding to each and every item completely by circling the responses. Inclusion
of the NCCP Coach Profile Form was deemed appropriate by the author in order to gather the previously mentioned demographic and coaching-related information for each baseball coach.

The 30 BCTQ test items were statements considered independent of each other and measured an underlying measure of technical coaching knowledge in baseball. A total of N=63 subscales were to be measured from the N=30 test items in the BCTQ. Of the 30 items, N=12 were summated from a multi-scaled format, that is, they contained either three or four subscales, each a partial measure of the same underlying construct. The researcher intended to summate these N=12 multi-scaled items by means of averaging their rated totals, in order that each item was weighted evenly with the other items in the BCTQ.

Each item consisted of a statement or set of statements designed to elicit a decision from the respondent regarding whether they agreed, were undecided, or disagreed with the validity of each positional statement.

Preparation of Scoring Procedures

and a Scoring Key

Each test item was to be carefully read and then
rated by the respondent according to the 3-point likert scale (agree, undecided, disagree). Test markers were to be given a coded master scoring key, which consisted of the item responses (circled) deemed most appropriate by the panel of baseball experts (refer to Appendix A).

For each correct response (i.e., a match) the respondent was to be awarded a score of 1 point. A response which was incorrect (i.e., no match) was subsequently awarded a score of 0. Originally, scores were to be awarded as 1 point for an incorrect response, 2 points for an undecided response, and 3 points for a correct response. It was felt by the researcher that an indecisive response constitutes a response indicating lack of knowledge and, therefore, responses were re-assigned new values of either 0 or 1 point. Thus, a dichotomous scale of test item responses was created, (agree-disagree).

The final step in the scoring procedure involved the markers placing a value of 1 or 0 beside each item (N=63) and then tabulating the overall test score. Multi-scaled items were summed and averaged to correspond with the single-scaled items.
CHAPTER IV

METHODOLOGY

The following chapter deals with the methods and procedures which were followed in the development and subsequent validation of the Baseball Coaching Technical Questionnaire (BCTQ).

Study Description

The Baseball Coaching Technical Questionnaire was designed to measure the technical knowledge of Canadian baseball coaches; in particular, coaches who have attained a Level II Technical standing within the NCCP for the sport of baseball. The questionnaire was constructed based upon a conceptual framework of the game of baseball encompassing the technical, philosophical, and administrative dimensions of baseball.

The intent of the Baseball Coaching Technical Questionnaire (BCTQ) is to provide a diagnostic and summative measurement of the technical knowledge of Canadian baseball coaches, ultimately to be administered by NCCP course conductors trained in the delivery of specified Level II and Level III Technical
baseball clinics.

The dimensions of the BCTQ are such that it is easily distributed i.e., by mail or in a classroom, and easily administered, requiring little prior training. It is comprised of a test booklet, with six typewritten pages of test items and consists of N=63 total test items.

The intended population for future application of the final test instrument (BCTQ) will be coaches who have taken the Level II Technical course in baseball. From a broader perspective, the BCTQ should provide a theoretical basis from which to develop tests of knowledge for other sport coaches.

A number of items (N=104) for each of the conceptual areas delineated were generated from the content of the NCCP Advanced Coaching Manual (CFAB, 1984). A panel of baseball experts (N=11) provided feedback on this pool of items, based upon a set of criteria that were systematically applied to each item. These criteria included the item's level of difficulty, discriminability, and relevance to the Level II Technical course in baseball. The baseball experts were requested to assess the suitability of each item, as well as make suggestions for modifications and adjustments to the entire scale of test items.

Based upon the expert ratings, a second large pool
of items (N=43), having considerable face validity, content validity, and construct validity, was pared down to a total of N=30 test items. These N=30 items constituted a total of 63 independent item scales. A stratified random sample of test items was chosen for inclusion in the BCTQ, based on the relative percent of Level II Technical emphasis placed upon each particular construct area. The decision to use N=30 items (see Chapter III) was due to time and practicality considerations.

Identification of Variables

The opening section of the Baseball Coaching Technical Questionnaire provides a standard NCCP Coaching Profile Form that was adapted to serve the needs of the research study in terms of demographic and coaching-related information (refer to Appendix A). The following variables were to be included for responses from each coach: (1) the test procedure used (mailed or classroom), (2) the level of NCCP coaching certification held by the coach, (Non-certified, Level I, or Level II Technical in baseball), (3) the coach's community (Ajax, Hamilton, Windsor, other), (4) the age of the coach, (5) sex of the coach, (6) the number of years this coach has been actively coaching baseball,
(7) the level of baseball team coached by the individual, (8) their level of formal education, (9) the age of the athlete coached, (10) sex of the athlete coached, (11) their status as either a full-time paid, a part-time paid, or volunteer coach, (12) whether they held a recognized diploma or degree in the area of sport and recreation, and (13) their total score on the BCTQ.

The test items were representative of the three primary construct areas identified in the conceptual model (Figure 6 - Conceptual Model of the NCCP Level II Technical course in baseball, p.52) and included the following conceptual areas: batting, baserunning, catching, defensive strategy, facilities, infielding, outfielding, physical conditioning, philosophy, pitching, practices, and offensive strategy.

Validity

A number of measures were taken to ensure the validity of the BCTQ including content, construct, and criterion validity. The instrument was derived from a conceptual model based on the content of the Level II Technical course in baseball. A panel of 11 technical experts from across Canada (Appendix B) was formed to
assist in the development of the test instrument. Each potential test item was thoroughly analyzed for its difficulty, discriminability, and relevance to the coaching properties being measured.

In addition, the study incorporated a qualitative appraisal of each potential test item by the members of the panel of experts in order to ascertain the relative face validity of the BCTQ.

Reliability

The following steps were taken to improve upon the reliability of the BCTQ: (1) clear instructions were given to all coaches on how to write the BCTQ, (2) items were straightforward and clearly stated, (3) item scales were not summated for more meaningful reliability measurement, (4) items were pre-tested by an expert technical panel who rated each item in terms of its difficulty and discriminability.

All BCTQ test forms were subjected to the SPSSx Reliability procedure (SPSSx Manual, 1985). Cronbach's Alpha coefficient of reliability was used to test for internal consistency. In using dichotomous scales, Cronbach's Alpha approximates the Kuder-Richardson 20. The estimated Alpha reliability coefficient for the 63
item BCTQ was calculated to be .66.

Pre-Test Administration

Pre-test administration involved the following procedures: determination of a suitable time frame for test administration, selection of testing sites for the research administration of the BCTQ, and selection of participants to be used in the study.

Time Frame

Testing procedures began near the beginning of October, 1985 and concluded with the predetermined cut-off date of December 20, 1985. During this period, a total of three separate classroom testing sessions were held within a week of each other. The mailed questionnaires were given a longer period to be returned due to mailing circumstances, (i.e., Christmas).

Testing was held during the early part of October, just after the close of the regular season for most Ontario minor baseball associations.
Selection of Test Sites

Three sites were selected for testing, including the Ajax Minor Baseball Association, Hamilton District Minor Baseball Association, and the Windsor District 5 Baseball Association. Each of these associations had been involved in the general promotion of the sport of baseball for a number of years. A number of criteria were considered in selecting each test site, including:

1. The size of the association's coaching membership.
2. The convenience of a contact person from each of these associations who would be willing to volunteer time and effort in assisting with the study.
3. The proximity of the associations within the same region (southern Ontario).
4. Historically, these three communities have had a long-standing reputation for producing successful baseball coaches.
5. With few exceptions, these community associations were run by volunteers.
6. All three associations have numerous levels of competition from which to draw coaches.

Selection of Participants

A large pool of potential study participants was made possible through the following means:

1. An updated listing of Level I and Level II baseball coaches from the Ontario region (Ontario Baseball
Association, 1985). This list is renewed yearly and provides details on all NCCP courses which have been completed by the coach.

2. Updated community association coaching lists, including the level of age coached and addresses. These lists were the primary source for non-certified baseball coaches.

Including both classroom and mailed-in participants in the study, the overall sample size was N=142. Coaches from all three levels (non-certified, Level I, and Level II baseball coaches) were enlisted to participate based upon their inclusion in the overall stratified random sample of N=142 coaches.

Coaches were classified as follows:

1. Non-certified coach - baseball coaches who have not taken any NCCP training.

2. Level I coach - baseball coaches who have taken at least the NCCP Level I Technical course in baseball.

3. Level II coach - coaches who have taken at least the NCCP Level II Technical course in baseball.
Test Conditions and Procedures

Two separate procedures were used in administering the BCTQ. The first procedure involved a classroom situation in which the researcher was present to administer the test and pre-determine the conditions of the testing environment. The second procedure involved test administration via Business Reply mail. The following is a description of each procedure.

Classroom Testing

The classroom testing procedure was limited to a controlled classroom environment approximating the conditions which would normally be found in a NCCP clinic for baseball coaches.

