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An Analysis of the Effect of Immediate Corrective Feedback Administered as a Study Aid to Undergraduate Medical Technology Students

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AN ANALYSIS OF THE EFFECT OF IMMEDIATE CORRECTIVE FEEDBACK ADMINISTERED AS A STUDY AID TO UNDERGRADUATE MEDICAL TECHNOLOGY STUDENTS

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

AN ANALYSIS OF THE EFFECT OF IMMEDIATE CORRECTIVE FEEDBACK ADMINISTERED AS A STUDY AID TO UNDERGRADUATE MEDICAL TECHNOLOGY STUDENTS

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Medical College of Virginia—Virginia Commonwealth University, 1981.

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Twenty-six undergraduate medical technology students at Virginia Commonwealth University were provided with a Hemostasis Study Guide to use during this unit and in preparing for an exam in this area. The study guide contained fifty objective-related questions in multiple-choice format. Answers were printed in latent image and included positive reinforcement for correct selections and remediation for incorrect ones. Thus the student received immediate feedback concerning his response to each question.

An examination grade continuum was plotted for this class utilizing all exam grades in the Hematology course. A similar continuum was plotted for each of the three previous classes. (These classes served as control groups.) A positive peak between the hemostasis exam grade and the grade of the prior exam was noted for the experimental class. The three previous classes also showed the same positive peak.

In order to determine whether the amount of gain obtained by the experimental class was significant, an unpaired t-test was used to compare this gain with each of the three previous classes.

The gain of each of the control classes was also compared with the other control classes using the same test. The gain of the experimental group was significant when compared with the gains of each of the previous three control classes at the 99% confidence interval. No significance was observed between the control classes.

These results suggest that learning was enhanced in the experimental group when compared with the control groups. It is probable that this enhanced learning was due to utilization of the study guide and/or immediate corrective feedback.

CHAPTER I

INTRODUCTION

Education, one of the cornerstones of American society, is on trial. Illiterate youths are graduating from high schools. National attention has focused on the cry: "teacher can't teach". Psychologists are busily poring over learning and behavior theories seeking the key that will unlock the human mind. The world of the present, with breathtaking technological advances a daily occurrence, demands individuals better educated than a generation ago. Instead, the results appear worse.

Medical technology education is also in a dilemma. The quantity and quality of knowledge which laboratory professionals must possess is staggering. When viewed in the context of the twelve-month training program, the need for efficient and effective teaching methods becomes absolutely imperative.

The days of apprentice-type training for medical technologists are over. We, as educators, must join the psychologists and educational theorists of all disciplines to formulate new instructional methodologies. We must adapt successful existing methods and theories to the laboratory environment.

HISTORY OF MEDICAL TECHNOLOGY EDUCATION

The history of medical technology education is as interesting as it is unique. Doctors themselves were performing their own laboratory tests less than 80 years ago, and the title of "technician" simply refered to those physicians who did laboratory testing in the early 1900s(13).

"In the community hospital the pathologist was one of the few physicians who owned a microscope and who could be found in the hospital most of the day. Consequently, he became the logical person to carry out laboratory procedures"(87).

World War I created a great hardship on clinical laboratories because many of the pathologists were called to military duty(180). This fact, coupled with the increasing popularity and usefulness of laboratory testing, led pathologists to begin training assistants. The majority of these were co-workers of the pathologist, such as nurses and secretaries, and the training was apprentice style(180).

Dr. John Kolmer, a Philadelphia pathologist, developed the first formal training program for laboratory assistants in 1918(13). The first baccalaureate degree program, "Courses in Medical Technology for Clinical and Laboratory Technicians", was offered by the University of Minnesota in 1922(180).

The American Society of Clinical Pathologists(ASCP) was founded at the yearly meeting of the American Medical Association(AMA) in 1922(13). Six years later, the ASCP established the Registry of Medical Technologists (later called the Board of Registry) to standardize the educational requirements of laboratory workers(87) and to register (certify) those persons who met these basic standards(13). Two categories of workers were classified: "1) medical technologist, a person with a university degree, and one year of experience in a laboratory and 2) laboratory technician, a person with a minimum of a high school education and six months' experience in a laboratory"(180).

