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The Relationship between Dental Students' Perception of Basic Science Knowledge and the Clinical Practice of Dentistry

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THE RELATIONSHIP BETWEEN DENTAL STUDENTS' PERCEPTION OF BASIC SCIENCE KNOWLEDGE AND THE CLINICAL PRACTICE OF DENTISTRY

by

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LIFE

The author, Kathlyn Coan McElliott, is the daughter of Neil Francis Coan and Vivian (Nelson) Coan. She was born September 10, 1944, in Flint, Michigan.

Her elementary and secondary education was obtained in the Bendle Public School System, from which she graduated in 1962.

After attending Flint Junior College and Western Michigan University, she entered Columbia University where, in June 1967, she received the degree of Bachelor of Science in Dental Hygiene and, in June 1969, the degree Master of Science in Dental Hygiene Administration and Education.

She joined the faculty of Loyola University of Chicago in 1969 as an instructor in the dental hygiene program. In 1971 she became the Supervisor of the dental hygiene program with the rank of Assistant Professor. Since that time she has continued as the Supervisor of the program, receiving tenure in 1974, and was awarded the rank of Associate Professor in 1977.

She has served as a consultant to the Commission on Accreditation of the American Dental Association from 1971 to 1978 and from 1979 to the present. She was elected a member of Sigma Phi Alpha, the Dental Hygiene National Honor

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CHAPTER I

INTRODUCTION

Few curricular dilemmas have received as much attention as the attempts to apply basic science instruction to the clinical practice of dentistry. Few topics have been discussed in as much depth and from every conceivable approach as that of the relevance of basic science instruction as a part of the dental curriculum. Yet few topics, after lengthy discussion, have remained unsolved and still disputed in terms of the rationale for the existence and correlation of basic science instruction.

Two terms should be defined at this time for comprehension of the problem and the ensuing discussion. The term _basic science_, which will be utilized interchangeably with the term _biological science_, refers to those courses or subjects that relate to scientific inquiry or knowledge solely for its own sake, without concern for clinical or practical application. The basic sciences, as defined in the publication _Dental Education in the United States 1976_[1] published by the American Dental Association (ADA) are:

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[1]American Dental Association, Council on Dental Education [hereafter cited as ADA], _Dental Education in the United States 1976_ (Chicago: American Dental Association, 1977), pp. 44-46.

Anatomy--Gross

Anatomy, Microscopic (General)

Anatomy--Head and Neck

Oral Histology

Biochemistry

Microbiology and Immunology

Pathology--General

Pathology--Oral

Pharmacology

Physiology

The term clinical science can be thought of as the applicability of concepts. The term refers to those courses or subjects that relate to scientific or skills concepts that can be utilized mentally or physically to cause an alteration in the structure, health, or function of tissues usually found within the oral cavity. Clinical sciences, as defined in the ADA publication,[2] are as follows:

Endodontics

Operative Dentistry

Oral Diagnosis

Oral Surgery

Orthodontics

Pedodontics

Periodontics

Prosthodontics--Fixed

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[2]Ibid., pp. 54-56.

Prosthodontics--Removable

Radiology

The subject of basic sciences and their place in dentistry has been discussed and debated in the professional dental literature for well over one hundred years. Several articles concerning the history of dental education indicate that basic sciences were taught in the first dental schools so as to place the practice of dentistry in a position of equality with medicine. Various articles went on to indicate that basic science material was also included to permit the practice of dentistry to develop along biological lines. In 1884 C. S. Harris made the following statement referring to the founding of the Baltimore College:

> The objective of this institution is to give those who receive its instructions a thorough medico-dental education, so that when they enter upon the active duties of the profession, they may be enabled to practice it, not alone as a mere mechanical art, but upon sound scientific principles, as a regular branch of medicine.[3]

Over the years the complexity of clinical dentistry and of the basic sciences has increased, and the extent of the training given in each area bears little resemblance to that given in the nineteenth century.

There appears to be sound justification for inclusion of basic sciences within the dental curriculum. They often represent a source of advancement for dentistry.

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[3]C. S. Harris quoted in John B. Macdonald, "The Role of Basic Sciences in Dental Education," Journal of Dental Education 21 (1957): 17.

Dental disease clearly exists and is costly to treat. The most plausible mechanism for eliminating dental disease is through preventive measures which, in turn, are dependent upon a thorough comprehension of the biological processes involved in health and in dental disease.

In Dental Education in the United States 1976, it was noted that

> concern for each individual patient, as well as recognition of the biological foundation of dental practice, were identified as important parts of the rationale for oral biological concepts and basic sciences teaching. Little that is done in dentistry does not in some way impinge upon the patient's biology.[4]

Thus it would seem that the goal of dental education should be the preparation of a graduate who not only possesses the skills to accomplish the necessary technical procedures, but who can also apply the biological concepts as they are related to the clinical practice of dentistry.

According to Burket, the objective of education should be the preparation of a graduate who

> . . . can practice his profession with an understanding of his patient as a human being. There is no primary interest in developing an anatomist, a chemist, a physiologist or pathologist, but rather clinicians who can intelligently use these sciences when dealing with clinical problems.[5]

Excellent clinicians must have a strong foundation in the basic sciences, and those that have such a background

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[4]ADA, Dental Education, p. 97.

[5]Lester W. Burket, "Correlation of the Biologic Sciences in Clinical Teaching," Journal of Dental Education 21 (1957): 33.

are usually the most zealous advocates of a strong basic science curriculum content. They realize that basic information is the necessary prerequisite for answering "why" and not just "how" which will ensure progress in the clinical fields of dentistry. "A commitment to the basic sciences is not to deny the centrality and the overwhelming importance of training excellent clinicians. Rather, it is the corollary observation that one complements the other."[6]

So it would appear that there are many ways in which the inclusion of basic science instruction in the dental curriculum can be justified: from a philosophical point of view whereby a well-educated, well-rounded individual is the end result; from the point of view that only through science can new breakthroughs in research, both theoretical and practical, advance the science of dentistry; and from the practical point of view in which the completion of clinical procedures must explicitly imply sufficient in-depth knowledge of the human body and its physiological functions so as to ensure the safety and well-being of the body.

Chapter II, Review of Related Literature, explores these viewpoints in detail. Sufficient at this time is the notion that all viewpoints are important, with no one view being considered ultimate. It is the whole of the parts that can justify the inclusion of basic science knowledge in the dental educational program.

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[6] R. Hammond, "Basic Science at Pennsylvania," Pennsylvania Dental Journal 3 (1973): 16.

For the purpose of this study, the subject of basic science instruction as part of the dental curriculum was approached from the practical point of view. Basic science instruction was treated as being part of the dental curriculum so as to enhance the students' understanding and appreciation of the human body, and therefore result in professional health personnel who were well equipped to deal with the biology of the human body during the performance of clinical procedures.

The professional dental literature clearly indicated that a problem exists concerning the integration of basic sciences and clinical experiences. While many would agree that teachers are the key to success or failure of this integration, no consensus has been reached concerning which teacher--the basic science, the clinical science, or both--is responsible.

One school of thought would say that the effective application of basic science knowledge to clinical procedures is the responsibility of the clinical educators. However, proponents declaring that basic science educators must make their subject matter relevant are just as adamant.

Wedged in between both camps and their respective philosophies is one source that usually is overlooked--the student. Shouldn't he, as the recipient of this knowledge, be in a position to offer relevant observations pertaining to the relationship between basic science instruction and clinical procedures?

The problem addressed in this study was to ascertain whether and to what extent a relationship existed between basic science knowledge and the clinical practice of dentistry. Specifically stated, the question was: Is basic science knowledge utilized and applied in the clinical practice of dentistry?

Perhaps the truth of subject matter integration lies in a thorough study of the dental curriculum, the individual courses that comprise the curriculum, the individual lectures that comprise courses, and an overview of how these various aspects fit together. However, such an all-encompassing review may be premature or unnecessary. Initially, the curriculum should be taken as is and put to the test. Is the curriculum meaningful? Does it result in the desired end product? As stated by Dachi,

> Basic sciences have always been meaningful in the general practice of dentistry, because the quality of health care which we can render to our patients depends on our understanding of health and disease processes, as well as the mechanical procedures employed to restore teeth.[7]

There is a recognized need for basic sciences for background information. There is also a need for the correlation of these basic sciences to clinical dentistry, for the correlation of basic sciences to each other, and, just as important, for the correlation of clinical sciences to each other.

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[7]Stephen F. Dachi, "Basic Health Sciences and Correlated Dental Sciences," Journal of Dental Education 29(1) (1962): 360.

How can one determine if the curriculum was successful in meeting school and society goals? Student test scores indicate a grasp of knowledge. But is it a grasp of material achieved through utilization of the material or simply through rote memorization? Clinical procedures being performed by students can be observed and/or graded for their excellence. But can the correlation of related scientific material to the technical procedure at hand be demonstrated and measured?

The student represents the focal point around which a curriculum should be structured. It is not meant that the faculty and administration do not also have valid input. Rather, the beginning is communication with the student and noting his perceptions regarding the curriculum. In this manner existing weaknesses can be identified and misconceptions on the part of the student concerning the worth and value of particular portions of the curriculum can be clarified by the faculty and administration.

Therefore, the question being discussed here cannot be addressed through evaluation of student grades in respective basic or clinical science courses. Nor can the question be answered through a study of the student's clinical procedures. Procedures such as comparing grades or reviewing clinical procedures only indicate the student's ability or inability to perform on a test or complete a clinical procedure. There would be no proof, either visible or measureable, that a relationship did in fact exist between the two areas, basic science course material presented and clinical procedures completed.

The only manner in which the question could accurately be addressed was through asking the dental student how he perceived the relationship. The dental student must be asked whether he applied the basic science instruction he had received when performing clinical procedures. The major limitation that could occur as a result of this procedure was the tendency for the student to offer what he felt would be socially acceptable responses. It was anticipated that this type of response would prove minimal due to the confidentiality of the individual responses.

Hypothesis testing was employed to test the relationship between basic sciences and clinical dentistry. The null hypothesis was:

H_o: There is no relationship between the dental student's perception of basic science knowledge and the clinical practice of dentistry.

H_1: Not H_o

The existence or nonexistence of this relationship was determined by surveying junior and senior dental students from fifty-one of the fifty-nine accredited dental schools in the United States.

In an effort to survey similar schools, the eight dental programs that employed a three-year curriculum or were in a transitory phase from a four-year curriculum to a three-year curriculum, or vice versa, were omitted from this study.

The assumption of homogeneity of individuals within a particular class or institution and the homogeneity between all junior and senior students was based on nationalized admission procedures and standardized curricular patterns that generally exist in all dental programs. A detailed explanation of these assumptions can be found in Chapter III, Methods, pp. 60-61.

This particular study can be defined as ex post facto research due to the inability to directly control the independent variables since they have already occurred.

The structure of the research was that of a field study questionnaire aimed at discovering the relations and interactions among certain variables.

The instrument utilized was a twenty-item questionnaire consisting of five statements in each of four subject categories. The four categories which served as independent variables consisted of the following subject areas:

1. Basic science curriculum
2. Basic science faculty
3. Clinical science faculty
4. Clinical procedures

The sample was asked to react to the statements by selecting one of four responses to each of the statements in all four categories. These student responses served as the dependent variables. Other strategies and procedures regarding the methodologies employed in respondent selection, instrument design, content validity, field testing, and interpretation of the results will be addressed in Chapter III, Methods.

CHAPTER II

REVIEW OF RELATED LITERATURE

The History of Dental Education

"The evolution of the dental curriculum has seen many struggles in arriving at a proper balance between biological, technological, and clinical aspects of dental education."[1] The first formal attempts to teach dentistry in the United States were made in 1837-38. During that time, at the University of Maryland at Baltimore, a dentist, Dr. Horace Heyden, gave a series of lectures on dentistry as a part of the medical school curriculum. "The lectures were not repeated the following year because of lack of interest in, or agreement on, dentistry or dental subjects by the faculty."[2]

Heyden's desire to have dentistry included as part of the medical school curriculum led to a proposal to the medical school faculty that dentistry be included in the curriculum as a specialty of medicine. This request was rejected with the following statement by the medical school

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[1]Reidar F. Sognnaes, "Oral Biology--Its Raison d'Etre," Journal of Dental Education 41(9) (September 1977): 597.

[2]William F. Vann, Jr., "Evolution of the Dental School Curriculum--Influences and Determinants," Journal of Dental Education 42 (February 1978): 66.

faculty: "The subject of dentistry is of little consequence and thus justifies this unfavorable action." This led Heyden and three associates, two of whom were physician-surgeons and one a dentist, to found the Baltimore College of Dental Surgery in 1840. "It is significant that the school was called a college of 'dental surgery' indicating that the founders considered dentistry a subspecialty of medicine."[3]

> The objective of this institution was to give those who received its instruction a thorough medico-dental education, so that when they entered upon the active duties of the profession, they would be enabled to practice it, not alone as a mere mechanical art, but upon sound scientific principles as a regular branch of medicine.[4]

When it opened its doors in 1840, the Baltimore College of Dental Surgery became the cornerstone of institutional dental education in the United States as well as the world's first dental college. The first curriculum, which would serve as a guide for other developing schools, was much like the medical curriculum of the time. It consisted of anatomy, pathology, physiology, therapeutics, and the dental aspects of these disciplines. Clinical dentistry and related principles of surgery were also an integral part of the curriculum.

Gies, seventy-five years after the establishment of dental education, commented as follows about the thoughts of

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[3]Ibid.

[4]John B. Macdonald, "The Role of Basic Sciences in Dental Education," Journal of Dental Education 21 (1957): 18.

the founders:

> When dentistry knocked at the door of medicine and, seeking fellowship, was turned away, the leadership that founded the earlier dental schools, aiming to raise dental practice from the status of a mechanical trade to that of a healing art, endeavored to give it the quality of a branch of surgery. For the attainment of this object, the procedures of the medical schools were closely followed; medical sciences were made the basic subjects in the dental curriculum, although all of the courses were directed sharply to the particular needs of dentistry.[5]

The founders of dentistry therefore considered instruction in sciences as a part of the education necessary to equip a candidate for professional membership.

There were already ten dental schools in the United States when Harvard opened the first university-related dental school in 1863. At that time the medical profession took a dim view of dentistry because of internal problems associated with quackery and apprenticeships. Establishing dentistry as a university discipline had a profound impact on dental curriculum and the profession.

At Harvard the curriculum included anatomy, chemistry, histology, materia-medica, therapeutics, mechanical dentistry, operative dentistry, pathology, physiology, and surgery. In switching to a progressive or graded curriculum, Harvard, in 1884-85, considerably altered the dental curriculum. Students received lectures by medical faculty and were required to pass final examinations. Prior to this

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[5] William J. Gies, "Dental Education in the United States and Canada," <u>Carnegie Foundation for the Advancement of Teaching Bulletin</u> 19 (1926): 115.

time Harvard had a three-year preceptorship associated with the curriculum whereby students would have the opportunity to perfect their clinical skills. Though apprenticeships were still in effect after 1885, the dental school now had a well-established dental infirmary at the Massachusetts Hospital, and students were encouraged to complete their clinical requirements there.

In 1875 the University of Michigan opened the first state university dental school. The curriculum implemented there did not deviate dramatically from that outlined by the Baltimore College earlier.

By the late 1870s all dental schools required attendance of at least two academic years of twenty weeks each. By 1891 the three-year dental curriculum was quite well established, particularly in the university-affiliated schools. However, the newly lengthened curriculum offered little new content, and often students sat through a lecture or demonstration several times.

Though professional training in dentistry was well established at the university level by 1884, it is of note that most of the twenty-eight dental colleges in existence were privately owned. Soon after the founding of the Baltimore College, it was discovered that dental schools could be operated at a profit. As a result, about eighty such schools were organized. As many as 150 schools were established prior to 1920. The mechanical phases of dentistry dominated the proprietary school's curricula due to the generation of income and the fact that the inclusion of a basic science program was an expensive investment from which there was no financial return. As a result, basic sciences were minimized and clinical dentistry was emphasized in proprietary schools.

Around 1885 common concerns of the dental schools led them to form a national organization. The constitution of the National Association of Dental Faculties, chartered in 1884, declared that "the objectives of this association shall be to promote the interest of dental education." From its inception this association influenced the dental curriculum. The curriculum trends initiated at Baltimore, Harvard, and Michigan were modestly recommended for all member schools. In 1894 the association recommended that all member colleges increase the course of study to not less than six months in each year for three academic years. By 1899 detailed requirements were outlined for the three-year course of not less than six months per year. The curriculum further specified certain clinical courses and set aside the third year primarily for clinical dentistry.

> Dental schools operated in the United States for nearly 70 years before any concerted effort was made to standardize the programs. The Dental Educational Council of America was the first extramural agency instituted expressly to evaluate and improve dental education, and to classify and accredit dental schools.[6]

In 1909, when it was organized, the Dental Educational

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[6]Vann, "Evolution of the Dental School Curriculum," p. 68.

Council found the three-year curriculum to be the generally accepted format. In 1914 the council recommended a four-year course of eight months in each year, and the following year the National Association of Dental Faculties also proposed the four-year course of study.

In 1916 the council specified a curriculum that outlined subject matter and time allotments for each subject. The curriculum included a total of 4,400 hours over a four-year professional course of study. In 1918, after reviewing special reports from all schools and hearing the report of a committee that had visited and inspected each school, the council issued its first classification of the dental schools. This classification ranked the schools on their academic and clinical efforts. "Thirteen schools were classified as 'A,' 26 were classified as 'B,' and seven were classified as "C." Two schools did not receive classification."[7]

Through its recommendations, the council greatly influenced the course of the future dental curriculum. In 1918 the council dealt the proprietary schools a serious blow by announcing that a dental school conducted for a profit to individuals or a corporation does not meet the standard of fair educational ideals. The council would not classify such schools in the "A" category.