Prior to testing, specified contacts from each of the official test sites were responsible for acquiring classroom space suitable for administering the BCTQ. These same contacts were asked to distribute copies of a preliminary letter to the members of their associations to inform them of the intended session.

Ajax coaches were tested at the Ajax Community Centre, a sport and recreation complex with lecture rooms designed specifically for clinics and seminars.
Hamiton testing was held at the main clubhouse of the Hamilton District Minor Baseball Association.

Windsor coaches were tested at the Faculty of Human Kinetics building at the University of Windsor.

The researcher tested an additional N=28 baseball coaches from other Canadian centres in a classroom setting closely approximating conditions like those in Windsor. This testing also took place in London, Ontario, at the Annual General Meeting of the Ontario Baseball Association.

In all test situations, coaches were provided with table or desk space, a test booklet, and writing implement in order to complete the test.

With the exception of the London test site, the test was administered by the researcher. London testing was under direction of a member of the study expert technical panel.

An upper time limit of one hour was set but, in general, coaches took less than thirty minutes to complete the instrument.

Prior to testing, coaches were directed not to converse with the researcher or other coaches, nor were they to consult any resource materials.

After completing the BCTQ test instrument, forms were collected and numbered for indexing purposes, i.e., names, dates, etc.
Mailed Questionnaires

The BCTQ was administered by mail during the month of October, 1985. Names and addresses were obtained from the NCCP Database for baseball coaches in Ontario (Ontario Baseball Association, 1985), as well as lists provided by each of the three associations. A total of N=385 questionnaires were sent to the study participants.

Respondents received a mail package containing two explanatory cover letters (Appendix C) regarding the written evaluation and the actual test booklet, complete with test items and directions. In addition, a Business Reply envelope was inserted to facilitate the convenient return of each booklet.

Coaches received the same test directions as those in the classroom setting. Each was requested not to refer to any resource materials and was assured of confidentiality in their results. One change in test procedure involved the time limit placed on the respondents. No writing time restrictions were placed on item completion in the mailed questionnaires, but coaches were asked to return their test booklets within two weeks of receiving them. Coaches were reminded to pay close attention in completing all of the items in
the BCTQ in order to decrease the number of cases with missing values.

Scoring Procedures

Initially, the BCTQ was comprised of 63 total items, 18 of which were separate and independent and the remaining 45 items were dependent members of a larger component item, i.e., items with three or four part responses.

Each item was based on a scale of 1-3, where 1 = agree with the statement, 2 = undecided about the statement, 3 = disagree with the statement. Respondents were asked to read a statement and rate it based upon whether they agreed, disagreed or could not decide on their feelings about the statement.

Scoring for each positional statement was based on a predetermined scoring key developed by the researcher and the expert panel members. Coaches' responses were compared to those in the key and given a value of 1 or 2 points, based on a scale: 1 point = response is incorrect or neutral, and 2 points = response is correct. Originally, the responses were to be scored as 1 point = incorrect response, 2 points = neutral or undecided response, and 3 points = correct response. It was decided by the researcher, that a neutral
response, (i.e., 2 = undecided about the statement), constituted a non-answer and was therefore not a correct response. Logically, it was felt that a dichotomous scale was more interpretable than the original 3 point likert scale, since it would specify only right or wrong responses. Thus, any item with a response of 2 (undecided about the statement) was scored with a value of one point.

For the purposes of factor and discriminant analyses 12 of the 63 items were recoded and then summed to decrease the total N of the items to N=30 test items. That is, the item sub-scales were averaged.

Analysis of the Data

The Statistical Package for the Social Sciences (SPSSx) was used as the computer package to assess the data gathered from the BCTQ. Results of these procedures are detailed in Chapter V. The following is an outline of the data presented.

Univariate Statistics

Univariate statistics for both the demographic
variables (V1-V13) and predictor variables (I1 to I30d) were calculated, including frequencies, means, standard deviation, and standard error of measurement for each variable and the total scale.

**Factor Analysis**

An Unweighted Least Squares (ULS) method of factor analysis for dichotomous variables was selected, using a varimax (orthogonal) rotation and including the following data: size and characteristics of the sample, the correlation matrix, based on item and variable cross-tabulations, initial and final communality estimates, a scree plot of the eigenvalues, the number of factors retained, the factor structure matrix, identification of the factors, and factor scores.

**Discriminant Analysis**

A stepwise discriminant analysis was performed on each of the demographic and predictor variables, these findings reported: (1) the standardized discriminant function coefficients, (2) the group centroids, (3) the relative percent of variance, absolute variance, and canonical correlations, (4) Wilks' lambda and
chi-square, and (5) the proportion of correct classifications.

**Reliability**

Reliability statistics were calculated for both the entire scale and individual factors, including: (1) the number of variables in the scale, (2) the mean, (3) the variance, (4) the standard deviation, (5) item means, (6) item variance, (7) inter-item covariance, (8) inter-item correlation, and (9) the Alpha coefficient of reliability for the BCTQ.
CHAPTER V.

RESULTS AND DISCUSSION

The goal of this research study was to develop a written test instrument to measure the construct of technical coaching knowledge in baseball. Consequently, the Baseball Coaching Technical Questionnaire (BCTQ) was constructed to evaluate the technical knowledge of NCCP Level II Technical baseball coaches.

Two research objectives were proposed for BCTQ test development:

1. To determine if the BCTQ provides a valid measure of NCCP Level II Technical coaching knowledge in baseball.

2. To determine if the BCTQ is reliable in measuring NCCP Level II Technical coaching knowledge in baseball.

Analysis and discussion of the results pertaining to these objectives are presented in the following chapter in the form of research questions and related research hypotheses. Figure 9 (p. 87) provides an operational illustration of these research objectives.
Initial Group Differences

Four hundred and twenty-two BCTQ test forms were administered to baseball coaches from three southern Ontario communities (Ajax, Hamilton, and Windsor). Twenty-eight of these test forms were administered to baseball coaches from other communities across Canada. A total of 149 BCTQ test forms were returned to the author prior to the specified cut-off date of December 20, 1985. Seven BCTQ test forms were omitted by the author due to inconsistencies in the responses to the demographic and coaching-related questions in the attached NCCP Coach Profile Form (refer to Appendix A). Therefore, the final sample size was 142 baseball coaches.

Each coach was administered the BCTQ in either a clinical classroom setting or by mail. Of the coaches, N=68 (48%) were tested in a classroom setting, with the remaining N=74 (52%) responding by mail.

Coaching experience ranged from no technical coaching experience to involvement in the Canadian National Baseball Team. The following is a summary of the characteristics associated with each of the three identified coaching levels used in the study (i.e.,
Non-certified, Level I, and Level II baseball coaches).

Non-Certified Baseball Coaches

Non-certified coaches comprised N=54 (38%) of the study sample. Twenty nine of these coaches were administered the BCTQ in a classroom setting, with the remaining (N=25) coaches returning the BCTQ by mail.

The mean age for non-certified coaches was determined to be 36.18 years. Of the N=54 coaches, only 4 were female. Average level of education was determined to be at the trade/vocational level and the coaches' average for coaching status, (i.e., full time paid, part time paid, volunteer), indicated that most were volunteer coaches. The mean total score on the BCTQ for non-certified coaches was 137.14 points of a possible 189 points.

Level I Baseball Coaches

Level I coaches comprised N=45 (31.7%) of the total study sample. Of these coaches N=15 were administered the BCTQ in a classroom while N=30 coaches returned the BCTQ in the mail. The mean age for this age group was 38.5 years. There were no females in the Level I group of 45 coaches. The average level of education was
slightly above that set for non-certified coaches, also at the trade/vocational school level. Again, most of the coaches were unpaid volunteers, with less than 1% (N=4) paid in some way for their services. The mean total score for Level I coaches on the BCTQ was 138.9 of a possible 189 points. This mean total for Level I coaches was not much different than that observed for non-certified coaches.

**Level II Baseball Coaches**

Level II coaches comprised the remaining N=43 (30.3%) of the total sample. A total of N=18 completed the BCTQ in a classroom while an additional N=25 coaches responded by mail. The mean age for this group was younger than the other levels, at 36.14 years. Three females (7%) were tested from the sample of coaches. N=42 coaches were unpaid volunteers, leaving only one coach who was paid. The mean total score was found to be the highest of the three groups with 140.66 of a possible 189 total points.

**Validity**

The following section focuses on the first research
objective concerning the determination of validity of the BCTQ in measuring technical coaching knowledge of Level II Technical baseball coaches.

Content Validity

The first research question related to validity of the BCTQ was concerned with test content validity and posed the question:

How well does the BCTQ reflect the content and objectives of the NCCP Level II Technical baseball course, as contained in the Advanced Coaching Manual (MacKenzie, 1984) and Course Conductor's Guide (CAC, 1984)? Will there be a significant difference between the item content of the BCTQ and the instructional content of the Level II Technical course?