In 1933, the AMA's Council on Medical Education(CME) issued the first list of accredited programs for technicians and now required one year of college, with courses in biology and chemistry, for program admission(13). The Registered Medical Technologists founded their professional organization this same year. First called the American Society of Clinical Laboratory Technicians, the name was changed to the American Society of Medical Technologists(ASMT) in 1936, and to the American Society for Medical Technology in 1972(180).

Requirements for program admission were increased by the Board of Registry in 1934 to two years of college. The effective date of 1936 was postponed until 1938(180).

In 1935, the Board of Registry voted the title of "Medical Technologist" to all registrants holding college degrees, and in 1936, dropped the "Laboratory Technician" title altogether(180). That same year the Board published the first list of AMA-ASCP accredited programs in the Journal of the American Medical Association(13).

The Board of Registry designed the first _Essentials of an Acceptable School for Clinical Laboratory Technicians_ using Kolmer's original course description as a model. The _Essentials_ were adopted by the AMA in 1937(13).

The policy of registration had also changed over the years. Recommendation of the program pathologist was sufficient for registration until 1 April 1933(61), after which registration was only by examination(180). In 1948, only those completing twelve consecutive months of training in an approved AMA-CME program were eligible for examination(177).

In 1949, the Board of Schools of the ASCP was founded to assist the AMA-CME in program evaluation(87). Revised Essentials were published in 1958 and required three years of college as prerequisite to program admission(13). That same year Medical Technology was recognized as a true profession by the Civil Services-Armed Services Administration of the federal government(177).

The Board of Schools once again revised the Essentials in 1969. Minimum prerequisites for admission to the clinical training phase were 90 semester hours of college including 16 semester hours each of chemistry and biology (including microbiology) and one semester of mathematics(87). The following year the Board of Schools began reviewing college transcripts of all program applicants to insure conformity(180).

A study by the National Council on Medical Technology Education was published in 1967(108). A sample of 1,861 technologists revealed that "curriculums leading to the Bachelor of Science degree in medical technology constitute more adequate preparation for the profession than other curriculums" and one of their recommendations to the AMA was to require college or university affiliation of all clinical programs(108). The Essentials of 1972 incorporated this recommendation(61).

The last revision of the Essentials was in 1977. Immunology was added as a college prerequisite, either as part of the microbiology course or as a separate course(107).

The National Accrediting Agency for Clinical Laboratory Sciences(NAACLS) was incorporated in 1973 and assumed the functions of the Board of Schools in 1974(180). NAACLS was founded through the joint effort of the ASMT and the ASCP to provide autonomous evaluation of laboratory programs. Final accreditation approval still rests with the Committee on Allied Health Education and Accreditation(CAHEA) of the AMA(180).

As of 31 July 1980 there were 652 accredited Schools of Medical Technology which produced 6,371 graduates in 1979. Sponsorship for 530 programs rests with hospitals and clinics, 73 with colleges and universities, 17 with medical schools, and the remainder with the US government and special schools(13).

The apprenticed medical technologist no longer exists. Today technologists must be more than trained they must be educated. Broski states: "The mission of the medical technology program is to prepare men and women who wish to become professional medical technologists....The major goal of this program is to prepare personnel thoroughly versed in the theoretical aspects and basic principles of laboratory medicine. These technologists must be capable of adapting to changing needs, new procedures, and new fields in the clinical laboratory. The medical technologist must be prepared to assume responsibility for supervision, quality control, research and development, and the educational aspects of clinical laboratory practice"(26). A busy hospital laboratory surely cannot be the ideal environment in which to mold Broski's - and our - medical technologist.

Prior to the revised Essentials of 1972, laboratory professionals were attempting to direct the medical technology education base to the college/ university setting and away from the isolated clinical facility. Hovde(62) in 1957 reported the success of the program based at the University of Minnesota.

A four year integrated program was developed at West Virginia University in 1963(86), the same year the first master's degree program in medical technology at Temple University was reported(130). The cry for more such programs rose throughout the profession(63, 178, 60). Sample curricula demonstrating effective integration were published(e.g., 80, 181, 135). Some hospital-based programs developed student lecture and laboratory facilities in which to prepare students before allowing them "hands-on" experience(59, 150).

In 1970, Light(83) argued that medical technology education must be removed from the hospitals for the sake of lower cost to the patient and "in recognition of the need for a more sophisticated level and amount of general knowledge possessed by all health personnel - knowledge which cannot be acquired solely from on-the-job, skill-focused exposures".