Initially, pressure from the proprietary schools

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[7]Ibid.

made it impossible to implement this recommendation. But the council continued in its reform efforts and with the refinement of the curriculum. The onset of World War I indirectly dealt the proprietary schools a serious blow.

> In setting up the dental reserve corps in 1918, Congress established personnel qualifications which included graduation from a well-recognized dental college. The Office of the U.S. Surgeon-General, in seeking information from the profession, chose the council as its authoritative source. Thus, it was able to publicly question the professional quality of the dentist with a proprietary school education.[8]

In 1921 Dr. William Gies, a biochemist at Columbia University, conducted the most comprehensive survey of dental education up to that time. Dr. Gies was especially interested in dental education, and his study was the equivalent of the Flexner Report published in 1910 which dealt with medical education. The Gies study, supported by the Carnegie Foundation, was published in 1926 under the title, Dental Education in the United States and Canada. As a result of his study, Gies identified several specific problems in dental education. He proposed a 2-3 plan whereby two years of prescribed college work for admission was followed by a three-year course of dental study. He went on to state that courses should be equal in quality to corresponding medical curriculum courses. "Gies specifically recommended improvement in the teaching of the technical and clinical aspects of dentistry and the more

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[8]Ibid.

specific application of the basic sciences to clinical dentistry."[9] The Gies study and report was of tremendous assistance in bringing the dental schools into the intellectual and scientific environment of the university community. The report also spelled the final doom for the proprietary schools.

In 1923 the American Association of Dental Schools was organized. Like other dental associations, including the National Association of Dental Faculties, it, too, was primarily interested and concerned with the progress of dental education and teaching. From its inception the AADS gave serious attention to problems of curriculum. In 1930 a grant from the Carnegie Commission enabled the AADS Curriculum Survey Committee to extensively study American and Canadian dental school curricula. This was the first attempt by a profession, on a national basis, to outline in detail a course of study in its field. In 1934 the "Report of the Curriculum Survey Committee" was presented to the AADS House of Delegates and was adopted with numerous recommendations dealing with faculty, facilities, students, and curriculum. The four-year course of study with specific subjects was outlined and a request that the 2-4 program be put into effect in the school year beginning in 1937. "The AADS Curriculum Survey committee's report was published in 1935 under the title 'A Course of Study in Dentistry.' It

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[9]ADA, Council on Dental Education, Dental Education in the United States 1976 (Chicago: ADA, 1977), p. 1.

was aimed at outlining a suggested undergraduate curriculum in dentistry."[10]

When the AADS Curriculum Survey Committee's report was completed, the committee decided to prepare a report dealing with the process of teaching with special reference to dentistry. "This task was undertaken by Dr. Lloyd M. Blauch, with support from the Carnegie Foundation. This report resulted in a degree of standardization of dental curriculums which had not existed previously."[11]

The Council on Dental Education, designated as the successor to the Dental Educational Council of America, first met in 1938. It had three representatives from the American Dental Association, the National Association of Dental Examiners, and the American Association of Dental Schools. The council was established as a standing committee of the American Dental Association with its goal being to oversee programs in dental education. It, too, concurred with the concept that dental education should be incorporated as a university-based discipline.

> Even though AADS carefully emphasized that the recommendations contained in the "Report of the Curriculum Survey" were offered only as guidelines, the Council on Dental Education found, in its first survey of U.S. dental schools, a rigid adherence to these recommendations, for reasons not completely clear.[12]

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[10]Vann, "Evolution of the Dental School Curriculum," p. 69.

[11]ADA, Dental Education, p. 1.

[12]Vann, "Evolution of the Dental School Curriculum," p. 70.

In 1940 the Council on Dental Education published its Requirements for the Approval of a Dental School, which was a reflection of the AADS guidelines. However, only two requirements were specifically made. One dealt with the standards for admission, and the other dealt with the range of clock hours that should be considered when setting up the four-year dental curriculum.

In 1958 a national survey of dental schools was undertaken to ascertain trends that had taken place since the 1935 Curriculum Survey Report. As a result of this study, it was found that several subjects, e.g., physics and chemistry, were moved out of the four-year curriculum and were considered prerequisites for dental school; more courses were classified as applied biological sciences. Other trends noted were: clinical dental science courses being offered attempted to emphasize the application of basic science material to clinical practice; a number of special areas of study were evolving into separate fields of study, e.g., periodontics, endodontics, and public health; and there was more emphasis on research and biostatistics in the curricula of the dental schools.

In 1967-68 the Council on Dental Education of the American Dental Association completed another study of dental education and in 1976 completed and published another study which is the most recent to date. The 1976 survey will be discussed in greater detail at a later time. Both surveys dealt extensively with dental curricula including courses, sequencing, clinical instruction, faculty, facilities, and clock hours devoted to the various activities within the dental curriculum.

It would seem readily apparent that the reason for basic sciences being taught in the first dental schools was to place the practice of dentistry in a position of equality with medicine. Published records also indicated that the inclusion of sciences would permit the practice of dentistry to develop along biological lines. With the establishment of the first dental program and the inclusion of instruction in biological sciences, the general pattern of dental education was established, and few major alterations have occurred over the years. The expansion in time of the dental curriculum was to ensure adequate coverage of newer clinical concepts and procedures as they became known and practiced.

According to Macdonald, "One of the purposes of professional education is to provide a basis for growth of professional knowledge. This, by itself, without any consideration of applied basic science, is enough reason to teach basic sciences."[13] He went on to state that

> it may be suggested that this desire to emulate medicine and to correlate biology with the dentistry of that day was not founded on practical considerations related to the dentist's duties toward his patient. Dentistry was a craft and the chasm between the so called theoretical

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[13] Macdonald, "Role of Basic Sciences in Dental Education," p. 17.

> dentistry (basic sciences) and practical dentistry was very wide and very deep.[14]

Through surveys such as those completed by the ADA and from the writings of experienced dental educators, one can see how dental education and its curriculum evolved, often by trends seeming to address the latest thinking, but in truth more often due to longevity and misdirection.

The evolution of the dental curriculum could be likened to the theories of Kuhn and, in particular, his notion of paradigms. Kuhn's fundamental concept in The Structure of Scientific Revolutions is that of "paradigm," which he defined as "a universally recognized scientific achievement that for a time provides model problems and solutions to a community of practitioners."[15] Paradigms are sets of beliefs, ways of thinking about something, or models to offer guidance.

Paradigms serve to guide ordinary scientific practice, which Kuhn labels "normal science." Paradigms guide normal science by giving rules, procedures, and standards by which to conduct and evaluate further research and/or innovations.

> Most normal scientific periods are marked by a lack of debate about fundamentals, a lack of critical spirit. The normal scientist is not a deeply concerned open-minded investigator who is committed to following the

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[14]Ibid., p. 20.

[15]Thomas S. Kuhn, The Structure of Scientific Revolutions (Chicago: University of Chicago Press, 1962), p. viii.

evidence wherever it leads him.[16]

Rather, Kuhn's normal scientist is a puzzle solver who accepts certain presuppositions and rules of procedure without questioning and employs them in an attempt to solve the puzzle.

Occasionally the puzzles which normal science is concerned with resist the efforts of the scientific community to resolve them. When this happens the unsolved problem constitutes a crisis and the paradigm could be in jeopardy. Once a paradigm is in jeopardy, scientists begin to hunt for a new paradigm to resolve the crisis.

Dental education has followed a similar course. The models of dental curricula first initiated were not thoroughly challenged, and investigation of these models often was not followed to the ultimate end with close scrutiny of the various facets involved.

Such puzzles or problems that arose in dental curricula often centered around major concerns such as the inequality of dental education versus medical education, the early continuation of proprietary schools, the length of the curriculum, curricular content, and the methodologies employed to instruct students as well as the increased effort to apply basic science knowledge in the clinical areas. As did other normal scientists, those responsible

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[16]Harvey Siegel, "Kuhn and Critical Thought," Philosophy of Education Annual, 1977, p. 175.

for dental curricular changes accepted certain presuppositions and rules of procedure without question and employed them in an attempt to solve the puzzle without fully investigating the puzzle to its eventual conclusion. If the results of these superficial investigations proved to be unacceptable, new paradigms were initiated.

The changes in dental education over the years should not be seen only in a seemingly negative light. Newly instilled paradigms have often proven to be advantageous and successful. However, caution should be exercised as the curriculum continues to change. Perhaps a more in-depth and exhaustive effort should be made to follow each puzzle to its ultimate conclusion regardless of what the outcomes might mean. For only through such an investigation can true progress be made.

The Basic Science Curriculum

The separateness of the biological and clinical portions of the dental curriculum has been felt for a long time, since there has always seemed to be much in physical and biological sciences which was not directly applicable to the practice of dentistry. Dental educators have, for over twenty years, encouraged the scientific education of the dentist, but not always for the same reasons. Some have visualized dentistry as applied biological sciences and have encouraged the teaching of basic sciences; others have seen the efficient practitioner as the pinnacle of professional achievement and have encouraged the teaching of clinical sciences to be utilized in the daily diagnosis and treatment of patients.

Brightman, in his writings, was interested in ways in which information and ideas taught in biological science in the first two years of dental education could be retained in the minds of students throughout the four years of education and, hopefully, in professional life. He wrote that

> the contribution of this aspect of a dentist's education to his understanding of daily clinical problems and to the confidence with which he handles them is not inconsiderable. Perhaps for this reason the scientific basis of dental education was stressed by its founders. However, this phase of the student's education is usually not considered in any concrete manner once he enters the junior year. Further, it is rarely discussed by dental educators. This lack of attention makes basic science courses particularly vulnerable to criticism from both students and faculty.[17]

Brightman felt that if one believes instruction in basic sciences to be essential to the education of a dentist, one should attempt to demonstrate this significance to both students and faculty. Initially, perhaps, one might attempt to show them that the scientific education given during the first two years is not a separate and completed part of the student's education, and that it can be utilized profitably in the clinical years.

> Many basic science departments give courses to dental students which are inferior in quality and scope to those given to medical students. This is often done on

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[17]Vernon J. Brightman, "Increased Utilization of Basic Science Knowledge for Clinical Problems," Journal of Dental Education 31(1) (1967): 91.

> the grounds that the application to dental practice is less than to medical practice and therefore the dental student does not need as thorough a basic science education. If the basis for education in the biological science is placed on the need for understanding and the need for growth, then there is no justification for abbreviated or superficial courses.[18]

Macdonald stated that training in biological sciences should be equal in scope and quality to that provided to medical students.

While it is true that certain aspects of basic sciences may appear more important to medical students than to dental students, this is not to say that one should receive an education superior to the other. Dental students require more in-depth education in areas such as oral physiology, oral pathology, oral bacteriology, and the biochemistry of dental and oral tissues.

Basic science instruction should acquaint the professional student with important principles found within the several disciplines. Details that follow basic principles should complement these principles and show the way to apply principles regarding specialized instances involved in clinical practice. As Macdonald indicated, only in the specific application of concepts and principles should there be a difference in the basic science courses offered to medical and dental students.

Lefkowitz stated:

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[18]Macdonald, "Roll of Basic Sciences in Dental Education," p. 17.

> Today the major part of the first two years of dental education is devoted to preclinical (basic) sciences. Justification for this division of time can only be made if we examine critically the finished product. Here is an individual who is prepared for dentistry in his time. His development has not achieved its ultimate goal. He had been taught how to think and should not be taught what to think. He is graduated if we are satisfied that he can progress to a higher degree of perfection.[19]

In determining a purpose for the basic sciences in dental education, the future role of the dentist must be considered. If the dentist of the future is going to supervise a dental team of technical assistants, he will require more comprehension of basic scientific concepts than if he were to practice in a manner typical of today.

> Knowledge in nearly every field of basic science has increased tremendously in recent years and continues to increase. Therefore specialists with a depth of fundamental knowledge and an active interest in curricular changes should teach any course of substance.[20]

Adams stated that, in addition to competence in his discipline, the basic science instructor, to effectively teach dental students, must have the respect of his faculty colleagues who are dentists.

> Too often the dental faculty attempts to use the basic scientist merely as a technician rather than to utilize his intellectual skills. They are often asked to help

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[19]William R. Lefkowitz, "What Are the Obstacles in Achieving Correlation of the Basic Sciences with Clinical Practice?" <u>Journal of Dental Education</u> 21 (1957): 21-22.

[20]A. Birk Adams, "The Basic Science Curriculum Problem in Dental Education: Some Causes and Solutions," <u>Journal of Dental Education</u> 40(4) (1976): 231.

> graduate students with certain laboratory procedures related to research, but are not consulted in planning the research. Thus they often find that the procedures to be performed are inappropriate from a scientific viewpoint.[21]

The basic science educator involved in dental education must be committed to his role as a dental educator. He must be given responsibilities and opportunities for professional advancement equal to other dental faculty members so as to assure his commitment to dental education.

The basic scientist, due to his specialized educational preparation, is probably better able than the dentist to teach relationships between basic science and clinical methods. As such, he must also instruct the clinical faculty about the scientific basis for various clinical methods. The clinical faculty can then pass this information on to the dental student.

As stated by Hunt and Benoit:

> The basic scientist can no longer remain remote from clinical dentistry if the educational program is to be effective. The basic scientist must become aware of the problems encountered in clinical practice in order to rationally prepare the student to make sound judgments.[22]

The basic science educator must know the application of his subject matter to dentistry, just as the clinical educator must be able to reflect the basic science aspects

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[21] Ibid.

[22] Lindsay M. Hunt and Peter W. Benoit, "The Basic Science Curriculum: A Major Problem in Dental Education," Journal of Dental Education 39(2) (1975): 108.

in his presentation of treatment methods.

Lefkowitz observed:

> We should seek to produce a graduate capable of educating himself, of keeping abreast of the developments in the profession. Self education requires the broad basic science background presently offered in dental education. In his future years the product of our schools may draw on this reserve force of knowledge so that he may retain professional status and integrity.[23]

Bahn commented that,

> as principles of basic science areas increasingly permeate the clinical sciences, they challenge and stimulate the dental profession because the application of the philosophies and techniques of basic science to dental practice enhances dental progress.[24]

The progress referred to becomes more evident as recent graduates take their newly acquired tools and knowledge into public service. Here they communicate with their fellow dentists; through their combined influence, dentistry should advance.

Realizing that the dental graduate of the future must be prepared to understand and use advances in science, the dental educator must foster a stronger application of basic science knowledge in the clinical practice of dentistry.

How can this increased application be accomplished?

> The basic scientist must consider which fundamental concepts have direct application to clinical dentistry; which are presently indirectly correlated, but clearly

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[23]Lefkowitz, "What Are the Obstacles?" p. 22.

[24]Arthur N. Bahn, "The Basic Scientist in Dental Education," Journal of Dental Education 31(1) (1967): 17.

> will ultimately have a direct effect; and which principles have minimal application for clinical consideration. It is clear that the basic scientist must cultivate an appreciation of clinical dentistry and that he must be familiar constantly with current clinical problems.[25]

For many years dental education was primarily technical in nature. The emphasis was on techniques. Changes in the ratio of time and importance given to the basic sciences versus the clinical sciences has not greatly affected the image of dentistry in the eyes of the public. Many continue to think of dental schools as trade schools. However, today there is a growing tendency to educate the student to be a practitioner of dental health rather than a technician. He is given the bases for understanding the physical, chemical, and biological concepts of dentistry, with emphasis on the biological.

As teachers of biological sciences, the basic scientists should be able to educate the dentist for his future role rather than to prepare him only to meet current minimal standards for dental practice. To meet this challenge, basic science instructors have to eliminate their feelings of frustration with the design of dental school curricula. They will have to strive to make their courses meaningful and relevant. The notion that after two years of basic science instruction the student will finally have the opportunity to practice what he came to school to do must be negated through perceptive instruction that will show the

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[25] Ibid., p. 18.

student that all material and all courses are important to the acquisition of the final product.

> Without the reinforcement of applying what is learned from the basic sciences to patient care settings, without faculty role models demonstrating the application of biologic principles as an integral part of clinical teaching, and until students treat the basic sciences as something other than an obstacle to overcome on the way to the clinic, the idea that correlation is possible remains an illusion. Any curricular revisions that can be effected will fail because basic sciences don't have the same payoff as the clinical portion of the curriculum. The technical requirements of the curriculum will continue to win out.[26]

There can be little incentive to continue study after graduation if there is an inadequate foundation from which to proceed. Thus, in dentistry, basic science means progress. The real reason for teaching basic sciences is to permit understanding and not merely to provide material for correlation with clinical practice.

The Clinical Science Curriculum

> This commitment to the basic sciences is not to deny the centrality and the overwhelming importance of training excellent clinicians. Rather, it is the corollary observation that one complements the other. Excellent clinicians almost always have strong foundations in the basic sciences and . . . are often the most vigorous advocates of increased emphasis on basic sciences. They realize that basic information is the necessary prerequisite for answering "why" questions and the only way to ensure progress in clinical fields.[27]

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[26] Sheldon Rovin, "A Curriculum for Primary Care Dentistry," Journal of Dental Education 41 (April 1977): 179.

[27] R. Hammond, "Basic Science at Pennsylvania: Continuity and Commitment," Pennsylvania Dental Journal 3 (1973): 29.

The basic sciences have been responsible for many modifications in clinical practice. Lefkowitz has indicated that "the greatest obstacle to change is the lack of an in-service training program for clinical instructors. It is here scientific contributions are best integrated into the clinical program."[28] Such an in-service training program could work to serve both basic and clinical science faculties equally well. Science teachers could teach their clinical colleagues and at the same time learn dentistry so as to be more effective dental educators. Conversely, clinical teachers may teach dentistry to basic science teachers and at the same time learn science.