Three descriptive methods were used to determine the content validity of the BCTQ:

1. A content analysis, involving a thorough review of Level II Technical materials for baseball, and the development of a conceptual model to illustrate the construct of "technical coaching knowledge in baseball" as it relates to the Level II Technical course in baseball.
2. A table of test specifications was constructed to determine if the underlying dimensions of the construct "technical coaching knowledge in baseball" were adequately contained in the BCTQ.

3. A panel of technical baseball experts was formed (N=11) for consultation in determining the relevance and validity of each item in the BCTQ.

1. Content Analysis

An analysis of the content of the Level II Technical course in baseball was accomplished by summarizing each of the sections and sub-sections of the Advanced Coaching Manual and determining the type and proportionate percentage of content found in each. The sub-construct "Infielding" was found to have the highest percentage (23%) of representation. Table I illustrates the percentage totals for each sub-construct area represented in the Advance Coaching Manual. A total of 15 sub-construct areas were identified by the researcher. Each of these sub-constructs were placed into a conceptual model of the Level II Technical course for baseball as a further indication of content representativeness (refer to
2. Table of Test Specifications

From the test item pool (N=104), the researcher constructed a table of test specifications (Thorndike, 1971) to determine the representativeness of potential BCTQ items in reflecting the construct of "technical coaching knowledge in baseball" as it relates to Level II baseball coaches (Table II). This table was based on item complexity and content. Table II illustrates the placement of each generated test item into a cell, depending on that item's perceived degree of complexity and content-appropriateness as determined by a panel of baseball coaching experts (N=11) formed to determine the face validity of the BCTQ (Table II, p. 58). The table indicates the placement of each item (N=104) into a complexity x content cell and the relative percentage of items generated for each sub-construct area. The number of items generated for each sub-construct area was directly proportional to the percentage of content in the Advanced Coaching Manual.

3. Panel of Experts

Borg (1963) stresses that content validity in test
development is dependent upon comparison of the course content and instructional objectives with the content and objectives of the test instrument.

Nunnally (1967) elaborates further and indicates that the content validity of a test measure should have agreement by potential users of the test, or at least by persons in positions of responsibility (i.e., a panel of experts), that the plan of the test was "sound and well carried-out" (Nunnally, 1967).

A panel of 11 baseball coaching experts from across Canada was formed to evaluate the content and objectives of the BCTQ (Appendix B, p. 151). Each panel member was asked to rate the N=104 original short answer-essay style test items, based on each item's relevance to the Level II Technical course in baseball and its perceived difficulty and complexity.

Following the initial rating, the test items were reconstructed as positional statements, measured on a likert scale, with responses based on the degree to which the expert agreed, was undecided, or disagreed with the technical statement. The N=104 were re-administered to the panel members in order that they might supply responses to these positional statements related to baseball. An item analysis of these responses provided information regarding the degree of difficulty and discriminability inherent in
each item (Guilford, 1954) (refer to Appendix D).

Table III illustrates the 30 dichotomous test items selected from the N=104 preliminary test items for inclusion in the BCTQ. Selection of test items from the N=104 item pool was based on the item analysis of the responses given by the 11 member panel of baseball experts.

Scale items with an "I" prefix are indicative of single scale responses to positional statements (e.g., I1). Scale items with a "Q" prefix indicate that the positional statement has a composite of response scales, where more than one response is to be rated relating to the same statement (e.g., Q2).

Exhibit I (p. 97) illustrates the BCTQ in actual test booklet form. Each item stated in the booklet corresponds directly with the items in Table III. For example, item 1 in the BCTQ test booklet is the same as I1 in Table III. Likewise, item 2 in the BCTQ test booklet is a composite item which also corresponds with Q2 in Table III (p. 96).

Construct Validity

The second validity related research question involved the determination of construct validity of the BCTQ involving the derivation of underlying dimensions
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**TABLE III**
TEST ITEMS IN THE BCTQ

96
BASEBALL COACHING TECHNICAL QUESTIONNAIRE

DIRECTIONS

PART I - NCCP PROFILE FORM

At the beginning of this questionnaire, you will find a National Coaching Certification Program Coaching Profile Form. It is important that you complete this form as accurately as possible, since level of coaching background is a factor to be considered in this study. The information which you provide will remain strictly confidential and will not be used for any other purposes than this research effort.

PART II - BASEBALL COACHING TECHNICAL ITEMS

Each of the items is based upon material found in the National Coaching Certification Program for baseball. For each item, a statement or statements is/are presented, with a corresponding scale of responses defined as:

1 = I agree with this statement completely.
2 = I am undecided about this statement.
3 = I disagree with this statement completely.

Read each statement carefully and then circle the number of the response (e.g., 1 = Agree) which you feel best describes your rating of that statement. NOTE: Please do not refer to any notes!

For example,

1. In a technically sound ready position to hit, the batter should have these qualities:
   a. The head is stationary. 1 2 3
   b. The bat grip is firm. 1 2 3
   c. The shoulders and hips are level. 1 2 3
   d. Body weight is evenly distributed. 1 2 3

After completing each item please double check that all statements have been completed and return this questionnaire and NCCP Profile Form in the envelope provided no later than December 28, 1985.

EXHIBIT I
CONT'D

98
# NATIONAL COACHING CERTIFICATION PROGRAM

## PROFILE FORM

**Certification Level:**
No. Years Coaching:

To be completed by coach

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<tr>
<td>Ms. □</td>
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**Permanent address:**

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**DATE OF BIRTH**

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**SEX**

M-Male □ F-Female □

**FORMAL EDUCATION**

1. Elementary (Grades 1-5)
2. Secondary (Grades 9-13)
3. Trade/Vocational School
4. Community college (CEGEP)
5. University

**STATUS**

1. Paid (Full-time coach)
2. Paid (Part-time coach)
3. Volunteer

**TYPE OF COACH**

Please check all applicable boxes

26 □ Elementary school 32 □ Club
27 □ Secondary school 33 □ Service group
28 □ Trade/Vocational school 34 □ Industrial league
29 □ Community college 35 □ Provincial team
30 □ University 36 □ National team
31 □ Community (Recreation Centre) 37 □ Not actively coaching

Sports which you are actively coaching:

| 38 | 39 |
| 40 | 41 |
| 42 | 43 |

Sports in which you wish to be certified:

| 44 | 45 |
| 46 | 47 |
| 48 | 49 |

If you coach disabled athletes, check all applicable boxes

21 □ Wheelchair
22 □ Silent
23 □ Blind
24 □ Amputee
25 □ Mentally handicapped

Language of future communication □ English □ French

Exhibit 1 (Continued)
PART II

BASEBALL COACHING TECHNICAL QUESTIONNAIRE

* Please make sure that you respond to each and every statement and its corresponding scale.

Agree  Undecided  Disagree

1  2  3

1. A short single is hit to left field on a force play at third base (one is out with runners at first and second base). In this situation, the third base coach should tell the incoming runner to slide directly into the third baseman to get the safe base at third and also make it difficult for any additional throws to be made.

1  2  3

2. Often, stiffness in the muscles after a workout can be attributed to:
   a. An improper warmup. 1  2  3
   b. Fluids which collect in the muscles during and after exercise. 1  2  3
   c. Potassium which accumulates in each muscle. 1  2  3
   d. Too much water taken in during the practice. 1  2  3

3. If it is at all possible, the ideal length for trimming the grass on a natural turf playing field would most likely be:
   a. .75" - 1" 1  2  3
   b. 1" - 1.25" 1  2  3
   c. 1.25" - 1.5" 1  2  3
   d. 1.5" - 1.75" 1  2  3

4. A bat with a wide grain and one or two knots would be considered a good investment for a baseball coach.

1  2  3

5. A quick single is hit deep to the first baseman. In the underhand pass made to the covering pitcher, the ball should be held at the base of the fingers with full extension of the throwing arm. Upon releasing the ball, a few short steps following through towards the base will finish the play.

1  2  3

EXHIBIT I
CONT'D
100
EXHIBIT I
CONT'D

6. The most important factor leading to the development of any young baseball player involves the coach's conduct on the field, and, specifically, his rapport with the umpires.

7. In order for a right-handed batter to get a good jump on his start to first base, he must consider:
   a. Getting a good follow through on the swing
   b. Placing more weight over his right foot.
   c. "Throwing" his body in the direction of first base.
   d. Taking his first step (out of the box) with his front foot.

8. What advantage does a batter have in taking a shorter stride in his batting action?
   a. It helps keep the head, shoulders, and hips level for a more even swing.
   b. It enables the batter to swing faster and therefore harder.
   c. It allows the batter to make the transition to running much faster.
   d. It allows the batter a greater range of plate coverage.

9. It is important for the pitcher to practice off-speed pitches as well as fastballs since they are most effective in upsetting the batter's timing and swing.

10. With one out, the bases loaded and a close score, a sharp single is hit straight up the middle. Where should the ball be thrown?
    a. Either home or first base.
    b. Either home or third base.
    c. Second or third base.
    d. Home plate only.

11. On a sure double hit to the right field line and with a runner on first base, the defensive strategy on the field should probably involve cutting-off any runs with a throw to home plate.
EXHIBIT I
CONT'D

12. With no men on base, the shortstop should normally position himself approximately 20 feet to the right of second base and 30-35 feet back of the baseline.