French(47) stated that there is "a dichotomy in which we see academic education as the 'knowledge phase' and clinical work as the 'application phase'". Cicarelli(33) agreed, arguing that one of the greatest problems has been "the lack of relevance between the academic and clinical education". Yeazell(183) cited the need for broader education for medical technologists in problem-solving abilities and not just technical skills.

Alternative programs have been developed to this end. Some programs have minimized the time spent in the clinical setting by increasing time spent in more efficient and effective student laboratories(173, 126, 54). Others allow students to spend two years preparing for Medical Laboratory Technician certification and then choose, if they wish, to complete two additional years for Medical Technologist certification(126, 14, 143). The number of "2+2" programs - those university-based programs which rely heavily on student laboratory settings - has increased dramatically(13). A few programs allow students to concentrate in an area of special interest during their fouth year(81, 123). One program includes a course in educational methodology(166) while another offers students human relations training(28).

The results of such experimentation are encouraging. Rausch(124, 125) studied various parameters of competence of graduates of both traditional "3+1" programs and those of "2+2" programs. Some of the latter experienced as much as a 62 per cent decrease in the amount of clinical exposure. She found no significant difference between the performance capabilities of the groups.

The profession has committed itself to competency-based education, "a method of preparing students to function in a manner and at a level that is required in actual clinical laboratory practice"(146). Consequently teaching approaches in medical technology have been modified to incorporate various educational methodologies which will make this goal more attainable. Some examples of these include the use of behavioral objectives (4, 92), criterion-referenced testing(144), and personalized instruction(79).

Another methodology which has learning enhancement properties is the use of corrective feedback. It has been written that "learning is improved when students are given specific feedback regarding their progress. In general, the more specific this feedback is, the greater is the probability that students will improve"(142). Educators and psychologists have continually evaluated the effects of feedback on learning in order that its potential can be maximized. This methodology, however, has received little or no attention in medical technology education. Therefore a project incorporating corrective feedback in medical technology education was developed for this study.

The term feedback will be defined here as that information given to a learner which informs him whether an instructional response is correct or incorrect, and if incorrect, provides him with knowledge of the correct response. A non-graded study guide was selected as the vehicle in which to provide feedback to students.

PURPOSE AND SCOPE

This study was undertaken to develop, implement, and evaluate a novel educational tool, a study guide providing immediate corrective feedback, in the education of undergraduate medical technology students.

The purpose of this study was two-fold: 1) to develop a study guide utilizing corrective feedback in medical technology education, and 2) to evaluate the effect of this treatment by examining class examination grade trends. The hypothesis is as follows: corrective feedback administered as an aid to study enhances learning, as indicated by a positive shift (or peak) in an examination grade continuum following such treatment.

The intent of the study was to determine if this type of study aid which provides feedback affects the subsequent examination grades of the class relative not only to the grades of prior classes but also to the individual's own grade trend prior to treatment.

While the target population of this study was a class of undergraduate medical technology students, it is thought that the study guide format can be developed and utilized in virtually any classroom environment.

CHAPTER II

REVIEW OF LITERATURE

INTRODUCTION

The literature on feedback research is complex and fascinating. This review begins with a brief history of learning theory to trace the roots of feedback in education, followed by a review of the literature defining feedback and studying its role in the learning process. A brief discussion of teaching machines and programmed learning is included because such techniques have been the predominant educational vehicles through which corrective feedback has been utilized in the classroom. As a result of reviewing these reports, we can see the potential of the material developed for this study in the area of medical technology education.

BRIEF HISTORY OF LEARNING THEORY

Introduction

We must first understand why and how students learn before we can design effective instructional methodology. The formative years for learning theories were the late 1800s through the middle of this century. Psychology, for much of its history, was intimately tied to philosophy since "all science has sprung from man's philosophical gropings after the meaning and nature of things"(109).

The branch of psychology known as Associationism was the first to address the question of learning. This group felt that knowledge was comprised of associations between concepts and ideas, and learning was simply "the acquisition of association" and not a separate process(109).

William James was one of the first to theorize that learning had a biological basis. He felt that "learning was an association of experiences through repetitious exposure. The nervous system was altered by the repetition, so that the occurrence of one experience facilitated its recurrence"(109).