As stated by Brightman:

> There is no need to elaborate on the advantages of a scientific education, because it is usually found that a person who has been educated to think as a scientist can handle certain problems more efficiently than one who has not been so educated. The process of accurate investigation, formation of an hypothesis, and its subsequent experimental testing are well-founded technics, the success of which, paradoxically, is probably responsible for the current dilemma in the selection of appropriate material for biologic science courses.[29]

During any basic science course, students are encouraged to think in an analytical manner about specific problems relating to the material at hand. However, the problems of clinical dentistry do not always receive the same attention during the years of clinical experiences.

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[28] Lefkowitz, "What Are the Obstacles?" p. 24.

[29] Brightman, "Increased Utilization of Basic Science Knowledge for Clinical Problems," p. 91.

Most of the clinical courses deal with the numerous didactic concepts that must be learned in order to be successful in a day-to-day dental practice. As Brightman has observed, "Few clinical faculty members have the time or inclination to make the student think rationally about clinical problems. There is too much didactic material to be given in a short period of time."[30]

"Clinical dental faculty, by virtue of their training, motivation, and experience, should be able to incorporate the basic sciences into their presentations of treatment methods."[31] However, in reality this task is becoming extremely difficult due to the accelerated expansion of oral research and basic science knowledge. In addition, the clinical educator is hampered in his efforts to stay abreast of emerging basic science concepts due to his extremely heavy teaching schedule, often exceeding thirty contact hours of teaching per week. With such a time commitment, something must suffer and the clinical educator is forced to view his teaching as relating to the art and techniques of dentistry rather than to the biological science of dentistry.

Lefkowitz believes the most effective integration of basic science subjects with clinical practice occurs during the years of clinical practice. The student has completed most basic science courses with only minor relation to the

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[30] Ibid.

[31] Hunt and Benoit, "Basic Science Curriculum," p. 108.

practice of dentistry. The acquired information may be revitalized with the surfacing of appropriate clinical situations. However, unless clinical instructors courageously "cross departmental lines from clinical to science subjects, the impetus to student correlation may never arise. If there is to be correlation in the student's mind, it must exist in the clinical teacher's mind."[32] It is in the teaching of clinical dentistry that basic science becomes an applied science. Lefkowitz also believes that since dentistry has advanced from a skill to a skillful science, "it is essential that teachers with basic science training be included in clinical departments. The basic science trained clinical teacher is the key to correlation."[33]

The Structure of the Dental Curriculum

Traditionally, the typical dental curriculum has been horizontal in structure, with concentration on basic science as individual uncoordinated disciplines in the first two years of study; the primary emphasis on clinical science courses and experiences comes during the last two years. This approach often permitted little opportunity for students to integrate and apply basic science knowledge to clinical problems. As stated by Ross, "Students found the delay in clinical exposure discouraging and most basic science

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[32] Lefkowitz, "What Are the Obstacles?" p. 23.

[33] Ibid.

concepts were forgotten when the students encountered the complexities of patient care."[34]

In the document Dental Education in the United States 1976, researched and published by the American Dental Association, total clock hours of instruction in all the various facets of dental education were compiled. From all fifty-nine of the operational dental schools in the U.S. and Canada, fifty-four schools reported total instructional clock hours ranging from 3,500 to 5,500 hours. "The total basic sciences hours reported by each school ranged from a low of 400-479 to a high of 1,983. Forty-six (46) of the 59 schools reported clock hours ranging between 700 and 1,199 hours."[35] A complete distribution of the hours can be seen in Appendix A.

> Hours in the clinical sciences ranged from a low of 376 (reported by a new school in its first year of operation) to a high of 4,528. Forty-two (42) of the 59 schools reported hours in the clinical sciences which ranged between 3,000 and 3,900.[36]

A complete distribution of the hours can be seen in Appendix A.

With the horizontal structure that is still found in most dental school curricula, the student often feels that the basic science courses are "academic hurdles" to be

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[34] Norton M. Ross and Carl O. Davis, "Experiment in Integrated Teaching: Group Problems in Oral Biology," Journal of Dental Education 38 (January 1974): 49.

[35] ADA, Dental Education, p. 43.

[36] Ibid., pp. 43-44.

endured for a length of time, rather than recognizing them as the basics from which a successful practice will rise.

Beginning in the middle 1960s, several dental schools attempted to change their curriculum structure from the traditional horizontal pattern to a vertical or diagonal curriculum whereby basic sciences are offered throughout the entire four years of instruction but in a decreasing pattern over the years. At the same time, clinical sciences are introduced during the first year on a simplified level and continued throughout the entire four years of education, growing steadily in concentration and breadth as the student progresses through the curriculum. This diagonal curriculum proved advantageous to those schools involved in several ways: the student was exposed to clinical experiences earlier thereby allowing him to perfect his techniques to a greater extent, and the integration of basic and clinical sciences provided greater opportunities for application of biological concepts to clinical procedures. According to Ross,

> This approach improved student motivation through earlier clinical experiences and allowed the student to appreciate the impact of biological concepts on clinical procedures. No attempt has been made, however, to correlate the basic science disciplines with each other or with the clinical sciences.[37]

In an effort to show a comparison of horizontal and vertical (diagonal) curricular systems, Tables 1 and 2

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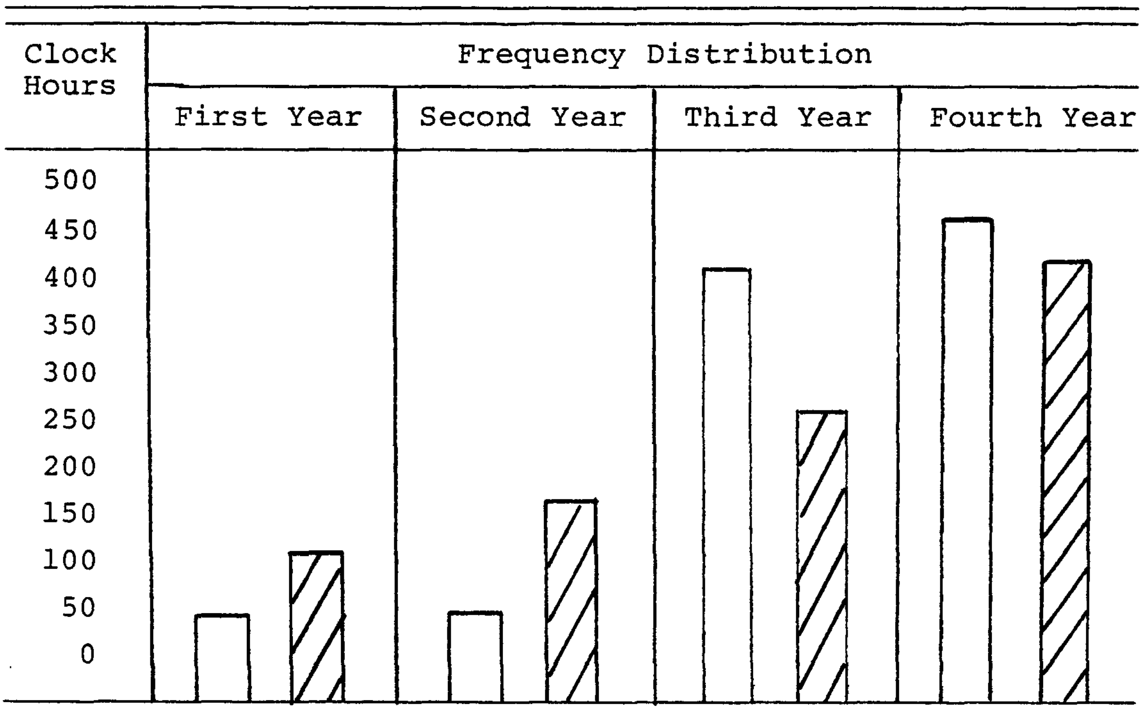
[37]Ross and Davis, "Experiment in Integrated Teaching," p. 49.

TABLE 1

CLINICAL SCIENCE INSTRUCTION

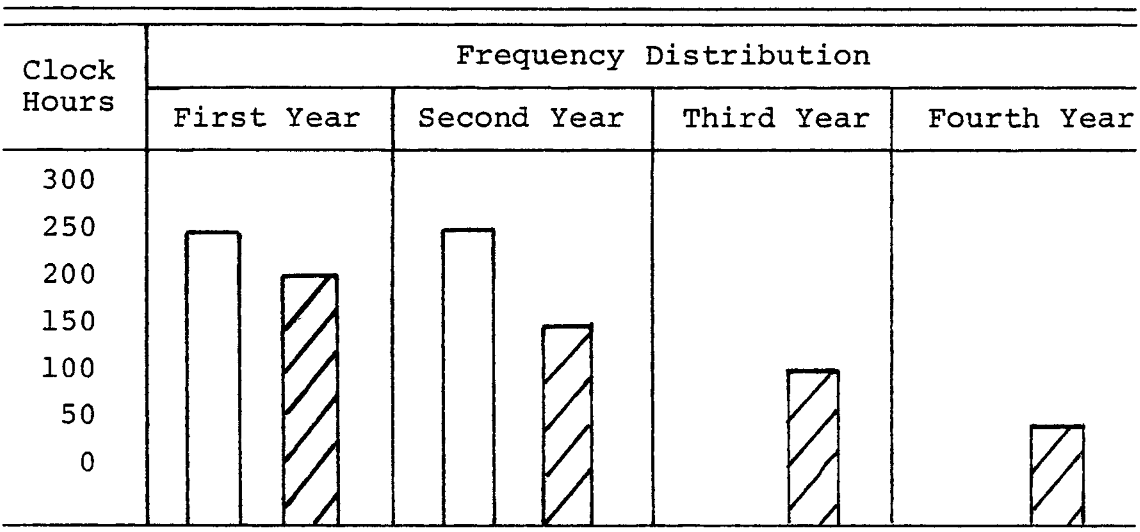


SOURCE: American Dental Association, Council on Dental Education, Dental Education in the United States 1976 (Chicago: ADA, 1977).

NOTE: A solid bar graph represents a hypothetical horizontal curriculum. A crosshatched bar graph represents a hypothetical vertical (diagonal) curriculum.

TABLE 2

BASIC SCIENCE INSTRUCTION



SOURCE: American Dental Association, Council on Dental Education, Dental Education in the United States 1976 (Chicago: ADA, 1977).

NOTE: A solid bar graph represents a hypothetical horizontal curriculum. A crosshatched bar graph represents a hypothetical vertical (diagonal) curriculum.

represent a graphic illustration of how the clock hours in the two areas--basic science and clinical science instruction--might be divided, considering both the horizontal and vertical curricular patterns.

In both tables dental programs are shown to be four-year programs in keeping with the vast majority of dental programs (forty-eight out of fifty-nine programs) as opposed to three-year programs.

When considering clinical science instruction, most schools employing a horizontal pattern offer the vast majority of the clinical instruction during the third and fourth years. Forty-two of the fifty-nine schools reported hours in the clinical sciences ranging from 3,000 to 3,900. Therefore, the clock hours in Table 1 show 450 as the maximum hours per year which represents 50 percent of the total. If the school employed a vertical pattern, clinical instruction is offered throughout all four years with a moderate increase each year.

As stated previously, most dental programs utilizing a horizontal curriculum conclude basic science instruction at the end of the second year. Forty-six of the fifty-nine schools reported clock hours in basic sciences ranging from 700 to 1,199 hours. Therefore, the clock hours in Table 2 show 250 as the maximum hours per year which represents 50 percent of the total. If the school employed a vertical pattern, basic science instruction is offered throughout all four years with a moderate increase each year.

In addition to restructuring the curriculum along diagonal lines, other attempts to increase the correlation between basic and clinical sciences have involved the establishment of what are generally referred to as Departments of Oral Biology. The organization of a Department of Oral Biology can vary. Some dental institutions incorporate the teaching of all basic science courses into this department, as well as the responsibility for the integration of these concepts into the clinical curriculum.

Other programs still offer basic science instruction as separate courses early in the curriculum. Then, during the last two years, courses in oral biology are offered in which reinforcement of basic science background is attempted employing a patient problem-oriented approach.

Many view the Oral Biology Department as a transitional department between the biological and clinical departments.

> The clinical relevance of biological principles must be underscored to the student at every stage of his/her development. Because of the all pervasive character of an oral biological concept of dental practice, it is believed that a separate department is a transitory phase necessary in schools until sufficiently trained faculty can routinely make basic science correlations an integral part of teaching in all clinical departments. This view requires the development of basic science faculty with a clinical orientation and, equally important, clinical science faculty with a basic science orientation.[38]

In a paper entitled The Department of Oral Biology from the Medical College of Georgia, School of Dentistry,

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[38]ADA, Dental Education, p. 96.

it is stated:

> There is agreement that a diagonal arrangement of courses by itself merely provides a better opportunity for integration. The real integration begins to occur when basic science faculty and clinical faculty get together to actively explore the problems of curricular integration.[39]

Sisca states it is no longer acceptable that

students

> . . . view the curriculum as a composite of isolated courses. Instead, if dental education is to narrow the gap between research and patient care, it is mandatory that the basic and clinical disciplines complement each other. It is only through the application of data derived from research that dentistry can validly claim that it is a profession of arts and sciences.[40]

Departments or divisions of Oral Biology have proliferated over the past several years in an attempt to better correlate and coordinate instruction in both basic and clinical sciences. Most of these departments are so structured that they provide some 25 percent of the "basic component" of the basic sciences curriculum and some 40 percent of the oral or "applied component" of the basic sciences curriculum at the individual schools.

Expanding upon the concept that Departments of Oral Biology should perhaps be considered only transitory, the 1976 survey published by the ADA further addressed the

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[39]Medical College of Georgia, School of Dentistry, The Department of Oral Biology (N.p.: Medical College of Georgia, 1978), p. 3.

[40]Roger F. Sisca, "The Triad of Success, A Philosophy in Dental Education," Journal of Dental Education 35 (August 1971): 54.

concept in several recommendations made as a result of the survey. In this survey the issue of correlation of basic sciences with clinical teaching was deemed to be an essential element of the oral biological concept. It was assumed that application of basic science material in clinical teaching should take place during all four years of the curriculum. Some specific mechanisms suggested in the survey were:

1. biochemical conferences involving students and faculty from both the clinical and basic sciences should be scheduled, and be problem oriented and involved with student decision making

2. the use of the examination, evaluation, and planning of the care of the patients as an opportunity to correlate basic sciences with clinical experiences [should be made]

3. day to day explicit application of basic science principles should be made with clinical experiences as a part of clinical teaching

4. preventive dentistry courses and clinical experiences that emphasize the basic science concepts underlying the clinical experience should be offered.[41]

The survey went on to state:

> . . . whether the mixing together of the time sequence in the major instructional areas has resulted in more effective correlation between the basic and the clinical sciences, and the behavioral/social and clinical sciences is still to be determined. The likelihood of improved graduates and better correlations certainly exists but cannot be determined without valid measures of the product in the field.[42]

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[41]ADA, Dental Education, pp. 95-96.

[42]Ibid., p. 109.

Another paper published by the Medical College of Georgia, School of Dentistry, entitled Six Steps to Better Dental Education, states:

> The ideal dentist is a perceptive diagnostician, an effective therapist and a competent craftsman in the technology of his profession. He sees himself, not as an isolated practitioner, but as a key member of an informal health team that includes the physician, nurse, dental hygienist, and others. He views his dental education not as a "fait accompli" but as the acquisition of tools for educating himself in future years. His world of concern extends beyond the oral cavity and includes the total environment of the patient.[43]

Such practitioners do not just happen. They evolve as a product of their training, their environment, and their mental capacity to learn and retain new and relevant knowledge. The dental education they receive is the pivotal point from which these practitioners emerge; and within the educational experience, one area of critical importance is that of basic science instruction.

Studies Concerning the Application of Basic Science Material to the Clinical Practice of Dentistry

Although many dental educators acknowledge that the problem of integrating basic science and clinical teaching does exist, little statistical evidence of this deficiency has been presented in the literature. Three views have been expressed concerning this problem: basic science teachers are responsible, clinical teachers are responsible, and both

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[43] Medical College of Georgia, School of Dentistry, Six Steps to Better Dental Education (N.p.: Medical College of Georgia, n.d.), p. 1.

groups are responsible for the integration and application.

To others, it seemed that an obvious source of information on the need and responsibility for better integration and application had been long overlooked--the dental students. In an effort to determine how the dental students felt about this issue, Collett and Phipps devised a questionnaire that was administered to a cross section of freshmen and senior dental students at the University of Pittsburgh, School of Dentistry.

> Most of the students expressed a need for better integration of basic science and clinical teaching with the proportion increasing from 54% of the freshmen to 89% of the seniors. This general trend of more unfavorable replies by seniors was also true of their evaluation of clinical teaching and their understanding of clinical course material. By contrast, the dental students felt that the instruction received in the basic sciences and their understanding of the course material was about the same when they were seniors as when they were freshmen.[44]

The responses to the questionnaire indicated that the students felt both groups of teachers, basic science and clinical, were at fault for the insufficient application. Sixty percent of the senior students indicated that the need for better application was first noticed during the initiatory clinical (junior) year. This conclusion suggests that the student-patient relation stimulates the student's viewpoint about his inability to integrate basic science knowledge with the clinical practice of dentistry.

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[44]William K. Collett and Grant T. Phipps, "Dental Students' Attitudes towards Integration of Basic Sciences and Clinical Practice," Journal of Dental Education 29(2) (1965): 192.