13. On a high pop-up handled by the catcher, the pitcher should cover very closely in case the ball pops out of the catcher's glove.

14. Late in the game, a first and third situation arises with two out and a weak hitter up to bat. One or both of the runners breaks early, forcing the pitcher to step off the rubber, feign a throw to third base and then quickly throw to second ahead of the advancing runner. As the pitcher's coach, you realize that he is attempting to evert a 'force balk' and perform a pick-off at second base.

15. Besides physical preparation, some additional duties of the on-deck hitter might include:
   a. Giving signs to the batter.
   b. Getting equipment out of the runner's way.
   c. Studying the pitcher.

16. In a close game, it is important for the first and third baseman to guard their respective lines for a safe defensive position.

17. The primary task of the first base coach is to:
   a. Guide the runner to first base.
   b. Get the runner to round first (or hold up) with the intent of getting to second base.
   c. Give directions to both runners on first and second.
   d. Give signals to the catcher for plays.

18. In a general practice time outline:
   a. Conditioning should be no longer than 10 min.
   b. Batting practice may often be close to 1 hour.
   c. Group drills are for learning defensive moves.
EXHIBIT I
CONT'N

19. The most important rule(s) to follow in the run-down play is/are:
   a. To avoid obstructing the runner. 1 2 3
   b. To run the runner back to the bag. 1 2 3
   c. To avoid hitting the player while on the baseline. 1 2 3

20. With a runner on second base, a deep single is hit to right field. Assuming there is a question as to whether the play will be at third base or home plate, the pitcher should cover in a position close to third base and react as the play develops. 1 2 3

21. A coach who has a batter hitting too many pop-ups should suggest that the hitter open up his stance slightly and choke up on the bat. 1 2 3

22. In feeding the ball to the shortstop in a double play where the ball is fielded close to the base, a soft lay-up underhand throw would be the most technically correct for the second baseman who is initiating the play. 1 2 3

23. Young catchers should give their signals from the 'squat' position and receive the ball in the 'crouch' position. 1 2 3

24. If a runner is on first and a grounded single is hit to the third base player, that runner going to second base should initially be concerned with:
   a. Breaking up a possible double play. 1 2 3
   b. Beating the throw to second base. 1 2 3
   c. Stopping at second base. 1 2 3
   d. None of the above statements. 1 2 3

25. The hitter at the plate has a count of 2 and 0 with runners at both second and third base. If the team is down by, say, four runs and the game is in late innings, the coach should probably advise the hitter to 'take' the next pitch. 1 2 3
26. Even with a man on first base, the first baseman can move off the bag as soon as the pitcher goes to the plate with his delivery.

27. In terms of catching and throwing, the following hints would be helpful for a coach to give to his/her fielders:
   a. Catch the ball at eye level.
   b. Step into the throw, using a 'crowhop' action.
   c. Have the throwing arm and shoulder cocked back and pointing in the direction of the throw.
   d. The follow through of the arm should be directly in line with the direction of the throw.

28. A pitcher, off the rubber, has a runner frozen between second and third base. In the ensuing rundown, he should only be required to initiate the play and then get out of the action as soon as possible.

29. With the pitcher behind in the count and the opposition ready to attempt a steal, the catcher should probably call for a 'pitch-out' play on the batter.

30. A short flyball is hit to centre field with a runner on third base. Both the centre fielder and shortstop run to catch the pop-up and collide just as the ball reaches their outstretched gloves. If this takes place in the midfield area of the park, who should have called for the ball to be played?
   a. The shortstop.
   b. The centre fielder.
   c. The pitcher.
   d. The catcher.

THANKS FOR YOUR INTEREST AND COOPERATION!
of the test instrument.

Cronbach (1971) states that construct validity can be evaluated by investigating the psychological qualities that a test measures. Thus, by means of a factor analysis, it was possible to determine the degree to which certain explanatory concepts or constructs account for performance on a test such as the BCTQ.

An unweighted least squares method (Christofferson, 1975; Muthen, 1978; Muthen, 1981) was used to factor-analyze the 30 items on the BCTQ. This was accomplished by utilizing SPSSx FACTOR statistical treatment as a computer-based procedure for computing a factor analysis of the items in the BCTQ.

Prior to factor analysis, Bartlett's test for sphericity was calculated to determine whether the correlation of the 30 variables provided an identity matrix of uncorrelated variables. The value of the test statistic, based on a chi-square transformation of the determinant of the correlation matrix, was 685.55. The associated significance of .00000, in combination with this chi-square figure indicated that the correlation matrix was comprised of off-diagonal coefficients of > 0.00 and, therefore, a correlation matrix identity was deemed not likely. This may also indicate that the possibility of obtaining a test
instrument comprised entirely of unique variables i.e., uncorrelated with any other variable(s), is not likely to happen.

A Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was calculated as an index for comparing the observed correlation coefficients to magnitudes of the partial correlation coefficients. Kaiser (1974) notes that measures above 0.50 can be considered as "acceptable" measures of sampling adequacy. In this study, the KMO measure was found to be KMO = 0.51840 and thus, was considered sufficient for use of the factor model.

Table IV (p.107) highlights the initial communality and variance estimates associated with each of the original 30 factors derived from the initial stages of the analysis. The total variance explained by each factor is listed in column EIGENVALUE, in addition to the percentage of total variance attributable to each factor. Of the total variance, 66.8% was attributable to the first 13 factors, with the remaining 17 factors accounting for only 33.2% of the variance.

Tucker, Koopman, and Linn (1969) suggest that only factors accounting for variances greater than 1.0, (i.e., eigenvalue > 1.0), should be included in the factor model (Norusis, 1985). Factors with eigenvalues lower than 1.0 were therefore not included since they
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**TABLE IV**

INITIAL STATISTICS - FACTOR ANALYSIS
were considered to be comprised of only unique variables and, thus would not indicate any linear combination of factors, required for a factor model.

Cattell (1966) suggests the use of a scree plot to identify those factors which are suitable to be included in further analysis (Norusis, 1985). Figure 10 (p.109) shows a distinct break between the slope of the large factors and the gradual trailing-off of the remaining factors. Inspection of the scree indicated that a limit of 13 factors would be sufficient for the purposes of the study.

Following the unweighted least squares factor extraction procedure, communalities for each variable ranged from .16684 to .99900, indicating the amount of explained variance in the common factors. The variance not explained by the common factors was attributed to the unique variable "U". The communalities for the final statistics were different than for the initial statistics, since the variances of the variables were not fully explained when only subset of factors was retained.

A varimax rotation was used as a method to minimize the number of variables with high loadings on each factor. Since the variables were uncorrelated, this orthogonal method was used to transform the initial factor matrix into one which was more easily
interpreted. Table V (p. 114) illustrates the final set of 13 factors and correlated items from the BCTQ. A correlation of > 0.3 in absolute value was set as the cut-off point for correlation coefficients to be included in the factor matrix. Dishman and Ickes (1981) suggest that this level (0.3) is a satisfactory criterion for the deletion of coefficients considered as not contributing significantly to the factor model (Green and Lewis, 1986).

In the mathematical factor model, each variable can be expressed as a linear combination of factors which are not directly observable. In this study, a limit of 13 factors was determined to be significant as contributing to the variance of the variables.

A description of each of the 13 factors extracted relating to the construct of "technical coaching knowledge in baseball" follows:

Factor 1: Baseball Overview

This subconstruct covers three main technical course areas of instructional objectives including technical, philosophical, and administrative considerations.

Factor 2: Batting
This factor is related to batting technique, types of hitters, hitting specific pitches, and the mental aspects of batting. Bunting is also included under the batting subconstruct.

Factor 3: Offensive Strategy

This includes batting order, hit-and-run situations, stealing bases, situations and strategies, other offensive manoeuvres, and coaching the bases.

Factor 4: Biomechanics

Primarily concerned with the biomechanics of hitting and stride technique.

Factor 5: Pitching

This factor involves the mechanics of the throw, types of pitches, pitching with men on base, fielding responsibilities, warm-ups, conditioning the arm, and protection of the arm.

Factor 6: Catching

This includes pre-game preparation, body position,
throwing to the bases, fielding bunts and pop-ups, intentional walks, pitch-outs and tagging runners.

Factor 7: Infielding

This includes the stance, fielding ground balls and catching fly balls, pop-up assignments, and individual assignments.

Factor 8: Coaching Philosophy

This factor is described by coaching tasks, conduct on the field, conduct off the field, rapport with players, and sportsmanship.

Factor 9: Defense

This includes infielding and outfielding responsibilities, situational defenses, relays and cut-offs, defending the steal, defending the hit-and-run, run-and-hit, and pop-up assignments.

Factor 10: Baserunning

Baserunning involves mental aspects, physical technique, taking signals, lead-offs, stealing bases,
Factor 11: Training and Practices

This includes athletic conditioning, warm-ups, spring training, indoor/outdoor workouts, and general practice outlines.