The Functionalists of the early 1900s paid little attention to learning. They assumed it "to be the process which eventually enabled behavior to pass from conscious control to automatic habit"(109).

One of the first coherent and detailed theories of learning was contributed by Edward L. Thorndike. He felt that all behavior, including learning, could be broken down into stimulus-response units(169). An "organism learned through trial and error, fixing upon those actions which were rewarded, dropping those which were not rewarded or were punished"(109). He developed the Law of Effect which stated that "any act which produced satisfaction in a situation became associated with that situation, so that when it recurred, the act became increasingly likely to recur as well"(109). Thorndike's views became known as the reinforcement theory of learning.

The Russian physiologist, I. P. Pavlov, demonstrated Thorndike's stimulus-response theory on animals. By substituting a stimulus different from the original one, the original response could be maintained through careful control of the stimuli. This process was known as conditioning(109).

J. B. Watson, the founder of the Behaviorism school of psychology, applied Pavlov's conditioning theory to human behavior. He felt that learning was "the establishment of connections between physiological events"(109). Watson(174) conditioned an infant to fear a rat by accompanying each appearance of the rat with a loud noise. He believed that the infant "learned" to fear the rat.

Two other behaviorists worked with the reinforcement theory of learning. Clark Hull(64) extensively applied reinforcement learning to his animal studies. He found that "the greater the delay between the time of the act and the time of its reinforcement, the weaker would be the connection"(109). O. H. Mowrer(109) felt that reinforcement learning applied only to motor activities, and that a great deal of learning came from an emotional basis.

B. F. Skinner and the Theory of Reinforcement

B. F. Skinner is undoubtedly the most well-known psychologist since Freud. His influence on psychology and education is unquestionably felt to this day.

To understand Skinner's theory of learning we must first understand his theory of behavior. There are three basic tenets to

Skinnerian psychology: "1) organisms...are active - they emit behaviors of various kinds; 2) when a behavior is emitted it has consequences that may affect the future of the behavior - these consequences may either increase or decrease the likelihood that the behavior will occur again; 3) the consequences are determined by the organism's physical and social environments"(112). Emotions do not cause behavior; consequences of behavior cause emotions(112).

Skinner differs from the earlier behaviorists in that their prime concern was conditioning. Conditioning exists, says Skinner, but only for reflexive responses. He feels that most of our behavior consists of operants, which are "behaviors that 'operate' or act on the environment to produce consequences, and are in turn affected by those consequences....The consequences determine whether we do the same thing (or something similar) again, or try something else"(112). Thus reinforcement can be defined as "a process whereby the probability that a certain response will occur in the future is elevated, due to the response having been followed in the past by some stimulus having reward value"(113).

Skinner spent many years studying the effects of reinforcement on animal behavior through the use of his now classical experiments. He felt that his studies on the animal learning process could be transferred to humans, so he turned to the fundamental question of why children do and do not learn(95).

Reinforcement, Feedback, and Learning

Learning, to Skinner, was "the establishment...of connections between operant behavior and reinforcement. The strength of the learner response depends on the amount of reinforcement it had received"(109). Also crucial to learning was the type of reinforcement utilized. This can be discussed in terms of feedback.

The consequence of a behavior which follows that behavior's emission is called feedback. It is important to understand that feedback and reinforcement are not synonomous. The former is "not necessarily defined by its effect on the recurrence of a response"(2). Reinforcers are feedback, but feedback is not always reinforcing. Those forms of feedback which are reinforcing must be identified and utilized in education, according to Skinner, to enhance learning. For example, feedback such as "praise, approval, success, novelty, and many other events are reinforcing, depending upon the individual's particular past experience"(118).

There are certain generalizations from the reinforcement theory that could be applied to education. These are summarized as follows:

> 1. An individual learns or changes the way he acts by observing the consequences of his actions.
> 2. Consequences that strengthen the likelihood of repetition of an act are called reinforcements.
> 3. The more quickly reinforcement follows the desired performance, the more likely the behavior will be repeated.
> 4. The more often reinforcement occurs, the more likely the student will repeat the act.
> 5. Absence or even delay of reinforcement following an action weakens the probability that the act will be repeated.