In 1966 Mackenzie and Bennett utilized the Functional Job Knowledge Test (FJKT) in comparing the biological orientation of dental students at the University of Kentucky --which has a vertical (diagonal) curriculum--with the biological orientation of students of twenty schools, most of which utilized variations of the horizontal curriculum.

> The FJKT is a combination of the critical incident technic and the technic of stimulated recall, and it describes quantitatively the functional knowledge possessed by a group. Essentially, it consists of asking a student to specify the biologic knowledge he used in treating clinical patients.[45]

In addition to the questions asked about specific incidents, Mackenzie and Bennett also asked the students whether they considered the service provided their last patient to be related or unrelated to biological knowledge. The rationale for this particular question was that if a student is impressed genuinely with the relevance of biological sciences in clinical practice, he will expend effort in trying to relate biological knowledge to the service provided. If he is oriented less biologically, he is less likely to attempt to report a relationship.

This procedure is an indirect way of measuring a group's attitude without appearing to ask the question, "Do you feel that biological knowledge is important in dental practice?" As the authors indicated, every student knows

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[45]Richard S. Mackenzie and Ian C. Bennett, "Evaluation of Biologic Orientation of Dental Students at the University of Kentucky," <u>Journal of Dental Education</u> 31 (1967): 71-72.

how he is expected to answer that question. In the indirect approach as used in the FJKT, if a student checked "not related" he was then asked to specify the service provided his last patient. Since the questions were arranged so the student did not avoid work by answering "not related," the main factor that influenced the checking of this item was a response disposition.

When the responses were compared with those dental students surveyed from twenty other dental schools, the University of Kentucky students demonstrated a comparatively in-depth biological orientation. They showed this orientation in (1) their tendency to report the use of biological knowledge, (2) the variety of biological principles used in clinical situations, and (3) the dispersed distribution of these principles. The responses of the Kentucky students to the "last patient" question indicated a relatively favorable attitude for the use of biological knowledge in clinical situations. The answers of the University of Kentucky students to the "last patient" question indicated that the service provided the last patient was reported as unrelated to biological knowledge in only 16.9 percent of the responses; the percentage in the comparison group of twenty other dental schools was 28.5 percent. The Kentucky students ranked second from the top in this tendency to relate biological knowledge to clinical activities.

Conclusion

The problem of the basic sciences in dental education is far reaching. As Hunt and Benoit have so succinctly put it, "This problem encompasses the total aspect of present and future dental practice. The gap between the basic sciences and clinical dentistry can no longer be tolerated."[46]

Patterson explains the degree of stress placed on the quality of instruction in that

> . . . dental education, more than any other, represents the "academic fusion of knowledge and skill." It therefore must be presented in a manner where a constant ratio is maintained, and where biologic concepts are balanced with clinical actualities.[47]

Over the years clinical dentistry and basic sciences have both increased in their complexity and in their interactions. Modern dentistry requires a sound knowledge of histology of the pulp and surrounding tissues, the pharmacologic response of tooth and other tissues to medicaments, the physiology of mastication and growth patterns, pathologic consideration regarding abnormal development of any and all oral tissues, the biochemical effects of food and saliva breakdown and the resulting oral manifestations, as well as the anatomic considerations involved in growth

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[46]Hunt and Benoit, "Basic Science Curriculum," p. 110.

[47]William R. Patterson, "A General Practitioner's Point of View on the Correlation of the Basic Sciences with Clinical Practice," Journal of Dental Education 21 (1957): 14.

in general.

As a result of significant breakthroughs in dental health, basic sciences often represent the difference between a professional education and vocational technical training. It is essential in a time when new scientific knowledge is forthcoming at an ever accelerating pace to decide which topics and information are of significant long-range value to dental students and to incorporate these concepts into the curriculum.

As Sognnaes has stated, "It would appear axiomatic that dental education of today should reflect the best of dental research of yesterday and serve as a sound foundation for dental practice of tomorrow."[48]

There appears to be ample justification for the inclusion of basic sciences in the dental curriculum. Basic sciences often are the source for advancement in dentistry. The term <u>prevention</u> is finally reaching the point of comprehension by all dental patients. Dental disease is costly, and the only true satisfactory solution to dental problems is through prevention. Prevention will emerge as a total comprehensible concept only through a better understanding of the biological processes and principles involved in health and in the disease processes concerning the body, which, after all, does include the oral cavity.

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[48]Sognnaes, "Oral Biology--Its Raison d'Etre," p. 598.

> In private practice, operative dexterity can be achieved by repeated performance, but the discipline of the scientific method based on understanding and intellectual curiosity, can only be instilled during the formative years of undergraduate training.[49]

Several approaches to the problem concerning the application of basic science knowledge to the clinical practice of dentistry have been discussed. Each approach has as its objective the preparation of a well-informed and reasonably skilled graduate who can practice with proper understanding of, and consideration for, the biological foundations of his profession and an adequate background for his continuing professional education.

> All will agree that better correlation of the biologic sciences in clinical teaching will result in a graduate who can practice dentistry with more understanding and intelligence. This can be achieved only when all contributing to the educational program are working towards the same ultimate goal rather than concentrating on departmental aggrandizement.[50]

A. N. Whitehead perhaps summarized the major concept best when he stated:

> . . . The antithesis between a technical and a liberal education is fallacious. There can be no adequate technical education which is not liberal, and no liberal education which is not technical; that is, no education which does not impart both technique and intellectual vision. In simpler language, education should turn out the pupil with something he knows well and something he can do well. This intimate union of theory and practice aids both. The intellect does not work best in a vacuum.[51]

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[49] Patterson, "Correlation," p. 13.

[50] Hunt and Benoit, "Basic Science Curriculum," p. 107.

[51] A. N. Whitehead, The Aims of Education (New York: Macmillan Co., 1929).

CHAPTER III

METHODS

Background

Ever since basic sciences were introduced into the dental curriculum, the problem of their integration into the clinical practice of dentistry has caused considerable concern. As discussed in Chapter II, pages 27-44, three views have been expressed: basic science teachers are responsible for the integration, clinical science teachers are responsible, and both groups are responsible for the integration. As Collett and Phipps so aptly put it: "It is highly probable that in any given month of any given year in some dental school somewhere in America a committee has been working on the problem of better integration of clinical and basic science teaching."[1]

Although many dental educators acknowledge that the problem of integrating basic science and clinical teaching exists, little empirical evidence has been presented. The most comprehensive research to date are the studies undertaken by Mackenzie and Bennett utilizing the FJKT instrument.

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[1] William K. Collett and Grant T. Phipps, "Dental Students' Attitudes towards Integration of Basic Sciences and Clinical Practice," Journal of Dental Education 29(2) (1965): 190.

A detailed account of their work and findings can be found in Chapter II, Review of Related Literature, pages 46-47.

To date there remains no consensus as to how the solution is to be attained. There is no unanimous agreement as to how, when, and to what extent these two curricular areas should be interwoven.

Though little empirical evidence is available, the numerous articles written by dental educators and other allied health educators as well can at least be taken to indicate that concern does exist regarding the relationship between basic science instruction and clinical dentistry.

Authors such as Brightman, Patterson, and Adams believe the basic science instructor is the key to the dilemma. "He must know and relate to the student the manner in which basic science material is to be applied clinically."[2]

Others such as Lefkowitz, Hammond, and Hunt and Benoit feel "clinical faculty, by virtue of their training, motivation, and experience, should be able to incorporate the basic sciences into their presentations of treatment methods."[3]

Several dental institutions, while aware of the

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[2]Vernon J. Brightman, "Increased Utilization of Basic Science Knowledge for Clinical Problems," Journal of Dental Education 31(1) (1967): 91.

[3]Lindsay M. Hunt and Peter W. Benoit, "The Basic Science Curriculum: A Major Problem in Dental Education," Journal of Dental Education 39(2) (1975): 108.

problem, have attempted the solution through curricular revisions. Some institutions have initiated the vertical or diagonal curriculum discussed in Chapter II, Review of Related Literature, in an attempt to achieve better integration of the two areas of instruction. Others, while employing either a vertical or horizontal curricular pattern, have initiated Departments of Oral Biology to bridge the gap between the two areas.

It is not possible in the span of this study to determine which group of educators should take the lead in improving the relationship between basic sciences and clinical dentistry or to determine which type of curricular pattern is most advantageous.

One source of information and opinion that could offer a great deal to the discussion but has usually been overlooked is the dental student himself. Shouldn't he, as the recipient of this education, be in a position to offer relevant observations pertaining to the relationship between basic science instruction and clinical procedures? Little research has been undertaken incorporating the experiences and opinions of the dental student as meaningful variables. This research attempted to study the perceptions and opinions of dental students as the main source by which the hypothesis was tested. Justification for the methodology can be found in Chapter I, Introduction, pages 8-9.

Statement of the Problem and the Hypothesis

The problem considered was the relationship between basic science knowledge and the clinical practice of dentistry. Specifically stated, the question was: Is basic science knowledge utilized and applied in the clinical practice of dentistry?

As stated in Chapter I, Introduction, this particular question could not be addressed through evaluation of student grades in respective basic or clinical science courses. Nor could the question be answered through a study of the student's clinical procedures. The only manner in which the question could accurately be addressed was through questioning the dental student as to how he perceived the relationship. The dental student was asked whether he applied the basic science instruction he received when performing clinical procedures.

The null hypothesis tested was:

H_o: There is no relationship between the dental student's perception of basic science knowledge and the clinical practice of dentistry.

H_1: Not H_o

As Collett and Phipps stated, an obvious source of information on the need and responsibility for better integration has been overlooked, i.e., the dental students. As a result, the subjects utilized in this study were junior and senior dental students from fifty-one of the fifty-nine accredited dental schools in the United States.

Manner of Research

This particular study was defined as *ex post facto*. Despite some inherent weaknesses, much *ex post facto* research has been done in education since education does not often lend itself to experimental inquiry.

> This does not mean that experimental research is necessarily more important or even more frequent in the behavioral sciences. Indeed, it is probably no exaggeration to say that a large proportion of research in sociology, education, anthropology, and political science has been ex post facto.[4]
>
> It can be said that ex post facto research is more important than experimental research. This is, of course, not a methodological observation. It means, rather, that the most important social scientific and educational research problems do not lend themselves to controlled inquiry of the ex post facto kind.[5]

The instrument which was utilized was a twenty-item questionnaire consisting of five statements in each of four subject categories. The four categories which served as independent variables consisted of the following areas:

1. Basic science curriculum
2. Basic science faculty
3. Clinical science faculty
4. Clinical procedures

The students in the sample were asked to react to the statements by selecting one of four responses to each of the statements in all four categories. The student responses

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[4]Fred N. Kerlinger, *Foundations of Behavioral Research*, 2nd ed. (New York: Holt, Rinehart & Winston, 1973), p. 383.

[5]Ibid., p. 392.

then served as the dependent variables.

Instrument Design and Application

The decision to employ a questionnaire as a form of survey research was based on the premise that only by soliciting and quantifying the perceptions of dental students could an accurate analysis of the status of basic science instruction and its application during clinical procedures be made. No amount of time spent comparing a student's background, potential, or academic achievement could result in a rejection or acceptance of the null hypothesis. The null hypothesis dealt with a situation that required personal judgment and perception on the part of the respondent.

The survey was designed to include the four major subject categories with which the null hypothesis was associated. These categories were outlined on page 55. Each category consisted of five statements concerning the major concepts of the particular category.

These statements were all designed from an affirmative or positive point of view so that the respondent would not have to alter his mental approach or comprehension of each statement.

Responses by those completing the questionnaire were of the type used in summated rating scales, e.g., a Likert scale. Each statement had the same four response choices, all of which were of equal attitude value ranging from "strongly agree" to "agree," "disagree," and "strongly disagree." However, each individual's responses were not summed to yield an individual score. Rather, the emphasis was on the individual items or categories and the resulting degree of response from the sample. By selecting samples and studying their responses, one is able to discover the incidence and distribution of the attitudes held by the sample.

In an effort to maximize the return, a letter of introduction addressed to the respective deans was included in each packet of questionnaires. The letter explained the purpose of the questionnaire and encouraged the school to actively participate so that the results, when compiled, could possibly be disseminated to all dental schools and dental organizations in the hope that such information could assist dentistry in the continued improvement of the educational system. The dean of each school then had the questionnaires given to the junior and senior students for their completion, collected the questionnaires, and returned them in one envelope.

Control

The particular type of instrument to be utilized was the mail questionnaire. The mail questionnaire has been popular in education, although it has some weaknesses. Two weaknesses are (1) the possible lack of response and (2) the inability to check the responses given. Responses to mail questionnaires are generally poor, and as a result of low returns valid generalizations often cannot be made. When mail questionnaires are used, every effort should be made to obtain a good return. The inclusion of junior dental students in the sample of interest ensured a larger pool from which a larger response could be expected.

Due to the specialized nature of the particular sample being studied, it was imperative that a large percentage of the survey questionnaires be returned. Two factors assisted in the realization of a large return: (1) all of the questionnaires completed by the students at a particular school were returned in one container that had a return address label and prepaid postage for shipping; (2) the letter of introduction to the dean of each respective dental school explained the purpose most clearly and indicated the possible future assistance the results might render for their particular institution. Several follow-up letters were also sent reminding institutions which had not as yet returned their questionnaires to please do so.

While precise statistical procedures have become more commonplace and the sophistication found in the latest computer programs is well documented, often the success or failure of research lies not in the statistical manipulations completed but in the data utilized in the research. In the preface of his book How to Experiment in Education, McCall said:

> . . . There are excellent books and courses of instruction dealing with the statistical manipulation of

> experimental data, but there is little help to be found on the methods of securing adequate and proper data to which to apply the statistical procedures.[6]

If the data collected are to be of benefit, one must consider several facets of both internal and external validity. Generally speaking, the internal validity of the study was controlled through the administration of the questionnaire only once to a homogeneous sample, asking for individual responses to the statements included in the questionnaire. As for external validity, the fact that all four-year dental programs have been asked to participate makes generalizability feasible.

In an effort to acquire valid and reliable results, the Maxmincon Principle will be applied. This principle is based on certain premises: a particular design is set up that will answer the question of interest; in order to attain valid results, variance must be controlled; and the design employed must be considered a control mechanism.

The particular design employed controls variance by maximizing systematic variance. The systematic variance is that experimental variance found in the dependent variables. These variables should be as different from one another as possible.

The student responses to the various statements which are considered to be the dependent variables will be

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[6]W. A. McCall, <u>How to Experiment in Education</u> (New York: Macmillan Co., 1923).

personal perceptions and observations with no one correct or incorrect response being called for. It is anticipated that any similarities in responses will represent significant data.

Minimizing error variance was accomplished through the selection and utilization of appropriate measurements. Due to the dissimilarities of the four categories and the similarities of statements within each of the categories, certain correlations and mutual factors may result from statistical procedures. As a result, factor analysis and canonical correlation techniques were employed.

The control of extraneous variance relating to the individual respondents was effected through the policies governing admission to U.S. dental schools. Admission to dental school, as with most other health fields, is highly competitive. In 1972 a national application service was introduced to assist dental schools with their admissions programs. The American Association of Dental Schools Application Service (AADSAS) is a central clearinghouse application service that provides participating schools with uniform information concerning an applicant, in a standardized format. At the present time forty of the fifty-nine dental schools use this service as the means by which a potential student can apply to a particular dental school. The computerized printout that a dental school receives on each applicant summarizes considerable academic and nonacademic information on the applicant. Items such as the earned scores on the Dental Aptitude Test (DAT)--a national achievement test including several subject areas--college GPA, college science GPA, college nonscience GPA, schools attended, majors, degrees earned, and extramural curricular activities are all included.

Individual dental institutions using this information and any other criteria that are deemed essential can then select their students from this national pool. Due to the standardized nature of the reported information and the acceptance of the AADSAS program by the vast majority of the dental schools, it would be permissible to assume that there is both inter- and intrahomogeneity among dental students.

The null hypothesis tested involved the student's perception of relationships between two academic areas and the faculty associated with the areas. As a result, the instrument was designed to incorporate these four dissimilar categories.

The literature indicated that there seemed to be a dichotomy between basic sciences and the clinical practice of dentistry. If the dichotomy was the result of dental education, there also was no agreement as to which group of dental educators--basic science, clinical science, or both--was at fault.

Due to the subject dissimilarities between the categories of the questionnaire, and also the different emphasis of particular statements within a category, the content validity of the instrument was established based on existing literature support.

The content validity was established through blueprint designs that incorporated the four separate content areas as well as a representation of all content areas combined with author support. Table 3 is a blueprint design that incorporated all four major subject categories. The tabulations attributed to particular authors indicate which authors, in their published writings, support the subject content of a particular category.

Tables 4-7 are blueprints of each subject category with tabulations indicating author support of specific statements within a particular category.

As can be seen by the numerous tabulations, there was significant support for all items and subject categories as indicated by the published articles cited in the search of existing literature.