Factor 12: Batting Practice

This factor includes the sub-construct areas of batting and infielding and is most closely related to situations which might be found in a batting practice during the playing season.

Factor 13: Field Position

This is primarily involved with infielding and outfielding positional play.

A comparison of each of the 13 retained factors with those sub-construct content areas outlined in the initial content analysis (Table I, p. 50) revealed that the BCTQ does closely approximate the construct of technical coaching knowledge and its related sub-con structs. Additionally, the extracted factors
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TABLE V
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TABLE V CONT'D
were matched up with the conceptual model of the Level II Technical course in baseball. For example, the factors of batting (Factor 2), offensive strategy (Factor 3), pitching (Factor 5), catching (Factor 6), infielding (Factor 7), defense (Factor 9), baserunning (Factor 10), and field position (Factor 13) are all representative of the "games" sub-construct involved in the Level II Technical course in baseball.

The results of the factor analysis offer evidence, in the form of correlation coefficients, that the construct of technical coaching knowledge in baseball and its related sub-constructs have been adequately measured by the BCTQ.

Knowledge of the factorial weight of each variable provides an indication of the psychological qualities measured by the BCTQ and their relevance to the content and instructional objectives of the BCTQ.

In terms of criterion-referenced testing, the factors derived from the factor analysis provide evidence that certain variables are more relevant than others in developing criteria for performance based on technical coaching knowledge in baseball. Further testing and analysis of the BCTQ is necessary to confirm the accuracy of these factor derivations.
Construct and Criterion Related Validity

The third research question related to validity centred on the ability of the BCTQ to effectively discriminate between and classify each of the three levels (i.e., non-certified, Level I, and Level II) of technical coaching knowledge in baseball.

Discriminant analysis was used to further examine the construct validity of the BCTQ, as well as to determine its criterion-related validity. A three group discriminant analysis was carried out to distinguish between the three different levels of coaching knowledge, based on the 30 test items and 13 specified demographic and coaching related variables in the BCTQ. The stepwise discriminant analysis used in SPSSx, DISCRIMINANT deleted all cases with any missing information. A total of eight cases were deleted, leaving 134 unweighted cases available for use in the discriminant analysis.

Table VI (p. 119) shows the output for the start of stepwise variable selection and lists the criteria in effect. This study used a minimization of Wilks’ lambda where, at each step, the variable with the smallest Wilks’ lambda for the discriminant function was selected for entry into the equation. The maximum number of steps permitted in the analysis was 74. Table VII lists the entry or removal of variables based
on Wilks' lambda and its corresponding level of significance (p. 120).

Table VIII shows the linear discriminant function coefficients or classification coefficients which can be used in the direct classification of cases into one of the three specified levels of technical coaching knowledge (p. 121). These coefficients are useful for predicting group membership of cases having unknown origin. In baseball, these would be coaches who have not taken a NCCP Technical coaching course and therefore have no certified level of coaching expertise.

Table IX (p. 122) offers two sets of unstandardized discriminant function coefficients for the test. Based on these coefficients, it was possible to compute two discriminant function scores for each case, (i.e., one score for each function). Each of the two functions represents a criterion used to determine whether a coach might belong to one of the three identified levels of coaching expertise, based on certain discriminating variables associated with each criterion.

Table X (p. 123) illustrates a summary of the classification results for the test cases. Shown on the diagonal are the number of cases correctly classified into each group from the N=134 sample of coaches. The overall percentage of cases correctly
STEPWISE VARIABLE SELECTION

SELECTION RULE: MINIMIZE WILKS' LAMÉDA

MAXIMUM NUMBER OF STEPS ............... 74
MINIMUM TOLERANCE LEVEL .............. 0.0500
MINIMUM F TO ENTER .................... 1.0000
MAXIMUM F TO ENTER .................... 1.0000

CANONICAL DISCRIMINANT FUNCTIONS

MAXIMUM NUMBER OF FUNCTIONS ......... 3
MINIMUM CUMULATIVE PERCENT OF VARIANCE .......... 100.00
MAXIMUM SIGNIFICANCE OF WILKS' LAMÉDA .......... 1.0000

TABLE VI
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**TABLE VII**

SUMMARY TABLE - ENTRY AND REMOVAL OF VARIABLES

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<td>v4</td>
<td>.9046</td>
<td>.9565</td>
<td>.9335</td>
</tr>
<tr>
<td>v5</td>
<td>37.77</td>
<td>35.55</td>
<td>38.42</td>
</tr>
<tr>
<td>v13</td>
<td>1.961</td>
<td>1.864</td>
<td>1.96</td>
</tr>
<tr>
<td>(constant)</td>
<td>-253.78</td>
<td>-266.20</td>
<td>-268.01</td>
</tr>
</tbody>
</table>

**TABLE VIII**
Fisher's Linear Discriminant Functions (BCTQ)
<table>
<thead>
<tr>
<th></th>
<th>FUNCTION 1</th>
<th>FUNCTION 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>.3431</td>
<td>.1205</td>
</tr>
<tr>
<td>Q2</td>
<td>1.539</td>
<td>-1.278</td>
</tr>
<tr>
<td>I4</td>
<td>.4330</td>
<td>.4025-01</td>
</tr>
<tr>
<td>I6</td>
<td>.3814</td>
<td>.7807-01</td>
</tr>
<tr>
<td>Q10</td>
<td>.1262</td>
<td>-.9957</td>
</tr>
<tr>
<td>I11</td>
<td>.4821</td>
<td>.6466-01</td>
</tr>
<tr>
<td>I14</td>
<td>.3668</td>
<td>.3839</td>
</tr>
<tr>
<td>I16</td>
<td>-.7562</td>
<td>-.6146</td>
</tr>
<tr>
<td>Q17</td>
<td>-.2204</td>
<td>1.187</td>
</tr>
<tr>
<td>I20</td>
<td>.4264</td>
<td>-.1528</td>
</tr>
<tr>
<td>I23</td>
<td>.3961</td>
<td>-.1463</td>
</tr>
<tr>
<td>Q24</td>
<td>-.8392</td>
<td>1.040</td>
</tr>
<tr>
<td>I25</td>
<td>-.3421-01</td>
<td>.3677</td>
</tr>
<tr>
<td>Q27</td>
<td>.1774</td>
<td>.9611</td>
</tr>
<tr>
<td>I28</td>
<td>.3686</td>
<td>.3919</td>
</tr>
<tr>
<td>I29</td>
<td>.4055</td>
<td>.3074</td>
</tr>
<tr>
<td>Q30</td>
<td>2.161</td>
<td>.6197</td>
</tr>
<tr>
<td>V4</td>
<td>.2985-01</td>
<td>.1417-01</td>
</tr>
<tr>
<td>V5</td>
<td>-.6962</td>
<td>-2.091</td>
</tr>
<tr>
<td>V13</td>
<td>-.3955-01</td>
<td>-.6822-01</td>
</tr>
<tr>
<td>(CONSTANT)</td>
<td>-9.289</td>
<td>2.384</td>
</tr>
</tbody>
</table>

**TABLE IX**

UNSTANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS (BCTQ)
<table>
<thead>
<tr>
<th>ACTUAL GROUP</th>
<th>NUMBER OF CASES</th>
<th>PREDICTED GROUP MEMBERSHIP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>NON-CERTIFIED</td>
<td>50</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>(72%)</td>
<td>(12%)</td>
</tr>
<tr>
<td>LEVEL I</td>
<td>42</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>(23.8%)</td>
<td>(57.1%)</td>
</tr>
<tr>
<td>LEVEL II</td>
<td>42</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>(14.3%)</td>
<td>(21.4%)</td>
</tr>
</tbody>
</table>

PERCENT OF 'GROUPED' CASES CORRECTLY CLASSIFIED: 64.93%

TABLE X
CLASSIFICATION RESULTS (BCTQ)
classified was 64.93%. Eighty seven cases were correctly classified into their predicted groups (p. 111).

Non-Certified Coaches: A total of N=36 (72%) coaches were correctly classified, with an additional N=6 (12%) misclassified as Level I coaches, and N=8 (16%) misclassified as Level II baseball coaches. The moderately high percentage of correct classifications indicates that close to 75% of coaches with non-certified status were classified as having no formal NCCP training in their backgrounds. Coaches misclassified as non-certified indicate that even though these coaches may not have taken a NCCP course of instruction in baseball, their level of technical coaching knowledge may be sufficient to place them in one of these two groups of coaching expertise.

Level I Coaches: Level I coaches had the lowest rate of correct classifications, with only N=24 (57.1%) correct. A total of N=10 (23.8%) of the coaches were misclassified as non-certified coaches and N=8 (19%) were misclassified as Level II coaches.

The researcher posits that the fairly low rate of correct classifications for the Level I group indicate that Level I coaches are comprised of a fairly wide
range of baseball coaching expertise, since there are no Level I entry qualifications and no standards or criteria presently set by the NCCP to substantiate the attainment of Level I Technical knowledge in baseball.