> 6. Intermittent reinforcement of an act increases the length of time a student will persist at a task without further reinforcement.
> 7. The learning behavior of a student can be developed or shaped gradually by differential reinforcement - that is, by reinforcing those behaviors which should be repeated and by withholding reinforcement following undesired acts.
> 8. In addition to making repetition of an act more probable, reinforcement increases a student's activity, quickens his pace, and heightens his interest in learning. These may be called the motivational effects of reinforcement.
> 9. A student's behavior can be developed into a complex pattern by shaping the simple elements of the pattern, and combining them into a chainlike sequence(93).

The question remained: what form of reinforcement would best enhance learning? It was felt that knowledge of results, a form of feedback, had reinforcing properties. However, research on knowledge of results and other forms of feedback produced many startling findings.

FEEDBACK RESEARCH

Introduction

The term feedback, as it is applied to educational research, can be simply defined as providing a learner with knowledge of correct results following his response to an instructional query. A simple example of feedback is reviewing the correct answers to a test in class.

One of the first indications of the effect of knowledge of results was reported in 1923 when Jones(67) demonstrated that immediate testing following each class lecture resulted in improved retention of the material, even after eight weeks. Three years later Pressey(120, 121) published data from his teaching machine studies and expounded the virtues of corrective feedback. Curtis and Woods(36) reported in 1929 that students who correct their own test papers received higher scores on subsequent tests than those whose tests had been corrected by the teacher. They concluded that the former group was forced to face their mistakes and correct their misconceptions.

The following year Peterson(114) developed the "chemo card", a self-correcting device utilizing moisture-sensitive inks. He conducted a study in which the class used study questions to guide them through reading assignments. One group used the self-correcting device to gain knowledge of results from the study questions. Peterson(115) found that the group which used his "Self-Instructor and Testor" gained 2.4-3.0 times as much information from the reading than did the group without feedback, and that the gain was almost as great when the test questions were changed or reworded. Little(84) encountered similar results in his 1934 study.

Spitzer(157) reported in 1939 that feedback was not the factor that resulted in better performance. He demonstrated that simply taking a test strengthens performance on future tests. Some subsequent studies agreed(8, 128, 134, 46).

The next four decades of educational and psychological literature were full of studies on feedback and just as full of controversy. The promise of Skinner's premise - that feedback, if reinforcing, enhances learning - prompted a massive wave of experimentation.

The concensus of studies(77, 5, 127, 42, 138, 24, 106, 7, 27, 49, 55, 11, 176, 122, 66, 58, 15, 17, 167, 184, 10, 99, 70, 45, 103) apparently suggests one fact: "when students respond to an instructional communication, telling them whether or not their answer is correct increases the amount of material remembered on a later test"(77). "Unfortunately, the mechanisms responsible for such facilitation are frequently misunderstood, and one can find numerous examples in both research and instructional development where feedback is used inappropriately, neutralizing any positive effects it might have on student performance"(77).

Inappropriate Uses of Feedback

Examples of inappropriate feedback use are found in numerous studies which concluded that feedback does not enhance learning(163, 133, 73, 96, 43, 104, 105, 110, 52, 136, 16, 137). Some studies have also documented better performance by groups receiving no feedback or not even seeing test questions prior to the examination than groups receiving feedback(88, 72). Others have found that feedback increased the number of errors on subsequent tests(18, 158).

Kulhavy(77) feels that most of the studies cited above relied on heavy prompting and cuing of the feedback group so that this group could answer correctly simply by skimming the content of a reading assignment. This is supported by studies which report that feedback groups always finish testing sooner than groups which had not received feedback, yet both groups scored approximately the same on the posttest(163, 105, 88). Sullivan(105) feels the feedback groups may have acquired a false sense of learning due to the feedback.

The most widely accepted explanation is that learners copy the answers when available instead of studying the text material(77, 7, 88, 6). In studies where feedback was not available to the learner until after a response was made, the group performed significantly better than groups without feedback(7, 49, 11, 103).

Anderson(7) studied this so-called "peeking" effect and found that "achievement was a decreasing function of reported frequency of copying". He summarized that "even if they are not actually copying from the (feedback) students may study less carefully when (it) is always immediately available"(7). Kulhavy(77) refers to this as "presearch availability" and stresses that "availability must be low if one hopes to perform valid comparisons among different feedback arrangements".