Field Testing

The questionnaire was field tested at Loyola University of Chicago, School of Dentistry, in November 1978. Forty students, or approximately 30 percent of the senior class, were randomly chosen to complete the instrument. The major concern of the field test was the comprehensibility and the wording of each statement. Initial study of the student responses indicated that each item was discernible

TABLE 3

CONTENT VALIDITY BLUEPRINT:
AUTHOR-SUBJECT CATEGORIES

Authors	Subject Categories			
	Basic Science Curriculum	Basic Science Faculty	Clinical Science Faculty	Clinical Procedures
ADA survey	X	X	X	X
Adams	X	X		X
Bahn	X			X
Brightman	X	X	X	X
Burket	X			X
Collett and Phipps	X	X	X	X
Georgia, School of Dentistry	X	X	X	X
Gies	X			X
Hammond	X		X	X
Hunt and Benoit	X	X	X	X
Lefkowitz	X		X	X
Macdonald	X			X
Mackenzie and Bennett	X			X
Patterson	X	X		X
Rovin	X		X	X
Sisca	X			X
Sognnaes	X			X

TABLE 4

CONTENT VALIDITY BLUEPRINT: AUTHOR-SUBJECT CATEGORY "BASIC SCIENCE CURRICULUM"

Authors	Statements				
	1	6	10	16	19
ADA survey	X	X		X	X
Burket			X		X
Georgia, School of Dentistry				X	
Gies	X		X		X
Hammond			X		X
Macdonald	X	X	X		X
Mackenzie and Bennett			X	X	X
Patterson	X	X		X	X
Ross				X	
Sisca	X		X	X	X
Sognnaes	X	X	X		X

TABLE 5

CONTENT VALIDITY BLUEPRINT: AUTHOR-SUBJECT CATEGORY "BASIC SCIENCE FACULTY"

Authors	Statements				
	2	8	13	17	20
ADA survey		X		X	
Adams	X	X	X		X
Bahn		X			
Brightman	X	X	X		X
Burket				X	
Georgia, School of Dentistry	X	X			X
Hunt and Benoit	X	X	X	X	X
Sisca	X	X			X

TABLE 6

CONTENT VALIDITY BLUEPRINT: AUTHOR-SUBJECT CATEGORY "CLINICAL SCIENCE FACULTY"

Authors	Statements				
	3	5	9	12	15
ADA survey		X			
Bahn			X	X	X
Brightman	X		X	X	X
Georgia, School of Dentistry	X	X	X	X	X
Hunt and Benoit	X		X	X	X
Lefkowitz	X		X	X	X
Sisca	X	X	X	X	X

TABLE 7

CONTENT VALIDITY BLUEPRINT: AUTHOR-SUBJECT CATEGORY "CLINICAL PROCEDURES"

Authors	Statements				
	4	7	11	14	18
ADA survey	X	X		X	X
Burket	X		X		X
Collett and Phipps			X		
Gies	X			X	X
Hammond	X		X	X	
Macdonald	X		X	X	X
Mackenzie and Bennett	X	X	X	X	
Patterson		X	X	X	
Ross		X			
Sisca	X	X	X	X	X
Sognnaes	X		X	X	

and capable of being rated by all students. As a result of the field test, grammatical improvements were made on several statements. The introductory letter, survey questionnaire, and a summary of frequencies and category means can be seen in Appendices B and C.

For tabulation purposes, the answer choices to each statement were assigned a numerical score: "strongly agree" = 4, "agree" = 3, "disagree" = 2, and "strongly disagree" = 1. Any statement not answered or answered with more than one choice was assigned a numerical value of 0. All numerical ratings were arbitrarily assigned by the investigator after the field test data were collected. Students who participated in the field test were unaware of the ratings and, therefore, were not influenced by scores assigned to each response.

Identification was also made regarding categories to which each statement related. The numbers 1, 2, 3, or 4 found in parentheses after the answer choice "strongly disagree" refer to the subject categories (1) Basic Science Curriculum, (2) Basic Science Faculty, (3) Clinical Science Faculty, and (4) Clinical Procedures.

The final instrument utilized to collect the data can be seen in Appendix D. This instrument is the result of minor refinement of the field test instrument and was professionally printed for neatness and conservation of space as a double-sided sheet.

Selection Criteria Procedures

In 1977 the Council on Dental Education of the American Dental Association published the results of the most recent and complete survey of dental education. The publication, titled Dental Education in the United States 1976, contains the results of an educational survey completed by all fifty-nine operational dental schools in the United States.

> The primary purpose of this study was to gather quantitative and qualitative data and information which would permit an objective and subjective analysis of the curriculum of United States dental schools. The data and information collected should enable the profession to evaluate, on a national basis, the present status of the preparation of dental practitioners by United States dental schools. More importantly, it should permit a more enlightened forecast of the impact of recent changes in curriculums on the quality, quantity, and availability of oral health care for the American public.[7]

This publication is an indication of the current status of dental school curricula and the trends that are indicative of present-day curricular patterns. While accreditation of dental programs requires the inclusion of specific course material and clinical experiences within the educational program, schools are free to and encouraged to experiment with individual innovative programs, patterns, and procedures.

The decision to survey only dental programs that

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[7]ADA, Council on Dental Education, Dental Education in the United States 1976 (Chicago: ADA, 1977), p. 2.

were four years in length as opposed to the three-year programs or transitory programs was made in an effort to ensure parallel homogeneous groups for comparison purposes in the design of this study. No implication was intended that three-year programs were inferior, only that their curricular structure could be quite different.

An initial random selection of twenty-six dental schools was made and questionnaires were sent to these institutions to be completed by the senior dental students. Immediate feedback from several schools indicated that there would be problems. Due to clinical assignments that often place a senior student in an extramural facility during the last several months, not all dental schools would have senior students available to complete the questionnaire. As a result, those schools were requested to survey junior dental students. All of the schools experiencing difficulty in surveying senior students agreed to this change. Several other dental schools indicated that while senior students were still on campus, they were no longer together as a group to complete the questionnaire. Therefore, the questionnaires were distributed to senior students to be voluntarily completed.

Due to these several factors that indicated the response from students at the selected schools would be low, the remaining twenty-five four-year dental programs were also contacted with a request that both junior and senior students complete the questionnaire.

The final sample surveyed was junior and senior dental students at fifty-one accredited dental schools all of whom employed the four-year curricular concept. The decision to utilize both groups of students was a twofold decision: (1) the large sample ensured a larger return thereby resulting in a more reliable test of the hypothesis and more comprehensive results; this decision was justified due to the small return of questionnaires completed by senior students in the initial random selection of dental schools; (2) it was assumed that, for the purpose of this study, both groups represented a homogeneous group and could therefore be grouped together for analysis of their perceptions.

This assumption of homogeneity was based on the curricular structure of dental educational programs. Whether a program employs a horizontal or vertical curriculum pattern, all basic science courses are completed by the end of the sophomore (second) year and therefore also before the administration of the questionnaire. In the late spring of the sophomore year or early fall of the junior year, all dental students must take Part I of the National Board Dental Examinations. Part I consists of the following areas: Anatomic Sciences, Biochemistry, Physiology, Microbiology, Pathology, and Dental Anatomy. Part II, which is usually taken shortly before graduation, includes primarily clinical sciences such as Operative Dentistry, Prosthodontics, Oral Surgery, Pharmacology, Orthodontics, etc. Therefore, both junior and senior dental students would have completed basic science course instruction and be equally qualified to complete the questionnaire.

As for the homogeneity of their clinical background, both groups would have completed at least one year of clinical experience and perhaps more due to vertical curricular patterns and the common use of the summer after the sophomore year for extensive clinical exposure.

As a result of the assumption of homogeneity of the two groups, five additional minor hypotheses could be stated at this time. They are:

1. H_o: There is no difference between the junior and senior dental student and their perception of basic science knowledge and its application in the clinical practice of dentistry.

   H_1: Not H_o

2. H_o: There is no difference between the junior and senior dental student and their perception of basic science curriculum and its application in the clinical practice of dentistry.

   H_1: Not H_o

3. H_o: There is no difference between the junior and senior dental student and their perception of basic science faculty, their presentation of course material, and their expertise in relating their material to clinical procedures and the clinical practice of dentistry.

   H_1: Not H_o

4. H_o: There is no difference between the junior and senior dental student and their perception of clinical science faculty, their presentation of course material, and their expertise in relating basic science material to clinical procedures and the clinical practice of dentistry.

   H_1: Not H_o

5. H_o: There is no difference between the junior and senior dental student and their perception of clinical procedures and the clinical practice of dentistry.

   H_1: Not H_o

Statistical findings concerning the minor hypotheses are discussed in Chapter IV, Results.

As noted, the final sample consisted of junior and senior students enrolled in fifty-one U.S. dental schools during the 1978-79 academic year. Enrollment figures supplied by the Division of Educational Measurement of the ADA indicated that the total enrollment of junior and senior students who were participating in this study was 6,841.

Survey Results

The mixing of junior and senior students was based on the assumption of homogeneity between the two groups. From a statistical perspective, it was possible to apply a more vigorous design since junior and senior dental students were considered together. The assumption of homogeneity of the sample is statistically verified in Chapter IV, Results.

The final sample of 6,841 students consisted of 3,100 juniors and 3,741 seniors. A follow-up letter to all schools that had not responded by May 5, 1979, was sent requesting receipt of their questionnaires or a letter indicating their inability to participate. May 30, 1979, was the final day for receipt of data to be utilized in the study.

Of the fifty-one dental institutions surveyed, nine schools, or 18 percent, wrote to indicate their inability to participate in the study. Therefore, the final data represented forty-two out of the fifty-one programs, or 82 percent of all four-year dental programs and 71 percent of all dental programs in the United States whether they maintained a three-year or a four-year curriculum.

Of the forty-two participating institutions, thirty-two, or 76 percent, returned questionnaires as requested. Ten programs, or 19 percent of the institutions, did not return questionnaires and also did not indicate their inability to participate. However, these ten institutions were still considered in the overall sample.

Table 8 indicates the final tabulations for the sample. The figures indicate the total number of students enrolled in the various classes.

Table 9 shows the student population of the institutions that made up the final analysis which consisted of a sample size of 5,606.

Tables 10 and 11 depict the actual number of returned questionnaires from both the total sample and from the institutions which actively participated in the study.

TABLE 8

JUNIOR AND SENIOR DENTAL STUDENT POPULATION AT ALL ELIGIBLE INSTITUTIONS

School Identification	Junior	Senior	Total
Able to participate	1,813	2,286	4,099
Unable to participate	509	726	1,235
No response	778	729	1,507
Total	3,100	3,741	6,841

TABLE 9

JUNIOR AND SENIOR DENTAL STUDENT POPULATION AT PARTICIPATING INSTITUTIONS

School Identification	Junior	Senior	Total
Participants	1,813	2,286	4,099
No response	778	729	1,507
Total	2,591	3,015	5,606

TABLE 10

RETURNED QUESTIONNAIRES FROM ALL ELIGIBLE INSTITUTIONS

Student Year	Eligible Participants	Questionnaires Received	%
Junior	2,591	1,045	40
Senior	3,015	1,058	35
Total	5,606	2,103	38

TABLE 11

RETURNED QUESTIONNAIRES FROM PARTICIPATING INSTITUTIONS

Student Year	Participants	Questionnaires Received	%
Junior	1,813	1,045	58
Senior	2,286	1,058	46
Total	4,099	2,103	51

Statement of Hypothesis

The major hypothesis that was tested is as follows:

H_o: There is no relationship between the dental student's perception of basic science knowledge and the clinical practice of dentistry.

H_1: Not H_o

Construct Validity of Testing Instrument

Due to the dissimilarities found between the four major content categories in the instrument and the inability to construct the various statements so that they were parallel in form and meaning, many specific statistical procedures were not applicable.

The most appropriate statistical procedure to utilize in proving construct validity was factor analysis. This is a procedure for determining the number and nature of the constructs (factors) that underlie a particular set of variables. In this manner factor analysis attempts to provide a simpler explanation of the constructs that underlie measures of variables than would be provided by keeping all measures intact. Factor analysis is a technique that attempts to describe these underlying constructs. If two or more variables correlate highly, it is very likely that they share a common construct or factor. Therefore, factor analysis can identify and determine the extent to which variables are related and the number and magnitude of the factors that are identified as underlying the set of variables.

The instrument utilized in this study consisted of twenty statements all relating to the process of dental education and, in particular, the relationship between basic science instruction and clinical procedures performed by the dental student. The twenty items were written in a manner to encompass the four major subject categories of interest in this study. The four subject categories were:

1. Basic science curriculum
2. Basic science faculty
3. Clinical science faculty
4. Clinical procedures

There are two major uses of factor analysis: in an exploratory way and in a confirmatory way. This particular study involved confirmatory factor analysis which was used to test the goodness of fit between the model and the data. In addition, confirmatory factor analysis was used to confirm or to refute the hypothesis that was tested by the data as a result of the instrument's implementation. In this way factor analysis was used to establish the construct validity of the instrument to determine if the instrument did indeed measure four subject categories.

In this study there were twenty items or variables that were considered and supposedly four factors, those represented by the four subject categories. Each factor was to represent an area of generalization that was qualitatively distinct from that represented by any other factor.

Each of the four subject categories was to be an area qualitatively different where relatively little generalization could be made from one area to another and each could stand alone as a separate factor.

Since factor analysis indicates which tests or measures belong together and virtually measure the same thing, it is understandable to reduce the number of variables and locate and identify the fundamental factors underlying the tests and measures.

There were two basic questions to be answered: How many underlying factors were there? What were these factors? Computer calculations involving the study of interest indicated several factors, five of which were of significant value to be identified. Appendix E, subsection I, shows the Eigenvalues and percentages of variance associated with the twenty factors. It is generally assumed that an Eigenvalue less than 1.0 is not significant and should not be considered as a major factor. As can be seen in Appendix E, subsection I, one factor is especially strong and accounts for 33 percent of the variance associated with the twenty items.

Factor Matrices and Factor Loading

If a test measures one factor only, it is said to be factorially pure. If a test measures only one factor, it is said to be loaded on the factor. Many tests and measures are factorially quite complex with several factors underlying the measures of interest.

According to Gorsuch,

> Within an area where data can be summarized, i.e., within an area where generalization can occur, factor analysts first represent that area by a factor and then seek to make the degree of generalization between each variable and the factor explicit. A measure of the degree of generalizability found between each variable and each factor is calculated and referred to as a factor loading.[8]

Appendix E, subsection II, represents a factor matrix that expresses the relations between the twenty items and the five major underlying factors. The entries depicted under each factor are the factor loadings. Like correlation coefficients, these loadings range from -1.00 to +1.00. As do correlation coefficients, they express the correlation between the items and the factors. The further the loading is from 0, the more one can generalize from factor to the variable. Comparing loadings of the same variable on several factors provided information concerning how easy it is to generalize to that variable from each factor.

Varimax Rotation

The basic factor analysis method utilized was that of the principal factors method. The major solution feature of this method is that it extracts a maximum amount of variance as each factor is calculated. As can be seen in Appendix E, subsection I, the first factor extracted the most variance, the second the next most variance, and so on.

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[8]Richard L. Gorsuch, Factor Analysis (Philadelphia: W. B. Saunders Co., 1974), p. 2.

Most factor analytic methods produce results in a form that is difficult to interpret. In order to interpret factor matrices adequately, they must be rotated.

> A principal factors matrix and its loading account for the common factor variance of the test scores, but they do not in general provide scientifically meaningful structures. It is the configurations of tests or variables in factor space that are of fundamental concern. In order to discover these configurations adequately, the arbitrary reference axes must be rotated.[9]

In this way the simplest possible interpretation of the factors can be achieved. Rotation to achieve simple structure is considered to be an objective way to achieve variable simplicity and to reduce variable complexity.

On a set of axes designed to pictorially represent all measures of interest, measures that are highly correlated would be expected to be close together and those uncorrelated to be far apart. As a result of plotting the measures, groups of points would emerge. If a set of axes were inserted into this space, then any point could be located by its coordinates on the axes. Factor analysis requires fitting the axes to the groupings of points in the "best" possible manner. This "best" manner requires that the fit account for a maximum amount of the variances of the tests, which is accomplished by rotation of the axes so that they come closer to going through the groupings of points.

Rotated data and statistical analysis are discussed in Chapter IV, Results.

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[9]Kerlinger, Foundations of Behavioral Research, p. 671.

Canonical Correlation

While multiple correlation involves a single criterion variable that is correlated with a group of predictor or independent variables put together in a linear combination, canonical correlation can go one step further. It can indicate a multiple correlation of K_1 independent variables and K_2 dependent variables. As a result of canonical correlation, the focus of the correlation coefficient is on describing the relationship between two traits, one in each set of variables.

In this study two sets of variables have been assembled to observe if a relationship does exist between them. These two groups of variables consist of the dependent variable "basic science knowledge" and the independent variable "clinical procedures."

The dependent variable consists of the ten items from the instrument that relate to basic science knowledge, namely, the statements concerning Basic Science Curriculum and those relating to Basic Science Faculty. It was permissible to combine these two subject categories since statements relating to Basic Science Faculty were of a form that explored the efforts of basic science faculty members to offer their subject matter in a manner that allowed the student to utilize the basic science material in clinical situations.

Likewise, the independent variable consists of the statements dealing with Clinical Procedures and Clinical Science Faculty. Again, it was permissible to combine these statements as the statements relating to Clinical Science Faculty were of a form that explored the efforts of clinical science faculty members to relate basic science information to appropriate clinical situations.

Ten variate sets were possible to generate ten canonical correlation coefficients. Each coefficient was an index of the relationship between a construct in one set of variables and a related construct in the other set of variables.

The null hypothesis was tested utilizing the canonical correlation statistical procedure. Results of this statistical procedure as well as a discussion of the canonical variates is discussed in Chapter IV, Results.

CHAPTER IV

RESULTS

Summary of Study

Although many dental educators acknowledge that the problem of integrating basic science and clinical procedures exists, little empirical evidence has been presented. Though little empirical evidence is available, numerous articles written by dental educators and other allied health educators as well can at least be taken to indicate that concern does exist regarding the relationship between basic science instruction and clinical dentistry.

One source of information and opinion that could offer a great deal to the discussion but was usually overlooked or ignored was the dental student. Shouldn't he, as the recipient of this education, be in a position to offer relevant observations pertaining to the relationship between basic science instruction and clinical procedures? This study employed the perceptions and opinions of dental students as the main source by which the hypothesis was tested.