The comparatively high percentage of coaches misclassified as Level II (N=8 and 19%) indicates that these Level I coaches have a level of technical coaching knowledge which is higher, (i.e., Level II), than their certified status. It may also suggest that these coaches have had other training or instruction, or that their level of past experience in baseball was more advanced technically than that of their prescribed level.

Level II Coaches: These coaches have all had at least the Level II Technical course in baseball. The moderate percentage (64.3%) of correct classifications for this group (N=43) suggests that a number of these coaches may not have met the criterion technical knowledge level for the course content, as stated in the Advanced Coaching Manual (CAC, 1984a) and Course Conductors' Manual (CAC, 1984b). The remaining 35.7% of the coaches who were misclassified represent a group of coaches who do not meet the criterion for technical coaching knowledge of Level II baseball coaches. However, 64.3% of these coaches originally considered
as Level II were indeed classified into this level suggesting that the BCTQ does adequately measure the construct of "technical coaching knowledge in baseball" for Level II baseball coaches.

In terms of test item construction, the overall correctly classified cases percentage suggests that perhaps the items determined to be the best predictors and/or discriminators for each group were low in numbers and that other more non-discriminating variables were present. Thus, the predictability of the instrument for each of the three levels may have been somewhat negatively affected.

The fourth research question related to validity focused on determining a significant difference in the ability of the BCTQ to discriminate between each of the three levels of technical coaching knowledge. Associated with this research question were statements of the null and alternate hypotheses:

$H_0$: There will be no significant difference in the ability of the BCTQ to discriminate between each of the three levels of technical coaching knowledge in baseball (at the .05 level of statistical significance).

$H_1$: There will be a significant difference in the ability of the BCTQ to discriminate between each of the three levels of technical coaching knowledge in baseball (at the .05 level of statistical significance).
Table XIa (p.129) discusses the significance of the derivation of the two discriminant functions for the three groups of coaches, (i.e., non-certified, Level I, and Level II coaches). For each function, the eigenvalue offers a ratio of between-groups to within-groups sums of squares. The eigenvalue for Function 1 was 0.46907, and for Function 2 the eigenvalue was 0.28370. Canonical correlations for Functions 1 and 2 were 0.56507 and 0.470107 respectively.

Between-groups variability attributable to each of the functions showed that Function 1 had a greater amount of variability accounting for 62.31% of the total variance while Function 2 accounted for the remaining 37.69% of the total variance. The significance level of the observed Wilks’ lambda for both of the functions was based on a chi-square transformation of the statistic. For Function 1, the value of Wilks’ lambda was 0.53026 with an associated chi-square of 77.077 and 40 degrees of freedom. Function 1 was significant at the 0.001 level with a significance of 0.0004, indicating that Function 1 does contribute to differences between the three groups of coaches, (i.e., non-certified, Level I, and Level II coaches), and considered as a criterion for determining placement of baseball coaches into coaching levels.
Function 2 had a Wilks' lambda of 0.77899 and an associated chi-square value of 30.344 with 19 degrees of freedom. Function 2 was less significant than Function 1 with a significance of 0.0476 at the .05 level of confidence. However, this significance does indicate that it may be useful in determining group membership of baseball coaches.

Table XIb (p.129) contains group means for each of the two discriminant functions. Non-certified baseball coaches had a negative mean for Function 1 (- 0.87468) and a positive mean for Function 2 (0.05678). Level I baseball coaches had positive means for both Function 1 (0.59179) and Function 2 (0.62906). For Level II baseball coaches, Function 1 had a positive mean (0.44951) and a negative mean (-.69665) for Function 2.

Based upon observation of the absolute differences between group means for the canonical discriminant functions, the following labels were given to each of the two discriminant functions:

Function 1 = Training vs. Non-Training in Baseball Coaches

Function 2 = Degree of Training in Baseball Coaches
<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>EIGENVALUE</th>
<th>% VARIANCE</th>
<th>% CUMULATIVE</th>
<th>CANONICAL CORRELATION</th>
<th>WILKS' LAMBDA</th>
<th>X 2 DEGREES OF FREEDOM</th>
<th>SIGNIFICANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.46907</td>
<td>62.31</td>
<td>62.31</td>
<td>0.5650658</td>
<td>0.5302651</td>
<td>77.077</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>0.28370</td>
<td>37.69</td>
<td>100.00</td>
<td>0.4701075</td>
<td>0.7789930</td>
<td>30.344</td>
<td>19</td>
</tr>
</tbody>
</table>

TABLE XI A
CANONICAL DISCRIMINANT FUNCTIONS (ECTO)

<table>
<thead>
<tr>
<th>GROUP</th>
<th>FUNCTION 1</th>
<th>FUNCTION 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.87468</td>
<td>0.05678</td>
</tr>
<tr>
<td>2</td>
<td>0.59129</td>
<td>0.62906</td>
</tr>
<tr>
<td>3</td>
<td>0.44951</td>
<td>-0.69665</td>
</tr>
</tbody>
</table>

TABLE XI B
CANONICAL DISCRIMINANT FUNCTIONS EVALUATED AT GROUP MEANS (ECTO)
From evaluating the group means, based on absolute differences, Function 1 best discriminated between non-certified and Level I baseball coaches, (i.e., trained vs. non-trained). Function 2 discriminates best between Level I and Level II coaches, i.e., degree of training.

The null hypothesis (Ho) of no difference relating to the ability of the BCTQ to discriminate between each of the three coaching levels at the .05 level of confidence was rejected and the alternate (Ha) considered, based on the difference in group means for each of the two discriminant functions.

From the canonical discriminant functions it was possible to ascertain that there was a difference in the ability of the BCTQ to discriminate between each of the three coaching levels. Since Function 1 was more significant (p < .001) than Function 2 (p < .05) it is suggested that the BCTQ discriminates best between non-certified and Level I baseball coaches and moderately well between Level I and Level II baseball coaches.

The final research question related to validity concerned the possibility of a significant difference in the ability of the 30 BCTQ test items and 13 BCTQ
demographic and coaching-related variables to discriminate between each of the three levels of technical coaching knowledge in baseball.

The associated null and alternative hypotheses were stated as follows:

Ho2: There will be no significant difference in the ability of the 30 test items and 13 variables in the BCTQ to discriminate between each of the three levels of technical coaching knowledge in baseball (at the .05 level of statistical significance).

Ha2: There will be a significant difference in the ability of each of the 30 items and 13 variables in the BCTQ to discriminate between levels of technical coaching knowledge in baseball (at the .05 level of statistical significance).

Table XII (p. 133) illustrates the standardized coefficients computed to assess the contribution of each variable to the discriminant functions of 'training vs. non-training' and 'degree of training'.

For Function 1, the standardized canonical discriminant function coefficients provided the following algebraic equation:

\[ Y_{\text{trained vs. non-trained}} = 11(.32642) + Q2(.47835) + I4(.26478) + I6(.33138) + II1(.42030) + I16(- .38580) + I20(.42256) + I23(.30338) + I29(.34197) + Q30(.70599) + V4(.30979) \]

The sum of the variables in this equation provides a predictive model for trained vs. non-trained baseball coaches. This model includes the predictor variables of baserunning (II), physical conditioning knowledge
(Q2), batting knowledge (I4), philosophy (I6), defensive strategy (I11) and (I16), pitching knowledge (I20), catching principles (I23) and (I29), outfielding knowledge (Q30), and age of the coach (V4).

For Function 2, the standardized canonical discriminant function coefficients can be mathematically expressed as:

\[ Y (\text{degree of training}) = Q10(-.47150) + I14(-.33007) + Q17(.42496) + Q24(.33279) + I25(.34327) + Q27(.34635) + I28(.36446) + V5(-.46473) + V13(-.55712). \]

The sum of the predictor variables in this equation provides a model for "degree of training". This model includes the predictor variables of outfielding (Q10) and (Q27), pitching knowledge (I14) and (I28), offensive strategy (Q17) and (I25), baserunning knowledge (Q24), sex of the coach (V5) and total score on the BCTQ (V13).

For Function 1, the largest standardized coefficients were associated with the variables of outfielding knowledge, physical conditioning knowledge, pitching knowledge, and defensive strategy. These predictor variables were considered to be the best predictors of trained vs. non-trained baseball coaches.