Feedback as Reinforcement

Kulhavy(77) argues that much of the inconsistency in feedback research is due to the acceptance of the premise that feedback is reinforcing. Researchers assumed feedback was reinforcing and tried to fit their classroom experimental data to that concept(77).

Some interesting data began to emerge. If feedback were indeed reinforcing, then animal studies indicated that it must be administered as soon as possible following the desired behavior(65, 152, 155). Yet a number of classroom studies revealed that delaying feedback after a response (as little as ten seconds to as much as 48 hours) enhanced retention to a greater degree than did immediate feedback(42, 138, 24, 106, 72, 140, 91, 117, 165, 23, 21, 35, 82, 22, 159, 160, 161, 116). "These consistent results are sharply opposed to what we would expect to find if feedback reinforces, since one of the surest ways to destroy whatever control a reinforcer has over behavior is to seperate it from the response by a lengthy interval"(77). Brackbill(23, 22) named this phenomenon the Delay-Retention Effect or DRE.

Two explanations have been proposed for DRE. Kulhavy and Anderson(74) feel that "learners forget their incorrect responses over the delay interval, and thus there is less interference with learning the correct answers from the feedback". They called this the "interference-perserveration hypothesis". They also suggested that time is a critical factor. When learners take a test and immediately get it back, they spend less time studying the feedback "due to fatique and frustration"(74). They demonstrated that the probability of a student repeating incorrect answers is significantly higher for those who receive immediate feedback, a fact which lends credence to their hypothesis(74). Sturges(160, 161) modified this explanation somewhat. He felt that when a student is told that his response is correct, he pays no attention and proceeds to the next question. However, if there is a delay between responding and knowledge of results, the student must engage in a fuller exploration of the material, a "more thorough semantic analysis of information presented at feedback"(161).

Surber and Anderson(165) argued that if feedback were reinforcing, then it would increase the ratio of subjects repeating their correct responses between the initial and retention tests; this was not observed. Kulhavy(77) concludes that "it is difficult to find data indicating that feedback following written instruction functions in the manner predicted by Skinner and others. One is forced to accept the fact that whatever feedback does, it rarely acts as a functional reinforcer with text-based meterials". Another explanation must exist for the learning enhancement properties of feedback.

Feedback as a Corrective Force

Let us assume that the student has some prior knowledge of the material he is studying. "Under these conditions, the response to each question is based on both general information related to the item and specific information covered within the text just read. In other words, the feedback acts to inform the student of the accuracy of his response relative to knowledge he already possesses about the content"(77). Thus when a student answers an item correctly, the feedback which tells him he is indeed correct allows him "to perceive that his interpretation of the subject matter is the correct one"(77).

In the event of an error, feedback causes the student to realize he has made an error and must now substitute correct information for the incorrect information. A number of studies suggest that the effective function of feedback in learning is a corrective one rather than a reinforcing one(113, 6, 165, 170, 29, 9, 53, 168, 141). Persuasive evidence is found in studies which indicate that there is a very significant difference in performance when a learner is informed of the correct response to a question rather than simply being told "correct/incorrect"(49, 176, 170, 32). The student receives a chance to replace the misinformation with correct information before the test(9).

"By and large, it appears that feedback fails to facilitate only when instruction is so difficult and unfamiliar that students cannot glean a plausible answer....One should assure that the material used is appropriate for the learner population"(77). It is also critical to remember that both errors and correct answers have a marked tendency to be repeated on future tests(74, 68, 75, 76). Corrective feedback, if properly used, could help capitilize on the repetition of correct responses and decrease the frequency of incorrect ones.

Types of Feedback

Feedback types can vary greatly. Studies which compared simple feedback to more extensive formats generally revealed no difference in performance(77, 96, 19, 101, 129). Also, no difference was observed when feedback content was redundant to the correct response(113, 77, 69). Improvement was seen when the feedback was made more extensive, thus serving as a partial review of the material(77, 27, 20, 102).

Learner Expectations and Confidence

Learner expectations have an effect on the extent to which feedback is utilized. Locke(85) contended that a student who knows he is getting most of his answers correct sets high goals for himself and thus performs better. Yet Rust et al(136) found that goal setting in seventh graders had no significant effect on feedback utilization and performance. Salzberg(137) found that when feedback was combined with other motivation such as extra play time, kindergarten childrens' printing skills increased in accuracy. Hanna(56) argued that Locke's contention could swing to the other extreme by proposing that feedback may "adversely affect the performance of some anxious examinees who happen to score poorly on early items".