The manner in which this hypothesis was tested was in the form of a survey sent to junior and senior dental students enrolled in U.S. dental schools. The students were asked to react to twenty statements attempting to ascertain whether and to what extent a relationship existed between basic science knowledge and the clinical practice of dentistry. Specifically stated, the hypothesis question was: Is basic science knowledge utilized and applied in the clinical practice of dentistry? All twenty items were declarative sentences written from the affirmative point of view. Student responses were similar to a Likert scale in that the student was asked to react to each statement through one of four answer choices running from "strongly agree," to "agree," "disagree," and "strongly disagree."

The twenty items were further broken down into four subject categories, each containing five items. The four subject categories were:

1. Basic science curriculum
2. Basic science faculty
3. Clinical science faculty
4. Clinical procedures

Homogeneity of Students

To statistically prove the homogeneity of the sample made up of junior and senior dental students, both the total responses and the responses to the items within each subject category were analyzed using analysis of variance procedures. Tables 12-16 are designed to show the criterion variables for both total and the four subject categories with a coding of "1" indicating junior dental students and "2" indicating senior dental students.

The F values for all five tables are shown at a level of significance specific for that individual F-value calculation. It is generally assumed that for a population of this size, an F value of 2.00 or greater would be needed as an indication of significance. The level of significance utilized for all five ANOVA calculations was .05.

The F value seen in Table 12 representing the criterion variable total for all items indicated that there was no significant difference between the two groups and the responses on all of the items combined. Therefore, it could be stated that both junior and senior students were homogeneous with regards to all subject categories and no significant difference was apparent between the two groups as to their answer choices.

At a level of significance of .05, the F value for Basic Science Curriculum as seen in Table 13 would be significant. However, the significance of even this F value could be questioned due to the very close similarities of mean scores for both junior and senior dental students.

Table 14 indicates the criterion variable for the subject category Basic Science Faculty. At the .05 level of significance, there was no significant difference between the groups in their responses.

Table 15 indicates the criterion variable for the subject category Clinical Science Faculty. At the .05 level of significance, there was no significant difference between the groups in their responses.

TABLE 12

TOTAL CRITERION VARIABLE FOR ALL ITEMS

Code	Mean	SD	Sum of Sq.	N
1 (jr.)	2.4876	0.3792	150.1518	1,045
2 (sr.)	2.5171	0.3994	168.6326	1,058
Within gr. total	2.5025	0.3895	318.7844	2,103

Analysis of Variance

Source	SS	DF	Mean Sq.	F	Sig.
Between gr.	0.460	1	0.450	3.029	0.0819
Within gr.	318.784	2101	0.152		

TABLE 13

CRITERION VARIABLE FOR SUBJECT CATEGORY "BASIC SCIENCE CURRICULUM"

Code	Mean	SD	Sum of Sq.	N
1 (jr.)	2.7710	0.3971	164.6656	1,045
2 (sr.)	2.8066	0.4008	169.7987	1,058
Within gr. total	2.7889	0.3990	334.4642	2,103

Analysis of Variance

Source	SS	DF	Mean Sq.	F	Sig.
Between gr.	0.665	1	0.665	4.175	0.0412
Within gr.	334.464	2101	0.159		

TABLE 14

CRITERION VARIABLE FOR SUBJECT CATEGORY
"BASIC SCIENCE FACULTY"

Code	Mean	SD	Sum of Sq.	N
1 (jr.)	2.1996	0.4848	245.3957	1,045
2 (sr.)	2.2328	0.5214	287.3117	1,058
Within gr. total	2.2163	0.5035	532.7074	2,103

Analysis of Variance

Source	SS	DF	Mean Sq.	F	Sig.
Between gr.	0.579	1	0.579	2.283	0.1310
Within gr.	532.707	2101	0.254		

TABLE 15

CRITERION VARIABLE FOR SUBJECT CATEGORY
"CLINICAL SCIENCE FACULTY"

Code	Mean	SD	Sum of Sq.	N
1 (jr.)	2.2796	0.5239	286.0332	1,043
2 (sr.)	2.3069	0.5319	299.0492	1,058
Within gr. total	2.2934	0.5280	585.0824	2,101

Analysis of Variance

Source	SS	DF	Mean Sq.	F	Sig.
Between gr.	0.390	1	0.390	1.401	0.2368
Within gr.	585.082	2099	0.279		

Table 16 shows the criterion variable for the subject category Clinical Procedures. At the .05 level of significance, there was no significant difference between the groups in their responses.

TABLE 16

CRITERION VARIABLE FOR SUBJECT CATEGORY "CLINICAL PROCEDURES"

Code	Mean	SD	Sum of Sq.	N
1 (jr.)	2.7005	0.4753	235.8745	1,045
2 (sr.)	2.7217	0.4871	250.5412	1,057
Within gr. total	2.7112	0.4813	486.4157	2,102

Analysis of Variance

Source	SS	DF	Mean Sq.	F	Sig.
Between gr.	0.236	1	0.236	1.020	0.3126
Within gr.	486.416	2100	0.232		

As a result of the five one-way analysis of variance procedures seen in Tables 12-16, all five of the minor hypotheses were accepted. The homogeneity of the sample was statistically proven.

Test Instrument Results: Construct Validity

The statistical procedure utilized in proving construct validity of the testing instrument was factor analysis.

Factor analysis attempts to provide a simpler explanation of the constructs (factors) underlying a set of measures than is provided by keeping the measures intact. It is a descriptive technique by which one attempts to describe the constructs that underlie a set of measures. The major use was as a confirmatory process to test the goodness of fit between the instrument and the resulting data.

The two basic questions that were to be answered were: How many underlying factors were there? What were these factors? The instrument was designed to encompass four subject categories, each of which contained five of the twenty statements that made up the instrument.

Initial Eigenvalues and percentages of variance associated with the twenty items can be seen in Appendix E, subsection I.

Since most factor analytic methods produce results in a form that is difficult to interpret, Varimax rotation was completed on the initial factor analysis data. Rotation to achieve simple structure and the simplest possible interpretation of the factors is considered to be an objective way to achieve variable simplicity and to reduce variable complexity.

As shown in Appendix E, subsection I, five major unrotated factors were identified with Eigenvalues of 1.00 or higher. Table 17 shows these same five factors with rotation having taken place. The first factor was

TABLE 17

ROTATED FACTORS

Factor	Eigenvalues	Pct. of Var.	Cum. Pct.
1	6.09706	67.8	67.8
2	0.87771	9.8	77.6
3	0.89746	9.0	86.5
4	0.75370	8.4	94.9
5	0.45633	5.1	100.0

considerably stronger than the other four and, in fact, the final factor after rotation became weaker by comparison to when viewed on the unrotated data. The instrument was not factorially pure as more than one factor was identified, although one factor stood out as representing a much greater percentage of variance than any other factor. To have several factors was in keeping with the original instrument design where there were to be four major factors representing the four subject categories.

Table 18 depicts the twenty separate items and the established rotated communality. As defined by Gorsuch,

> Communality of a variable is that proportion of its variance which can be accounted for by the common factors, i.e., a communality of .75 = variance of variable as reproduced from only the common factors would be three-fourths of its observed variance.[1]

The communality computed for all items as seen in Table 18 would seem to indicate than ten variables, or

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[1]Richard L. Gorsuch, Factor Analysis (Philadelphia: W. B. Saunders Co., 1974), p. 26.

one-half of the items, show the proportion of variance of the item accounted for by the five major factors at the fiftieth percentile level or higher. An additional five items show variance proportion at least at the fortieth percentile level. One could conclude that the factors involved did account for a significant proportion of the variance associated with the twenty items.

TABLE 18

ROTATED COMMUNALITY OF VARIABLES

Variable	Communality	Variable	Communality
1	0.18655	11	0.45727
2	0.51009	12	0.60749
3	0.30658	13	0.26118
4	0.42410	14	0.54250
5	0.48792	15	0.63337
6	0.04190	16	0.40173
7	0.50116	17	0.68092
8	0.50563	18	0.32117
9	0.58072	19	0.57499
10	0.45684	20	0.51028

When considering factor loadings, a coefficient of .40 or higher is often considered significant. As can be seen in Table 19, ten of the twenty items had high loadings identified with a unique factor. Eight additional items evidenced factorial complexity with moderate loadings on two factors. Only two items (1 and 6) showed no generalizability between the item and any factor.

TABLE 19

VARIMAX ROTATED FACTOR MATRIX

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
1	0.07288	0.39453	0.12727	-0.08398	0.04833
2	0.27300	0.62842	0.03163	0.18931	0.06174
3	0.41104	0.34159	-0.03869	0.01404	0.13876
4	0.39144	0.24849	0.37745	0.12863	0.22386
5	0.62251	0.18870	0.17850	0.13756	0.11833
6	0.04506	0.14019	0.02259	-0.13992	0.01127
7	0.12276	0.04005	0.15283	0.01374	0.67892
8	0.26782	0.13629	0.18588	0.60952	0.09715
9	0.71804	0.15688	0.16208	0.11044	0.04532
10	0.31975	0.03474	0.47210	0.31022	0.18515
11	0.32478	0.10308	0.51871	0.17789	0.20113
12	0.67836	0.17317	0.31495	0.10845	0.07978
13	0.15806	0.41027	0.12265	0.21997	0.06668
14	0.13724	0.42601	0.56273	0.03849	0.15504
15	0.70894	0.22199	0.20489	0.17521	0.09192
16	0.08779	0.14807	0.13508	0.13267	0.57987
17	0.21943	0.16437	0.20874	0.73885	0.12755
18	0.34836	0.14682	0.38029	0.14175	0.11634
19	0.14568	0.53952	0.47133	0.12540	0.15667
20	0.26329	0.52940	0.17974	0.35295	0.06175

In an attempt to label each of the single factors, it was necessary to identify the consistent characteristic that underlies several items loading on that same factor. Tables 20-24 indicate the loadings on all five factors and the subject category with which the variable was associated. The numbers in parentheses shown after the variable represent the subject category for which the statement was written.

Factor I, as seen in Table 20, could be identified as having the greatest association with the subject category Clinical Science Faculty. All of the five items loaded in the category have significant loading scores. The other measure of generalizability between several variables and significant loadings corresponded with the category Clinical Procedures though these loadings were much lower. As a result, Factor I could be identified as Clinical Science Faculty.

Factor II, as seen in Table 21, was not as clearly identified as Factor I though the majority of the higher loadings were on items dealing with Basic Science Faculty. Since this item carried the majority of the significant loadings, Factor II could be identified as Basic Science Faculty.

Factor III, as seen in Table 22, could be named Clinical Procedures since the highest loadings for the factor related to this subject category. Factor III could be

TABLE 20

FACTOR I IDENTIFICATION THROUGH SUBJECT CATEGORY LOADINGS

Variable	Subject Categories BSC (1)	BSF (2)	CSF (3)	CP (4)
3 (3)			0.41104	
4 (4)				0.39144
5 (3)			0.62251	
9 (3)			0.71804	
12 (3)			0.67836	
15 (3)			0.70894	
18 (4)				0.34836

TABLE 21

FACTOR II IDENTIFICATION THROUGH SUBJECT CATEGORY LOADINGS

Variable	Subject Categories BSC (1)	BSF (2)	CSF (3)	CP (4)
1 (1)	0.39453			
2 (2)		0.62842		
13 (2)		0.41027		
14 (4)				0.42601
19 (1)	0.53952			
20 (2)		0.52940		

TABLE 22

FACTOR III IDENTIFICATION THROUGH SUBJECT CATEGORY LOADINGS

Variable	Subject Categories			
	BSC (1)	BSF (2)	CSF (3)	CP (4)
10 (1)	0.47210			
11 (4)				0.51871
14 (4)				0.56273
19 (1)	0.47133			

said to be factorially complex since Basic Science Curriculum also had significant loadings. However, since the higher two loadings were both on Clinical Procedures, the factor will be so identified.

Factor IV, as seen in Table 23, could also be named Basic Science Faculty since two items were loaded on that factor and both items were written to relate to that category. If Factors II and IV were considered together, they would represent all five items written for the category of Basic Science Faculty.

Factor V, as seen in Table 24, has factor loadings on only two items and no clear conclusion can be reached as to a name for the factor due to the complexity of the loadings.

It is of importance to note that Factor I, named Clinical Science Faculty, showed considerable loadings on all five items written specifically for that category.

TABLE 23

FACTOR IV IDENTIFICATION THROUGH SUBJECT CATEGORY LOADINGS

Variable	Subject Categories			
	BSC (1)	BSF (2)	CSF (3)	CP (4)
8 (2)		0.60952		
17 (2)		0.73885		

Factors II, III, and IV were able to result in significant loadings on two or three of the five statements in each category, with Factors II and IV combining to cover all five items in Basic Science Faculty.

Basic Science Curriculum was the only subject category that did not have a significant number of loadings on any one factor to result in a factor being so labeled. This may have been due to the five statements having key words that seemed to imply another category.

TABLE 24

FACTOR V IDENTIFICATION THROUGH SUBJECT CATEGORY LOADINGS

Variable	Subject Categories			
	BSC (1)	BSF (2)	CSF (3)	CP (4)
7 (4)				0.67892
16 (1)	0.57987			

The utilization of factor analysis is indicated to produce evidence of construct validity. The instrument used in this study could be said to possess considerable construct validity thereby validating and substantiating results of the study. Factor I indicated complete validity of the items dealing with Clinical Science Faculty. Factors II and IV indicated good construct validity of the category Basic Science Faculty and, if taken together, show complete validity. Factor III also showed good validity when dealing with the category Clinical Procedures.

Analysis of Descriptive Statistics

Frequency distributions for all students were computed showing absolute, relative, and cumulative frequencies. Appendix F, subsection I, shows the frequency distributions for all twenty items; and Appendix F, subsections II, III, IV, and V, indicates the frequency distributions for items in the four specific subject categories. The mean scores based on numerical ratings from 1-4 as seen in all subsections were employed rather than raw scores as they were more meaningful in the context of additional statistics considered.

As seen in Appendix F, subsection I, the median and mode for the total distribution (2.503 and 2.450, respectively) indicate neither agreement (3) nor disagreement (2) by the sample on the twenty items as a total group. Subsection II (BSC) with a median score of 2.8000 and a mode score of 3.000 and subsection V (CP) with a median score of

2.792 and mode score of 3.000 were almost identical in their scores, both indicating an inclination on the part of the sample to agree (3) with the statements. Similarly, subsection III (BSF) with a median score of 2.206 and a mode score of 2.000 and subsection IV (CSF) with a median score of 2.210 and mode score of 2.000 were also similar in that both median and mode scores indicated disagreement (2) with the statements.

Conclusions reached on the four subject categories would seem to imply that students did not overwhelmingly agree that faculty, either basic science or clinical, provided positive instruction, reinforcement, or examples concerning how to relate and utilize basic science instruction in clinical procedures.

Descriptive statistics are utilized to describe certain features of the data that are of interest. From descriptive statistics one can show certain relationships that allow predictions to be made. Measures of central tendency--namely, median, mode, and mean--serve to provide a single summary figure to describe the set of items which comprised the instrument. Analysis of these measures can indicate several important conclusions. While measures of central tendency describe levels of performance, variability will describe the spread of performance. Measures of variability such as standard deviation are also of great importance when determining acceptance or rejection of hypotheses.

Appendix G and Table 25 contain several forms of descriptive statistics from which relationships can be observed and from which several predictions can be made concerning the hypothesis in question.

Appendix G shows the descriptive statistics for all items. As mentioned earlier, the scoring for items was as follows: "strongly disagree" = 1, "disagree" = 2, "agree" = 3, "strongly agree" = 4. The letters shown under the column heading "Category" refer to the particular subject category within which a particular statement was found: BSC = Basic Science Curriculum; BSF = Basic Science Faculty; CSF = Clinical Science Faculty; and CP = Clinical Procedures.

Several of the median scores in Appendix G would seem to indicate that the students were in disagreement with the statements. Items 2, 5, 8, 12, 15, 17, and 20 all showed median scores close to 2.0 which indicated disagreement with a statement. Of course, it was possible that many of the scores on these particular items were scored at the "strongly disagree" level (1) rather than at the "disagree" (2) level. And once again, as with the mean scores, all of these low-median-score items dealt with faculty.

Only two items (1 and 6) showed median scores above 3.0. Both items dealt with basic science curriculum which would imply that this category had the most significant number of students agreeing with the statements and, perhaps, strongly agreeing.

The standard deviation scores in Appendix G indicated that for all items the spread of scores was consistently within one standard deviation of the mean. Therefore, one could say that all items clustered fairly closely either below or above the mean for the item. Once again, this illustrated proof that the sample consisted of a homogeneous group of subjects. It is of note that the higher standard deviation scores such as are seen in items 7, 10, 13, and 16 did not show any trend as to the particular subject category within which the higher standard deviations were found.

The means in Table 25 indicated that students reacted more favorably to statements concerning basic science curriculum and the use of such knowledge in clinical procedures than they did to statements concerning faculty, their expertise, and assistance in providing a bridge between basic science courses and the clinical practice of dentistry. The two pairs of means, in fact, were almost identical, indicating close consensus of student thinking in

TABLE 25

DESCRIPTIVE STATISTICS FOR CATEGORIES

Variable	Mean	Standard Deviation	N
Total	2.5025	.3895	2,103
BSC	2.7889	.3990	2,103
BSF	2.2163	.5035	2,103
CSF	2.2934	.5280	2,101
CP	2.7112	.4813	2,102

these two subject areas.

The standard deviations computed for the subject categories as seen in Table 25 were even smaller than those seen in Appendix G, further validating homogeneity of subjects and responses per category. The higher deviations both related to the two subject categories having the lowest means indicating generalized disagreement (2) with the statements. Again this is consistent with the generalization that students were basically in agreement with their reaction to the statements dealing with faculty.