Degree of training (Function 2) variables with significantly large standardized coefficients included
<table>
<thead>
<tr>
<th></th>
<th>Function 1</th>
<th>Function 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>0.32644</td>
<td>0.11472</td>
</tr>
<tr>
<td>Q2</td>
<td>0.47835</td>
<td>-0.39723</td>
</tr>
<tr>
<td>I4</td>
<td>0.26478</td>
<td>0.02461</td>
</tr>
<tr>
<td>16</td>
<td>0.33138</td>
<td>0.06837</td>
</tr>
<tr>
<td>Q10</td>
<td>0.05976</td>
<td>-0.47150</td>
</tr>
<tr>
<td>I11</td>
<td>0.42030</td>
<td>0.05636</td>
</tr>
<tr>
<td>I14</td>
<td>0.31534</td>
<td>0.33007</td>
</tr>
<tr>
<td>I16</td>
<td>-0.38580</td>
<td>-0.31360</td>
</tr>
<tr>
<td>Q17</td>
<td>-0.07892</td>
<td>0.42496</td>
</tr>
<tr>
<td>I20</td>
<td>0.42256</td>
<td>-0.15142</td>
</tr>
<tr>
<td>I23</td>
<td>0.30338</td>
<td>-0.11206</td>
</tr>
<tr>
<td>q24</td>
<td>-0.26835</td>
<td>0.33279</td>
</tr>
<tr>
<td>125</td>
<td>-0.05194</td>
<td>0.34327</td>
</tr>
<tr>
<td>027</td>
<td>0.06396</td>
<td>0.34635</td>
</tr>
<tr>
<td>I28</td>
<td>0.34281</td>
<td>0.36446</td>
</tr>
<tr>
<td>I29</td>
<td>0.34197</td>
<td>0.25926</td>
</tr>
<tr>
<td>Q30</td>
<td>0.70599</td>
<td>0.20243</td>
</tr>
<tr>
<td>V4</td>
<td>0.30979</td>
<td>0.14714</td>
</tr>
<tr>
<td>V5</td>
<td>-0.15468</td>
<td>-0.46473</td>
</tr>
<tr>
<td>V13</td>
<td>-0.32298</td>
<td>-0.55712</td>
</tr>
</tbody>
</table>

**TABLE XII**

STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS (BCTQ)
overall knowledge (total score), out-fielding knowledge, sex of the coach, and offensive strategy.

Assessing the Contribution of Each Discriminating Variable to Group Placement

In reviewing the group means for each of the functions it was possible to determine and predict into which group coaches were summarily placed in subsequent testing. By comparing the signs (i.e., "+" or "-"), of each discriminating variable with those of the group means for each function, it was possible to "match up" the predictor variables with specified coaching group membership.

For Function 1 (trained vs. non-trained coaches) non-certified baseball coaches were best discriminated by the variables "defensive strategy" and "overall technical knowledge". Level I baseball coaches were best discriminated by the variables "out-fielding knowledge", "physical conditioning knowledge", "pitching knowledge", and "defensive strategy".

For Function 2 (degree of training) Level I coaching placement was best predicted by the variables "offensive strategy" and "pitching knowledge". Level II placement was best predicted by "overall technical knowledge", "out-fielding knowledge", "sex of the coach", "physical conditioning knowledge", and
defensive strategy".

Reliability

The second research objective involved in the development of the BCTQ focused on the reliability of the test instrument.

Reliability estimates were calculated on the BCTQ for a single administration of the test instrument. In determining reliability, the items on the test were not collapsed down to 30, as with the factor analysis and discriminant analysis. Instead, all 63 original items and item responses were included. Nunnally (1967) states that increased test length tends to add to the reliability of a test instrument. Thus, the 30 items were returned to their original 63 sub-scale format in an attempt to determine a more significant reliability estimate.

Cronbach's alpha was calculated for the BCTQ as .6506 and was considered a more than adequate estimation for this test length (N=63). Nunnally (1967) states that a Cronbach's alpha of .50 - .60 represents "modest reliability" for a test in the early stages of development. A total of 65% of the variance in the BCTQ was accounted for by the items while the remaining 35% was attributed to unexplained variance.
In addition to Cronbach's alpha, SPSSx RELIABILITY calculated an equal-length Spearman-Brown coefficient of reliability, measured as 0.6152. In addition, a Guttman split-half reliability estimate, also measuring 0.6152, was deemed significant at the .05 level of confidence.

From the initial reliability estimate (alpha = .6506) the researcher determined that a new predicted reliability of .80 (derived as the square root of the original reliability coefficient) would be sufficient as a new predicted reliability for a length-altered BCTQ test instrument.

Guilford (1954) discusses the Spearman-Brown test length estimate formula as a means of determining the reliability coefficient after a test has been homogeneously altered in length, (i.e., increased in length). The equation for this procedure is:

\[
\frac{n}{rtt (1 - rnn)} = \frac{1}{rnn (1 - rtt)}
\]

where \( n \) = new test length

\( rnn \) = new reliability estimate

\( rtt \) = initial reliability estimate

In this study,
\[ n = 0.80 \left(1 - 0.65\right) = 0.28 \]
\[ 0.65 \left(1 - 0.80\right) = 0.13 = 2.15 \]

It was calculated that the test length must therefore increase by 2.15 times the original length of the test form (N=63) to achieve a reliability of .80. The new items would be of the same quality content, and character, (i.e., complexity and difficulty), as those approximating the original reliability estimate of .65.

It appears that a significant number of new test items would have to be included in the BCTQ in order to sufficiently increase its reliability to .80. A concern arises as to the practicality of the BCTQ, should its test length be increased to over twice its original length.

The standard error of measurement at the .05 confidence level was calculated as + or - 4.87 S.E.M. (standard error of measurement). This estimate was derived from the formula for the standard error of the measurement:

\[ \text{S.E.M.} = \text{S.D.} \sqrt{1 - \text{rtt}} = 8.235 \sqrt{1 - 0.65} = 4.87 \]

Thus, as an index of the extent of dispersion of error components in scores, the standard deviation of scores
an individual might be expected to obtain is 138.79 +
or - 4.8755 s.e.m.
CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the study, a number of conclusions were drawn in relation to the stated research objectives and questions. Based on these conclusions, a number of recommendations for future research were brought forth, as well as practical implications for baseball coaching development.

Conclusions

The following conclusions were made relative to the research objectives and questions in the study:

1. Based on content analyses of the Advanced Coaching Manual and the BCTQ, it was concluded that the test instrument has content validity. The items and constructs presented in the BCTQ are directly related to the content of the NCCP Level II Technical course in baseball.

2. As a result of a factor analysis of the 30 test items in the BCTQ, it was concluded that the test instrument has construct validity. The BCTQ more than
adequately measures the underlying dimensions associated with the construct of "technical coaching knowledge in baseball" as it relates to the Level II Technical course in baseball.

3. In terms of the ability of the BCTQ to effectively discriminate between and classify each of the three levels (i.e., non-certified, Level I, and Level II baseball coaches), it was concluded that the test instrument retains a fair degree of criterion-related validity. The BCTQ significantly discriminates between coaching levels, based on two discriminant function equations (i.e., "training vs. non-training" and "degree of training"). However, the magnitude of this discriminability was not considered strong, prompting the need for more items which are good predictors of Level II Technical coaching knowledge in baseball.

The BCTQ identifies untrained coaches with an accuracy of about 3/4 (72%), but Level II coaches had only 2/3 (64.3%) accuracy and Level I coaches 3/5 (57.1%). It was concluded that untrained or non-certified coaches were identified with more accuracy than either of the trained groups of coaches (i.e., Level I and Level II baseball coaches).

It was further concluded that, at less than 70% classification accuracy, the BCTQ has acceptable
validity but is not yet strong enough for use in accrediting Level II baseball coaches.

4. The items chosen for inclusion in the BCTQ were intended to vary both in their difficulty and discriminability while providing an adequate measure of the criterion "technical coaching knowledge in baseball". Based on a discriminant analysis, it was concluded that certain items are better than other items in discriminating between and within levels of technical coaching expertise (i.e., non-certified, Level I, and Level II baseball coaches).

5. It was concluded that the reliability of the BCTQ (alpha = .6506) following a single administration of the instrument, was a more than adequate estimate for a test length of N=63 test items. In addition, it was concluded that, in order to increase the reliability of the BCTQ (i.e., to alpha = .80), the test length would have to increase by approximately 2.15 times the original BCTQ test length or N=135 test items. The new items would have to retain the same content, difficulty, and discriminability of items as the original BCTQ test items. Thus, it was further concluded that the BCTQ be lengthened only moderately (e.g., N=80 test items) with a predicted reliability of
\( \alpha = .70 \) (1.2 \times \text{original test length}).

6. In general, it was concluded that the BCTQ provides both a valid and reliable measure of NCCP Level II Technical coaching knowledge in baseball. However, it is in need of some minor contextual changes (i.e., an increased number of discriminating items) in order to be considered ready for use by the NCCP.

**Recommendations for Future Research**

The development and evaluation of the BCTQ has presented many avenues for future research and investigation. The following recommendations pertain to future research involving psychometric concerns and research which might be carried out by the NCCP relating to coaching development in baseball and other sport.

**Psychometric Concerns**

1. The validity of the BCTQ, in terms of its ability to discriminate strongly between levels of technical coaching expertise should be improved as a means for better predicting group placement. In addition,
improved criterion-related validity should enhance the usability of the BCTQ as a criterion-referenced test instrument.

2. The BCTQ could be lengthened by means of additional "like" (i.e., similar) positional statements in order to improve on the validity and reliability of the scale. By retaining the 20 questions which were entered into the discriminant analysis and replacing the 10 non-discriminating questions with items of similar construction, it may be possible to better classify coaches into their respective levels of ability.