Hanna(55) related learner types to feedback types. He felt that highly motivated or inquisitive students utilize feedback more readily if it simply informs them if they answered correctly. These students will then seek the correct response on their own. However for poorly motivated or low achievers, knowledge of the correct response is necessary since the student probably would not have sought it out himself.

Conclusions

Thus, we see that feedback enhances learning in a corrective fashion rather than a reinforcing one. It is most effective when: 1) material is not overly difficult, causing a learner to guess answers, nor overly simple, where no errors are made; 2) students must respond before having access to the feedback; and, 3) feedback is extensive enough to constitute a partial review of the material.

Feedback has great potential to enhance learning if utilized properly. Teaching machines and programmed learning have been the classic educational vehicles through which feedback has been provided to students.

TEACHING MACHINES AND PROGRAMMED LEARNING

The first patent for a "teaching device" was issued in 1809(100). However, a teaching machine can be traced to medieval times to a device used to train knights for combat. The device supported a shield which the knight was to hit in the center with his lance. An off-center blow would cause the device to pivot "and deliver feedback by striking the horseman a blow with a flail or some other instrument as he rode by"(51).

The basic classroom teaching machine was developed by S. L. Pressey in the early 1920s. Pressey(120, 121) published his studies in 1926 and 1927; these reports were filled with enthusiasm for the new device. The machine was a mechanical device which presented a multiple-choice question to the learner. The student selected the response he thought correct and depressed a key which corresponded to his selection. The next question would appear if his response was correct. An incorrect response was tallied and the question remained until the student answered correctly. Pressey(121) felt that the immediate feedback received by the student would establish the correct response in the learner's mind "since the last answer chosen...is the right answer". An added benefit to the enhanced learning by the student was the freedom from the time-consumming task of test correction by the teacher(121).

The teaching machine represented "some form of variation on what can be called the tutorial or Socratic method of teaching"(89). Socrates was the master of the problem-and-solution method of teaching by using careful questioning to guide his students to knowledge. The modern variant was the tutorial method, perfected by English universities, which involved "continuous exchange of questions and answers between the tutor and his student...and the constant selection of new material on the basis of the student's mastery of what had gone before"(93).

The teaching machine also fulfilled three basic conditions of learning: 1) the learner learns best what he does (the student is continually active); 2) learning is enhanced by reinforcement and/or knowledge of results (there is prompt feedback to the learner); and 3) learners vary greatly in the rate at which they learn and perform (the student proceeds at his own rate)(90).

Interest in the teaching machine declined during the Depression. It was Skinner who renewed interest in the device with the publication of his 1954 paper, "The Science of Learning and the Art of Teaching"(151). Skinner propounded the beneficial effects of reinforcement on human learning. He also stressed that education must take advantage of latest technologies to become more efficient.

Skinner(151) developed his own teaching machine, a modification of Pressey's device but which taught instead of tested. Skinner's device required the learner to compose his own response rather than select from given choices. He wanted to reinforce correct answers and not just see if the student knew or could recognize correct answers. "Reinforcement theory stresses that a student learn from the consequences of his responding, not from the making of responses itself"(93).

Skinner(151) also raised the frequency of reinforcement to a maximum by breaking down the subject matter into very small steps. Thus if the previous problem had been answered correctly, the chances were very high that the present one would also be correctly answered.

The military began developing very sophisticated devices modeled after these teaching machines in the 1950s(e.g., 25). These devices were predominantely for basic skills training and equipment troubleshooting.

In 1959, researchers at the University of Pittsburgh developed the first "'paper teaching machine' or 'programmed textbook'"(50). They subdivided text material into very small concept units, called frames. The student was required to read and study each frame and then respond to the question within each frame. He would then turn the page to compare his answer with the correct one before proceeding to the next frame. This was the beginning of programmed instruction as it is known today.