Analysis of Canonical Correlation Statistics

> Canonical correlation analysis takes as its basic input two sets of variables, each of which can be given theoretical meaning as a set. The basic strategy of canonical correlation analysis is to derive a linear combination from each of the sets of variables in such a way that the correlation between the two linear combinations is maximized. Many such pairs of linear combinations may be derived.[2]

These canonical variates, as they are known, are similar to the principal components produced by factor analysis, with the exception that the criterion for their selection has been altered. However, where both techniques produce linear combinations of the original variables, canonical correlation analysis does so not with the objective of accounting for as much variance as possible within one

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[2]Norman H. Nie, C. Hadlai Hull, Jean G. Jenkins, Karin Steinbrenner, and Dale H. Bent, Statistical Packages for Social Sciences, 2nd ed. (New York: McGraw-Hill Co., 1970), p. 517.

set of variables, but with the objective of accounting for a maximum amount of the relationship between two sets of variables.

In canonical correlation, coefficients keep appearing as long as there are pairs of constructs that are correlated and are independent of pairs for which canonical correlations have previously been generated.

Each two constructs are correlated to the extent that they share variance or account for common variance in two sets of variables. As each successive canonical correlation coefficient is generated by a pair of constructs and is independent of any preceding pair, their sources of variance are also independent.

The results of the canonical correlation are contained in Table 26. Seven related pairs of constructs between the dependent and independent variables were highly correlated. As a result, the major hypothesis that was tested, namely,

> H_o: There is no relationship between the dental student's perception of basic science knowledge and the clinical practice of dentistry.
>
> H_1: Not H_o

must be rejected. The canonical correlation between the two variables shows a definite correlation.

The two most important types of information produced by canonical correlation analysis are the canonical variates and the canonical correlations between them. The canonical

TABLE 26

CANONICAL VARIATES AND CORRESPONDING CORRELATIONS

Canonical Variate Sets	Corresponding Canonical Correlations	Level of Significance
1	0.76418	0.000
2	0.38221	0.000
3	0.35342	0.000
4	0.28280	0.000
5	0.22813	0.000
6	0.12898	0.000
7	0.12169	0.001
8	0.05898	0.298
9	0.04372	0.435
10	0.00191	0.932

variates come in two sets, one for each of the subsets of variables entered into the analysis. They are composed of coefficients that reflect the importance of the original subset variables in forming the variates. Canonical variates from each subset are meant to correspond, e.g., the first canonical variate from the first set of variables and the first canonical variate from the second set of variables are chosen so as to maximally correlate with each other, and similarly for the second and all successive pairs of canonical variates. The canonical variates for each of the variables can be seen in Appendix H.

Examination of the loadings of the individual variables as seen in Appendix H was made with a coefficient of .3 or higher being the dividing parameter. The first canonical variate loaded on two variables from the first subset of variables and one variable from the second subset. All three of these variables refer to basic science course material and its relationship to clinical procedures.

The second canonical variate loaded on four variables from the first subset of variables and three variables from the second subset of variables. Three of the variables from the first subset refer to basic science course material, while the fourth variable refers to basic science faculty relating their material to clinical procedures. The three variables in the second subset all refer to increased incorporation of basic science concepts into clinical procedures.

The third canonical variate loaded on the same three variables as in the first subset of the second variate; these three variables refer to basic science course material. Loadings in the second subset were on the same three variables as in the second subset of the second variate.

The fourth canonical variate loaded on three variables in the first subset relating to basic science course material as well as one variable which dealt with faculty relating concepts to clinical procedures. The fourth variate loaded on six variables in the second subset. Three of the variables in the second subset related basic science knowledge to clinical procedures. The other three variables referred to the student's efforts to incorporate and use basic science knowledge.

The fifth canonical variate loaded on four variables in the first subset, all of which referred to basic science faculty and their assistance in relating basic science information to clinical procedures. In the second subset, loadings were on four variables, three of which related to clinical faculty and one to clinical procedures.

The sixth canonical variate loaded on only two variables in the first subset and on six variables in the second subset, most of which dealt with faculty and their efforts to relate basic science material to clinical situations.

The seventh canonical variate loaded on only three variables in the first subset, but on six variables in the second subset. Again, most of the variables dealt with faculty and their attempts to relate basic science material.

CHAPTER V

SUMMARY

History of Dentistry

The last 150 years has seen major evolutionary changes in the profession of dentistry. What began as a seemingly highly technical offshoot in the medical field has become a recognized profession incorporating biological, technological, and clinical curricular experiences. The leaders in the development of the dental curriculum sought to raise dental practice from the status of a mechanical trade in which apprenticeship was often the vehicle for acquiring the necessary skills to that of a healing profession involved in the knowledgeable treatment of the human body.

Early pioneers felt that to enable dentistry to be a recognized profession comparable to medicine, instruction in the biological sciences was essential. It was generally believed that only through a well-balanced curriculum that included biological instruction as well as technical material could dentistry emerge not just as a mechanical trade, but as a fully recognized health profession.

By the late 1870s all dental schools required attendance of at least two academic years of twenty weeks each.

By 1891 the three-year dental curriculum was quite well established and the curriculum was fairly standardized. By early 1900 not only had the schools organized, but a national organization--the Dental Educational Council--was established to evaluate and improve dental education as well as classify all dental instruction based on the quality of the educational structure.

By 1938 this council was replaced by the Council on Dental Education of the ADA and had representation from all major dental interests in the country.

Curriculum became standardized, and specific courses to be included in any dental curriculum were enumerated. The curriculum became structured around biological sciences, dental sciences, and clinical sciences. Since the beginning of organized dental education which included structured evaluation, many studies have been undertaken to further define the professional curriculum.

Problem

Basic sciences were first introduced in the dental curriculum to place the practice of dentistry in a position of equality with medicine. Also, the inclusion of sciences allowed the practice of dentistry to develop along biological lines. The inclusion of biological sciences in the first programs set the pattern to be followed by other emerging dental programs.

However, the inclusion of biological sciences was not only for prestigious reasons. Many leading educators of the time also felt that if the purpose of professional education was to provide a basis for growth of professional knowledge, a sound scientific background was essential. Others felt that a well-rounded, well-educated individual would need to have a diversified and in-depth education to fully function as a professional. If one was to work with and on the human body, it was essential to have an appreciation and an understanding of how the body functioned.

The separateness of the biological and clinical portions of the dental curriculum has been felt for a long time. There has always seemed to be much in physical and biological sciences which was not directly applicable to the practice of dentistry. Dental educators have, for over fifty years, encouraged the scientific education of the dentist, but not always for the same reasons. Some have visualized dentistry as applied biological sciences and have encouraged the teaching of basic sciences; others have seen the efficient practitioner as the pinnacle of professional achievement and have encouraged the teaching of clinical sciences that may be utilized in the daily diagnosis and treatment of patients.

As a result, many educators and practitioners have joined sides in an effort to define and justify what is dentistry and what should constitute curricular content and structure.

The generally accepted position at the present time is that there is sound justification for the inclusion of basic sciences within the dental curriculum, both from a philosophical and a practical point of view.

However, the professional dental literature has clearly indicated that a problem exists concerning the integration of basic sciences and clinical experiences. The literature indicates a lack of consensus not only concerning the fact that the two should be interrelated, but also regarding who is primarily responsible for the integration and how it should be accomplished.

The problem that was addressed in this study was to ascertain whether and to what extent a relationship exists between basic science knowledge and the clinical practice of dentistry. Specifically stated, the question was: Is basic science knowledge utilized and applied in the clinical practice of dentistry?

Methods

Since the student represented the focal point around which a curriculum should be structured, the decision was made to survey junior and senior dental students to determine their perception of this relationship. The question was not approachable through the evaluation of student grades in didactic courses or his progress in clinical procedures. The only manner in which the question could be addressed was through asking the dental student whether he valued and applied the basic science instruction he received when performing clinical procedures.

The format was a twenty-item questionnaire sent to all fifty-one U.S. dental schools employing a four-year curricular format. The questions related to four separate subject categories:

Basic science curriculum

Basic science faculty

Clinical science faculty

Clinical procedures

The instrument was designed as positively stated items to which the student responded by selecting one of four answer choices: "strongly agree," "agree," "disagree," and "strongly disagree."

The major hypothesis tested was:

H_o: There is no relationship between the dental student's perception of basic science knowledge and the clinical practice of dentistry.

H_1: Not H_o

The decision to survey both junior and senior dental students was based on nationalized admission procedures and standardized curricular patterns that made the two groups homogeneous in their ability to respond to the questions.

Conclusions

The homogeneity of the two groups was statistically proven through the application of one-way ANOVA procedures. Five minor hypotheses were tested concerning the whole questionnaire and the four subject categories comparing junior and senior responses. All five ANOVA procedures proved there was no difference between the two groups and therefore the associated hypotheses were all accepted, proving homogeneity of the sample.

Construct validity of the instrument was proven through the use of factor analysis. The instrument had been designed to incorporate four subject categories with five items referring to each category.

Factor analysis procedures identified five factors, one of which was quite weak and one of which was exceptionally strong. The strongest factor had significantly high loadings on all five items associated with the subject area, namely, Clinical Science Faculty.

Factor II had significantly high loadings on three of the five items associated with the subject category Basic Science Faculty and was so named.

Factor III had two of five significantly high loadings associated with the category Clinical Procedures. Perhaps the reason that the other three statements relating to Clinical Procedures did not show higher loadings was the wording of the statements. One statement referred to curricular restructuring that may have been misinterpreted. Another item was a complex statement concerning two thoughts, namely, clinical procedures and application of basic science principles, which may have confused the students.

Factor IV had high loadings on two items regarding Basic Science Faculty and if combined with Factor II would cover all five items in that category.

Factor V had significant loadings on only two items, and therefore no conclusion can be reached as to its identity, though, as previously mentioned, one item was loaded on Clinical Procedures, the other on Basic Science Curriculum.

The only subject category not clearly indicated as a factor was Basic Science Curriculum. Perhaps again, the reason was due to the construction of the items. One item dealt with curricular revision, two others were identified as Basic Science Curriculum associated with Factor III but were of lower loadings than those relating to Clinical Procedures. The fourth item was one of only two items that did not show generalizability between the item and any factor.

The utilization of factor analysis is indicated to produce evidence of construct validity. This instrument could be said to possess considerable construct validity thereby substantiating and validating the results of the study.

The descriptive statistics indicated neither agreement nor disagreement with the twenty items as a whole. Some students striving to give socially acceptable answers could account for this overall trend.

On the other hand, students as a whole tended to agree with statements concerning both basic science curriculum and clinical procedures. Perhaps this was due to the interpretation of the statements as relating to the overall curriculum rather than to specific courses or procedures. Generally speaking, the students felt a need for the basic science curriculum and saw the corresponding relationship to clinical procedures in a positive manner.

Student rating of items referring to both Basic Science Faculty and Clinical Science Faculty were almost identical in an inclination towards disagreement with the statements. These results indicated that faculty could improve the manner in which they offer instruction and also their ability to relate basic sciences to clinical procedures. This inclination towards disagreement could be attributed to the student's identification of a tangible area (group of people) on which to vent personal frustrations, whereas with Basic Science Curriculum and Clinical Procedures the categories were not specific enough for association.

It is of note that the two categories that showed the trend towards disagreement on the part of the sample, namely, Basic and Clinical Faculty, were the two areas in the factor analysis that had the most numerous significant loadings indicating a more absolute identification of key elements in the items.

Also of interest is the fact that the same two items that showed no generalizability to any particular factor had the highest median scores of any items. Both items dealt with Basic Science Curriculum which could imply that this category had the most significant number of students agreeing with the statements and perhaps strongly agreeing.

The testing of the major null hypothesis was done through canonical correlation. The ten items relating to Basic Science Curriculum and Faculty were correlated against the ten items relating to Clinical Faculty and Procedures.

In canonical correlation, coefficients keep appearing as long as there are pairs of constructs that are correlated and are independent of pairs for which canonical correlations have previously been generated.

Out of a possible ten coefficients, seven were highly significant, indicating there was a definite correlation between basic science knowledge and clinical procedures. Therefore, the null was rejected.

Recommendations

The fact that the null was rejected does allow for the alternative hypothesis to be accepted. However, further research is necessary to determine what specific factors are of consideration in determining how the student perceives this relationship.

Further study needs to be undertaken concerning specific basic science courses, their content, the relevance of such content, and how and when application is essential.

On-site observation of clinical procedures and an enumeration of scientific knowledge required for specific procedures need to be undertaken.

Further research into curricular innovations and patterns needs to be undertaken in an attempt to identify the ideal coordination of basic science curriculum and clinical procedures that produces the well-rounded, well-educated professional who will be dealing with the human body and being.

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APPENDIX A

Clock Hours

APPENDIX A

I. TOTAL CLOCK HOURS OF BASIC SCIENCE INSTRUCTION

Clock Hour Range	Frequency Distribution (Number of Schools Reporting)
1983	X
1500-1504	X
1200-1299	X
1100-1199	XXXX
1000-1099	XXXXXXXXXXXX
900-999	XXXXXXXXXXXXX
800-899	XXXXXXXXXXXXX
700-799	XXXX
600-699	XXXXXXX
500-599	X
400-499	XX

SOURCE: American Dental Association, Council on Dental Education, Dental Education in the United States 1976 (Chicago: American Dental Association, 1977).

II. TOTAL CLOCK HOURS OF CLINICAL SCIENCE INSTRUCTION

Clock Hour Range	Frequency Distribution (Number of Schools Reporting)
4528	X
4250-4499	XX
4000-4249	XXX
3750-3999	XXXXXXXXXXX
3500-3749	XXXXXXXXXXX
3250-3499	XXXXXXXXXXX
3000-3249	XXXXXXXXX
2750-2999	XXX
2500-2749	XXX
2250-2499	
2000-2249	XXX
376-1999	XX

SOURCE: American Dental Association, Council on Dental Education, Dental Education in the United States 1976 (Chicago: American Dental Association, 1977).

APPENDIX B

Field Test Instrument

APPENDIX B

I. INTRODUCTORY LETTER

Dear Senior Dental Student

I am a graduate student working toward a Ph.D. degree in Curriculum at Loyola University of Chicago. Having been involved in dental education as an educator and administrator for the last several years, I have become interested in several issues pertaining to dental education.

I would appreciate it very much if you would take a few minutes to fill out the enclosed questionnaire and return it to your instructor. Your school will return all questionnaires to me.

Please be assured that the results of this questionnaire will be kept confidential and utilized only by myself in the drafting and writing of my dissertation.

I sincerely thank you in advance for your willingness to participate in my study.

Sincerely yours,

Kathlyn McElliott, R.D.H., M.S.

II. FIELD TEST INSTRUMENT

Instructions. Please read the following statements carefully. As you read the statements please circle the response that most closely corresponds with your opinion concerning the statement.

The response choices are: SA Strongly Agree, A Agree, D Disagree, SD Strongly Disagree

For clarification, basic sciences would include only the biological sciences such as Anatomy, Physiology, Chemistry, Microbiology, Histology, etc.

1. The material presented in the basic science courses are related to modern biological concepts	SA	A	D	SD	(1)
2. Basic science faculty related major concepts to clinical procedures	SA	A	D	SD	(2)
3. Faculty teaching clinical procedures in lab settings, referred to major basic science concepts	SA	A	D	SD	(3)
4. You refer to basic science course material in performing clinical procedures	SA	A	D	SD	(4)
5. As a student you discussed, with the clinical faculty, basic science findings concerning your patients prior to performing clinical procedures	SA	A	D	SD	(3)
6. The amount of material presented in the basic science courses was of sufficient quantity	SA	A	D	SD	(1)
7. If clinical experiences are scheduled throughout the dental curriculum, application of basic science principles would be more effective	SA	A	D	SD	(4)
8. As a student, you contacted basic science faculty concerning questions dealing with application of basic science knowledge to clinical procedures	SA	A	D	SD	(2)

9. Clinical faculty assisted you in considering basic science information as it related to clinical procedures — SA A D SD (3)

10. You refer to basic science texts or other materials to assist you in your diagnosis and treatment planning for patients — SA A D SD (1)

11. Your incorporation of basic science knowledge into clinical procedures has increased as you have become more proficient — SA A D SD (4)

12. Clinical faculty related basic science material in diagnostic and treatment planning procedures — SA A D SD (3)

13. Basic science faculty coordinated the presentation of their material with other basic science courses being offered — SA A D SD (2)

14. Basic science course material was relevant for diagnostic and treatment planning procedures — SA A D SD (4)

15. Faculty supervising clinical procedures related basic science material to clinical procedures — SA A D SD (3)

16. If basic science courses are scheduled throughout the dental curriculum, application of basic science principles would be more effective — SA A D SD (1)

17. As a student, you contacted the basic science faculty concerning questions dealing with the application of basic science to diagnosis and treatment planning — SA A D SD (2)

18. As part of your diagnosis and treatment planning, you discuss patient's biological findings with other students or clinical faculty — SA A D SD (4)

19.	The content presented in basic science courses was relevant for performing clinical procedures	SA	A	D	SD	(1)
20.	Basic science faculty related major concepts to diagnostic and treatment planning procedures	SA	A	D	SD	(2)

APPENDIX C

Field Test Results

APPENDIX C

I. FIELD TEST FREQUENCY DISTRIBUTION*

Statement	Number of Responses to Strongly Agree	Number of Responses to Agree	Number of Responses to Disagree	Number of Responses to Strongly Disagree
1	4	26	8	2
2	1	18	18	3
3	2	19	18	1
4	3	21	13	3
5	1	12	20	7
6	8	17	14	1
7	17	17	4	2
8	2	11	23	4
9	1	12	24	3
10	4	14	19	3
11	9	23	8	0
12	1	14	21	1
13	1	14	17	8
14	17	20	12	1
15	1	15	20	4
16	4	18	15	3
17	1	11	23	5
18	6	29	4	1
19	7	18	14	1
20	2	14	23	1

*N = 40.