3. Although the BCTQ has attained a more than adequate level of validity and reliability, the researcher suggests that the BCTQ should be administered to a larger sample of baseball coaches from other Canadian baseball communities in order to confirm the reliability of the test instrument. Standardization of any criterion-referenced test requires test-retest procedures in order to retain greater confidence in the test instrument's ability to accurately predict group membership.
NCCP Research Concerns

1. The researcher suggests that the NCCP, in cooperation with Baseball Canada, should endeavour to adopt the BCTQ as a valid and reliable measure of Level II Technical coaching knowledge in baseball. Following further development. Additionally, it is recommended that the NCCP and Baseball Canada could use the development and evaluation of the BCTQ as a model for future evaluation of coaches at other levels of technical coaching expertise (i.e., Level I and Levels III to V in baseball).

2. It is recommended that the NCCP and Baseball Canada consider the operationalization of the BCTQ as a model for test development in the remaining two NCCP components (i.e., Practical and Theoretical components). The researcher suggests that the BCTQ could serve to enhance the development and evaluation of the Practical component in particular, since this component takes what is learned in the Technical component onto the actual playing field.

3. From a more general perspective, it is recommended that future NCCP research into evaluation for any sport and/or physical activity could make use of the
theoretical and operational models used in the development of the BCTQ to develop similar criterion-referenced tests of a sport-specific nature. The development of a NCCP Level II Technical component coaching knowledge test for the sport of ringette is one such sport-specific example.

4. Future NCCP research could also centre on the development of a battery of technical, theoretical, and practical test instrumentations to be used in a more objective certification process for determining the placement of coaches into appropriate levels of expertise and training.

5. Further research could also be conducted in terms of the accuracy of the course conductors in evaluating coaches with and without the use of the BCTQ.

6. A final recommendation is to consider the degree to which existing coaches can be improved by training (i.e., the Level II Technical course in baseball), and the degree to which various measurement procedures can be combined to assess this improvement with some level of accuracy (e.g., combining Technical and Practical course evaluations into a more comprehensive evaluation of a coach's skills and performance).
Implications for Baseball Coaching Development

This study offers a number of implications for baseball coaching development and general sport coaching development across Canada.

1. The first consideration is that there are many factors involved in the evaluation of technical knowledge and the development of a test instrument to facilitate this evaluation. Test development in a sport-specific environment requires an in-depth understanding of the sport and a responsibility to validity and accuracy of results and instrumentation.

2. With the deletion of questions which are poor discriminators of technical baseball knowledge (i.e., N=10 questions) and the addition of questions which are more contextually and structurally similar to the good discriminators, the BCTQ has the potential to be much more accurate.

In terms of the placement of baseball coaches into appropriate Technical program levels in the NCCP, the BCTQ should prove to be useful if revised to include 40 similarly discriminating questions. It can be used to
place new coaches involved in the NCCP into a level which is most suitable for their level of technical knowledge. For example, it would be useful in justifying the placement of a very experienced coach with no NCCP training into a high Level II Technical course, since he/she may already have the basic technical knowledge required for the Level I Technical course.

The BCTQ may also be used to confirm the placement of a baseball coach within a specified coaching level. For example, the study has disclosed that a number of baseball coaches who were administered the BCTQ had test results which placed them into coaching levels in which they were not predicted to be members. By using the BCTQ, it should be possible to confirm group membership for every coach involved in the NCCP Technical course in baseball. Coaches found to be misclassified (e.g., a Level II coach classified as a Level I coach) could then be given an appropriate level of certification.

The BCTQ could be used in a formative evaluation which follows the coach's learning progress during the entire NCCP instructional sequence.

In terms of certification, the BCTQ could also be used to acknowledge when each coach has achieved a predetermined set of minimum competencies, (i.e., Level
II Technical certification). The BCTQ would be useful in certifying the advancement of a coach to higher levels of Technical coaching expertise in baseball (i.e., from Level II to Level III). The criterion-referenced BCTQ could be used to set standards for certification in Technical baseball coaching levels based on the attainment of a specified criterion requirement for a particular level. The BCTQ is most suited for evaluating the criterion of Level II Technical coaching knowledge in baseball.

In terms of the NCCP, further development of the BCTQ could serve to determine whether the particular modules in the Level II Technical course meet the expectations which were set for that specific component. Consequently, it may then be possible to ascertain which instructional areas of the Level II Technical course require more or less development of resources to meet the Level II expectations of the NCCP for baseball.

3. In summary, the BCTQ has been developed theoretically and operationally to provide a practical model for test development in baseball. This model could be used as a template or blueprint for future testing and evaluation of baseball coaches, including the remaining Technical levels in baseball (i.e., Level
I and Levels III to V), as well as the Practical and Theory components of the NCCP baseball program.
APPENDIX A

Scoring Key - Baseball Coaching Technical Questionnaire

There are 63 items in this scale which have been divided for analysis purposes into either: (1) single response items, with the prefix "I" (e.g., I1); and, (2) composite response items, with the prefix "Q" (e.g., Q2). For each correct response, assign a value of 1 point. For each incorrect or undecided response, assign a value of 0 points.

The following key indicates the correct responses to each positional statement in the BCTQ. After assessing each response, please add up the total raw score for the individual at the top of page 1 in the BCTQ booklet.

I1 (3); Q2a. (3), b. (1), c. (3), d. (3); Q3a. (3), b. (3), c. (1), d. (3); I4 (1); I5 (1); I6 (1); Q7a. (1), b. (3), c. (1), d. (3); Q8a. (1), b. (3), c. (3), d. (3); I9 (1); Q10a. (3); b. (3), c. (3), d. (1); I11 (1); I12 (3); I13 (1); I14 (3); Q15a. (3), b. (1), c. (1); I16 (3); Q17a. (3), b. (1), c. (3), d. (3); Q18a. (1), b. (1), c. (3); Q19a. (3), b. (1), c. (1); I20 (3); I21 (1); I22 (1); I23 (1); Q24a. (3), b. (1), c. (3), d. (3); I25 (3); I26 (3); Q27a. (1), b. (1), c. (1), d. (3); I28 (1); I29 (3); Q30a. (3), b. (1), c. (3), d. (3)
## APPENDIX B

**Level II Baseball**  
**Expert Rating Panel**

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MACKENZIE, BILL  
c/o Baseball Canada  
333 River Rd.  
Tower B, Floor 10  
Vanier, Ont.  
K1L 8H9
APPENDIX C
November, 1985

Dear Baseball Enthusiast;

I am a graduate student in sport administration completing a Masters degree at the University of Windsor. For the past six months I have been working, in cooperation with the Canadian Federation of Amateur Baseball, on the development of a written questionnaire for the Baseball Technical component of the National Coaching Certification Program (NCCP). This five level program is geared towards the educational improvement of sport coaches from all across Canada.

The Baseball Coaching Technical Questionnaire has been designed for the collection of valuable information concerning coaching development in baseball at all levels of experience and expertise, including coaches who may have never taken an NCCP coaching course (e.g., Non-certified, Level I Technical, or Level II Technical coaches).

Since there are a large number of coaches in your area with very diverse coaching backgrounds, your community has been selected as one of three sites (Hamilton, Oshawa/Ajax, and Windsor) for initial distribution of these forms. IF YOU COACH BASEBALL, WE NEED YOUR ASSISTANCE!

Enclosed, you will find 30 technical statements directly relating to the game of baseball and coaching techniques. In addition, a NCCP Coaching Profile Form has been attached to help in obtaining added information on your coaching background. I would appreciate if you would please fill out both sections of this questionnaire and return them to me in the envelope provided as soon as possible. NOTE: This questionnaire is for research purposes only and will not be used in any other capacity. All questionnaire responses will remain anonymous and strictly confidential. Results can be made available to you upon request.

Regardless of your coaching background, your personal insight into the game of baseball is very necessary to ensure the successful completion of this study. Therefore, I am hopeful that you will participate!

Thank you for your cooperation and assistance in this project.

Sincerely,

Caroline Ball

401 Sunset Avenue, Windsor, Ontario, Canada N9B 3P4, 519/253-4232
## APPENDIX D

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Parkerson, J., Lomax, R.G., Schiler, D.P., & Walberg,


VITA AUCTORIS

Name: Caroline Ann Ball

Place and Date of Birth: Charlottetown, Prince Edward Island
July 24, 1961.

Education: B.Ed. University of New Brunswick, 1983
M.H.K. University of Windsor, 1986

Teaching Experience: 1982-83 Physical Education Teaching Intern
Fredericton High School, Fredericton,
New Brunswick.

1983-86 Graduate Teaching Assistant, Faculty
of Human Kinetics, University of
Windsor.

Professional Experience:

1982 Technical Assistant, Ontario Ringette
Association, Ontario Sport Centre.

1983 Administrative Assistant, Ontario
Ringette Association, Ontario Sport
Centre.