II. FIELD TEST MEAN SCORES

Statement	Total Numerical Score	Mean Score
1	112	2.80
2	97	2.42
3	102	2.55
4	104	2.60
5	87	2.18
6	100	2.50
7	112	2.80
8	91	2.28
9	91	2.28
10	99	2.48
11	121	3.03
12	92	2.30
13	88	2.20
14	153	3.83
15	93	2.33
16	103	2.58
17	88	2.20
18	120	3.00
19	111	2.78
20	97	2.43

Specific Category Numerical Results

Basic Science Curriculum (1)

5 items	
Total sum	525
Mean sum	13.125
Category mean	2.625

Basic Science Faculty (2)

5 items	
Total sum	461
Mean sum	11.525
Category mean	2.305

Clinical Science Faculty (3)

5 items	
Total sum	465
Mean sum	11.625
Category mean	2.325

Clinical Procedures (4)

5 items	
Total sum	627
Mean sum	15.675
Category mean	3.135

APPENDIX D

Finalized Instrument

APPENDIX D

FINALIZED INSTRUMENT

Instructions. Please read the following statements carefully. As you read the statements, please circle the response that most closely corresponds with your opinion concerning the statement.

The response choices are: SA Strongly Agree, A Agree, D Disagree, SD Strongly Disagree

For clarification, basic sciences would include only the biological sciences such as Anatomy, Physiology, Chemistry, Microbiology, Histology, etc.

1.	The material presented in the basic science courses is related to modern biological concepts	SA	A	D	SD	(1)
2.	Basic science faculty relate major concepts to clinical procedures	SA	A	D	SD	(2)
3.	Faculty teaching clinical procedures in lab settings, refer to major basic science concepts	SA	A	D	SD	(3)
4.	You refer to basic science course material in performing clinical procedures	SA	A	D	SD	(4)
5.	You and the clinical faculty discuss basic science findings concerning your patients prior to performing clinical procedures	SA	A	D	SD	(3)
6.	The amount of material presented in the basic science courses if of sufficient quantity	SA	A	D	SD	(1)
7.	If clinical experiences are scheduled throughout the dental curriculum, application of basic science principles will occur more often	SA	A	D	SD	(4)

8.	You contact basic science faculty concerning questions dealing with the application of basic science knowledge to clinical procedures	SA	A	D	SD	(2)
9.	Clinical faculty assist you in considering basic science information as it relates to clinical procedures	SA	A	D	SD	(3)
10.	You refer to basic science texts or other materials to assist you in your diagnosis and treatment planning for patients	SA	A	D	SD	(1)
11.	Your incorporation of basic science knowledge into clinical procedures has increased as you have become more proficient	SA	A	D	SD	(4)
12.	Clinical faculty relate basic science material in diagnosis and treatment planning procedures	SA	A	D	SD	(3)
13.	Basic science faculty coordinate the presentation of their material with other basic science courses being offered	SA	A	D	SD	(2)
14.	Basic science course material is relevant for diagnostic and treatment planning procedures	SA	A	D	SD	(4)
15.	Faculty supervising clinical procedures relate basic science material to clinical procedures	SA	A	D	SD	(3)
16.	If basic science courses are scheduled throughout the dental curriculum, application of basic science principles will occur more often	SA	A	D	SD	(1)
17.	You contact the basic science faculty concerning questions dealing with the application of basic science to diagnosis and treatment planning	SA	A	D	SD	(2)
18.	As part of your diagnosis and treatment planning, you discuss patient's biological findings with clinical faculty or other students	SA	A	D	SD	(4)

19. The content presented in basic science courses is relevant for performing clinical procedures	SA	A	D	SD	(1)
20. Basic science faculty relate major concepts to diagnostic and treatment planning procedures	SA	A	D	SD	(2)

APPENDIX E

Factor Analysis Statistics

APPENDIX E

I. ORIGINAL FACTORS

Factor	Eigenvalue	Pct. of Var.	Cum. Pct.
1	6.59293	33.0	33.0
2	1.41344	7.1	40.0
3	1.36019	6.8	46.8
4	1.24763	6.2	53.1
5	1.02155	5.1	58.2
6	0.95868	4.8	63.0
7	0.80800	4.0	67.0
8	0.71069	3.6	70.6
9	0.68380	3.4	74.0
10	0.65758	3.3	77.3
11	0.60769	3.0	80.3
12	0.59314	3.0	83.3
13	0.53583	2.7	86.0
14	0.48342	2.4	88.4
15	0.44448	2.2	90.6
16	0.42903	2.1	92.7
17	0.40438	2.0	94.8
18	0.38045	1.9	96.7
19	0.34381	1.7	98.4
20	0.32326	1.6	100.0

II. FACTOR MATRIX USING PRINCIPAL FACTOR

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
1	0.26725	0.14050	0.30252	0.06107	-0.00933
2	0.55463	0.08381	0.36687	-0.17052	0.17828
3	0.43563	-0.12530	0.21223	0.07214	0.22551
4	0.63462	0.02796	-0.02420	0.12901	-0.05785
5	0.63466	-0.27183	0.00262	0.08360	0.06507
6	0.05607	0.01500	0.16615	0.10452	-0.00095
7	0.35004	0.28867	-0.26094	0.38264	0.28426
8	0.55449	0.01313	-0.25478	-0.36107	0.05206
9	0.64291	-0.39626	0.02157	0.09008	0.04221
10	0.58950	0.03136	-0.27855	0.01157	-0.17500
11	0.60280	0.05989	-0.17783	0.12270	-0.20888
12	0.70424	-0.30051	-0.00660	0.13142	-1.06251
13	0.43734	0.12164	0.16476	-0.15581	0.06082
14	0.59277	0.29338	0.14695	0.12127	-0.26222
15	0.72226	-0.32467	0.01510	0.05726	0.05278
16	0.38520	0.31446	-0.19298	0.20802	0.27194
17	0.60171	0.09371	-0.31022	-0.45774	0.06580
18	0.53871	-0.02549	-0.06888	0.07492	-0.14125
19	0.63949	0.31175	0.20958	0.01358	-0.15732
20	0.62893	0.11483	0.18505	-0.25089	0.06598

APPENDIX F

Descriptive Statistics

APPENDIX F

I. TOTAL MEAN SCORES

Code	Freq.	Adj. Pct.	Cum. Pct.	Code	Freq.	Adj. Pct.	Cum. Pct.
1.00	4	0	0	2.09	1	0	12
1.10	1	0	0	2.10	33	2	14
1.15	3	0	0	2.11	4	0	14
1.25	3	0	1	2.15	52	2	17
1.30	3	0	1	2.16	1	0	17
1.35	4	0	1	2.20	69	3	20
1.40	9	0	1	2.21	6	0	20
1.43	1	0	1	2.22	4	0	20
1.45	8	0	2	2.24	1	0	20
1.47	1	0	2	2.25	76	4	24
1.50	5	0	2	2.26	3	0	24
1.53	1	0	2	2.28	5	0	24
1.55	5	0	2	2.29	1	0	24
1.60	8	0	3	2.30	86	4	29
1.65	8	0	3	2.31	1	0	29
1.70	11	1	4	2.32	5	0	29
1.71	1	0	4	2.35	86	4	33
1.73	1	0	4	2.37	8	0	33
1.74	1	0	4	2.38	3	0	33
1.75	13	1	4	2.39	1	0	33
1.78	1	0	4	2.40	106	5	39
1.80	13	1	5	2.41	2	0	39
1.84	1	0	5	2.42	12	1	39
1.85	16	1	6	2.43	1	0	39
1.89	3	0	6	2.44	9	0	40
1.90	17	1	7	2.45	116	6	45
1.95	29	1	8	2.47	8	0	46
2.0	42	2	10	2.50	116	6	51
2.05	43	2	12	2.53	14	1	52
2.06	1	0	12	2.55	101	5	57

TOTAL MEAN SCORES--Continued

Code	Freq.	Adj. Pct.	Cum. Pct.	Code	Freq.	Adj. Pct.	Cum. Pct.
2.56	8	0	57	2.95	48	2	90
2.57	1	0	57	3.00	74	4	94
2.58	8	0	57	3.05	30	1	95
2.59	3	0	57	3.06	1	0	95
2.60	92	4	62	3.08	1	0	95
2.61	6	0	62	3.10	23	1	96
2.62	1	0	62	3.11	4	0	96
2.63	4	0	62	3.12	1	0	96
2.65	97	5	67	3.15	19	1	97
2.67	6	0	67	3.16	1	0	97
2.68	8	0	68	3.20	16	1	98
2.69	1	0	68	3.21	2	0	98
2.70	85	4	72	3.25	8	0	99
2.72	2	0	72	3.30	2	0	99
2.74	6	0	72	3.35	4	0	99
2.75	83	4	76	3.40	7	0	99
2.76	2	0	76	3.45	3	0	99
2.77	2	0	76	3.50	1	0	99
2.80	72	3	80	3.55	1	0	99
2.81	1	0	80	3.56	1	0	99
2.82	2	0	81	3.60	2	0	100
2.83	4	0	81	3.65	2	0	100
2.84	5	0	81	3.70	1	0	100
2.85	67	3	84	3.75	2	0	100
2.87	1	0	84	3.79	1	0	100
2.88	1	0	84	3.80	1	0	100
2.89	8	0	85	3.95	1	0	100
2.90	62	3	88	4.00	1	0	100
2.91	1	0	88				
2.94	3	0	88				

Median 2.503

Mode 2.450

II. MEAN SCORES FOR BASIC SCIENCE CURRICULUM

Code	Freq.	Adj. Pct.	Cum. Pct.	Code	Freq.	Adj. Pct.	Cum. Pct.
1.00	6	0	0	2.75	28	1	40
1.20	2	0	0	2.80	427	20	60
1.40	5	0	1	3.00	458	22	82
1.50	1	0	1	3.20	200	10	91
1.60	6	0	1	3.25	7	0	92
1.75	1	0	1	3.33	8	0	92
1.80	20	1	2	3.40	90	4	96
2.00	56	3	5	3.50	10	0	97
2.20	87	4	9	3.60	37	2	99
2.25	4	0	9	3.75	1	0	99
2.33	4	0	9	3.80	20	1	100
2.40	231	11	20	4.00	8	0	100
2.50	12	1	21				
2.60	369	18	38				
2.67	5	0	38				

Median 2.800

Mode 3.000

III. MEAN SCORES FOR BASIC SCIENCE FACULTY

Code	Freq.	Adj. Pct.	Cum. Pct.	Code	Freq.	Adj. Pct.	Cum. Pct.
1.00	56	3	3	2.50	38	2	72
1.20	46	2	5	2.60	243	12	84
1.25	1	0	5	2.67	4	0	84
1.33	1	0	5	2.75	7	0	84
1.40	69	3	8	2.80	134	6	91
1.50	4	0	9	3.00	144	7	98
1.60	114	5	14	3.20	22	1	99
1.67	4	0	14	3.40	15	1	99
1.75	5	0	14	3.50	2	0	99
1.80	190	9	23	3.60	5	0	100
2.00	342	16	40	3.80	4	0	100
2.20	350	17	56	4.00	2	0	100
2.25	17	1	57				
2.33	7	0	57				
2.40	275	13	71				

Median 2.206

Mode 2.200

IV. MEAN SCORES FOR CLINICAL SCIENCE FACULTY

Code	Freq.	Adj. Pct.	Cum. Pct.	Code	Freq.	Adj. Pct.	Cum. Pct.
1.00	47	2	2	2.60	195	9	75
1.20	50	2	5	2.67	9	0	75
1.33	1	0	5	2.75	13	1	75
1.40	60	3	8	2.80	199	9	85
1.50	3	0	8	3.00	231	11	96
1.60	87	4	12	3.20	44	2	98
1.67	2	0	12	3.33	1	0	98
1.75	4	0	12	3.40	16	1	99
1.80	146	7	19	3.60	5	0	99
2.00	358	17	36	3.67	1	0	100
2.20	330	16	52	3.80	8	0	100
2.25	15	1	52	4.00	2	0	100
2.33	12	1	53				
2.40	251	12	65				
2.50	11	1	66				

Median 2.219

Mode 2.000

V. MEAN SCORES FOR CLINICAL PROCEDURES

Code	Freq.	Adj. Pct.	Cum. Pct.	Code	Freq.	Adj. Pct.	Cum. Pct.
1.00	14	1	1	2.67	1	0	44
1.20	9	0	1	2.75	15	1	44
1.25	2	0	1	2.80	363	17	62
1.33	1	0	1	3.00	442	21	83
1.40	15	1	2	3.20	208	10	92
1.60	26	1	3	3.25	5	0	93
1.75	1	0	3	3.33	1	0	93
1.80	46	2	5	3.40	79	4	97
2.00	105	5	10	3.50	7	0	97
2.20	153	7	18	3.60	37	2	99
2.25	2	0	18	3.75	1	0	99
2.33	5	0	18	3.80	15	1	99
2.40	206	10	28	4.00	13	1	100
2.50	26	1	29				
2.60	304	14	44				

Median 2.792

Mode 3.000

APPENDIX G

Descriptive Statistics for All Items

APPENDIX G

DESCRIPTIVE STATISTICS FOR ALL ITEMS

Item	N	Median	Mode	Mean	SD	Category
1	2,089	3.129	3.000	3.1747	.5321	BSC
2	2,079	2.335	2.000	2.3280	.7055	BSF
3	2,075	2.477	3.000	2.4429	.6761	CF
4	2,080	2.563	3.000	2.4688	.7340	CP
5	2,079	2.130	2.000	2.1554	.7152	CF
6	2,087	3.134	3.000	3.1457	.6464	BSC
7	2,075	2.964	3.000	2.9258	.7709	CP
8	2,088	2.005	2.000	2.0254	.7232	BSF
9	2,081	2.297	2.000	2.2960	.7271	CF
10	2,069	2.496	3.000	2.4548	.7809	BSC
11	2,064	2.766	3.000	2.6764	.6975	CP
12	2,048	2.335	2.000	2.3418	.6808	CF
13	2,045	2.431	3.000	2.3912	.7572	BSF
14	2,056	2.861	3.000	2.7797	.6952	CP
15	2,032	2.190	2.000	2.2234	.6532	CF
16	2,036	2.590	3.000	2.5270	.7748	BSC
17	2,045	2.058	2.000	2.0851	.6610	BSF
18	2,048	2.800	3.000	2.7012	.6852	CP
19	2,017	2.713	3.000	2.6118	.7193	BSC
20	2,028	2.223	2.000	2.2401	.7059	BSF

APPENDIX H

Coefficients

APPENDIX H

I. COEFFICIENTS FOR CANONICAL VARIABLES OF THE FIRST SET

	CANVAR 1	CANVAR 2	CANVAR 3	CANVAR 4	CANVAR 5	CANVAR 6	CANVAR 7
BSC1	-0.07568	0.24384	0.16040	-0.11596	0.20874	0.16453	-0.00531
BSC2	-0.06772	-0.15350	0.00206	0.21669	0.10180	0.81779	0.28977
BSC3	-0.40710	-0.35883	-0.55415	-0.46524	0.01830	0.29717	-0.62798
BSC4	-0.16038	-0.76902	0.52871	0.41845	-0.13612	-0.07681	-0.02559
BSC5	-0.43783	0.31201	0.71503	-0.65720	0.07108	-0.13739	0.17593
BSF1	-0.14555	0.19238	-0.07517	0.71167	0.60060	-0.21751	-0.58523
BSF2	-0.12535	-0.18293	-0.19243	0.01730	0.77828	-0.11171	0.74115
BSF3	-0.04065	0.11968	-0.03333	0.08650	-0.25221	0.12582	-0.20450
BSF4	-0.04175	0.03726	-0.22447	0.09934	-0.45893	-0.37870	0.22490
BSF5	-0.09037	0.34806	-0.28189	0.26762	-0.76183	0.23499	0.29144

II. COEFFICIENTS FOR CANONICAL VARIABLES OF THE SECOND SET

	CANVAR 1	CANVAR 2	CANVAR 3	CANVAR 4	CANVAR 5	CANVAR 6	CANVAR 7
CF1	-0.08355	0.28073	0.12333	0.65967	0.17597	0.55123	-0.57229
CF2	-0.05650	0.09553	-0.10958	0.32364	0.14408	-0.35367	0.30282
CF3	-0.08491	-0.04414	-0.17676	-0.08852	0.77342	0.51370	0.85115
CF4	-0.04662	0.05491	-0.25870	-0.07302	-0.47898	0.19698	-0.30792
CF5	-0.13580	0.03968	-0.13865	0.46888	-0.62154	-0.84286	0.11895
CP1	-0.25815	0.00323	0.06607	-0.34301	0.65718	-0.54124	-0.52210
CP2	-0.12171	-0.82240	0.51799	0.31418	-0.10796	0.02032	0.15389
CP3	-0.23282	-0.41869	-0.48960	-0.34017	0.04288	0.29604	-0.34485
CP4	-0.36987	0.58422	0.76019	-0.28413	-0.16630	0.08803	0.26617
CP5	-0.13344	-0.01768	-0.18751	-0.19699	-0.38808	0.38953	0.07077

APPROVAL SHEET

The dissertation submitted by Kathlyn Coan McElliott has been read and approved by the following committee:

Dr. Ronald D. Cohen, Director
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The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval by the Committee with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

December 4, 1979 — Ronald D. Cohen

Date — Director's Signature