Interest in this "paper teaching machine" increased. Lysaught and his colleagues(93) developed the first college course in programmed learning at the University of Rochester in 1961 and published the first basic guide to the techniques of programming. Lysaught(93) stated: "Programming is the process of arranging materials to be learned in a series of small steps designed to lead a student through self-instruction from what he knows to the unknown of new and more complex knowledge and principles". Skinner(153) wrote that "programmed instruction is primarily a scheme for making an effective use of reinforcers, not only in shaping new kinds of behavior but in maintaining behavior in strength". He credits Pressey for recognizing "the importance of immediate feedback in education"(153). Lysaught(93) agreed with Skinner, stating that one of the most important positive aspects of programmed instruction is that the "motivation to learn indeed may increase because of students' immediate knowledge of success".

Other forms of programmed instruction developed. Keller(71) popularized his modular unit program, now commonly known as the Keller plan. Postlethwait(119) utilized 8-mm films and taped lessons to create an audio-tutorial program. One of the most modern programs in self-instruction is Computer-Assisted Instruction which has been utilized in several types of settings(e.g., 12, 164).

Since programmed instruction has become the most popular vehicle for utilizing feedback in the learning process, we must examine its use in the education of medical technologists.

PROGRAMMED INSTRUCTION IN MEDICAL TECHNOLOGY EDUCATION

Programmed instruction was first studied extensively in medical education in 1962(175). Countless examples of its continued and expanded use in the education of physicians can be found in medical literature(132, 37, 3, 111, 94, 41, 98). Examples are also found in dental(40) and nursing(156) education. All such reports are enthusiastic about the success of such methodology.

The Department of Health, Education, and Welfare published a report on "Manpower for the Medical Laboratory" in 1967. Recommendations by the conference were numerous and included this: "New curriculums and teaching methods should be explored, with experimentation encouraged, and self-instruction in laboratory education should be utilized more effectively"(38).

The earliest published report on self-instruction in medical technology education was in 1965. Woodward(182) prepared two self-instructional packages and found they were efficient and effective. She felt they would be especially useful in hospital-based programs where students come from varied colleges and thus have different learning backgrounds(182). Another package was developed that year by Williams(179). She stated that "Medical Technology cannot afford to reject the assistance offered by any discipline, which will improve the efficiency and effectiveness of the teaching program. Programmed instruction may be one method by which improvement will be achieved"(179).

Additional self-instructional packages had been developed for use in medical technology education by the close of the 1970s(e.g., 147, 149, 44, 154,). Shafer et al(148) found that their self-instructional package was more effective than conventional methodology in red cell morphology instruction.

Audio-tutorial units have also been reported(162, 78, 1). These consisted of slides, tapes, and worksheets which provided immediate corrective feedback to the learner.

Keller's personalized system of instruction (modular learning) has also been tried(48, 172, 79). One contract method of personalized instruction allows students to set their own goals for each unit and then receive personalized feedback after the completion of each unit(34).

A latent image (see Chapter III) simulation was developed for "Laboratory Characterization of Anemias"(145). The feedback in this unit aids students in decision-making skills.

Programmed instruction is present in medical technology education. The quantity, however, is not impressive. No other vehicle for utilizing corrective feedback was found in the literature of medical technology education.

The education of medical technologists must keep pace with the increasing technological demands of the profession. Just as we must continually modify what we teach, we must also modify how it is taught in order to meet these demands.

Research has demonstrated that corrective feedback can enhance learning when properly utilized. Limited studies of its use in medical technology education are available but only through the educational tools of self-instructional packages, written simulations, and unit modules. While more of these tools need to be developed and studied for use in the education of medical technologists, the writer felt a new vehicle could provide feedback to students in a more effective manner. Thus a study guide utilizing immediate corrective feedback was developed and administered to undergraduate medical technology students.

CHAPTER III

MATERIALS AND METHODS

STUDY GUIDE

The overall topic for this project was hemostasis. The study guide itself consists of two sections. The first section (Appendix A) contains fifty questions in multiple choice format, each with four responses ("response" is used to designate the work/phrase choice available to the student in answering each question). Questions for the study guide came from three sources. The majority were developed by the writer. The balance was selected from both the question pool of Ms. Sandra R. Sommer, Assistant Professor of Medical Technology at Virginia Commonwealth University and from various hematology tests in the writer's possesion. Each question was followed by one best response and three distractors. All questions and answers were approved by the instructor and were objective-related to the course material (see LECTURE below).

The second section of the study guide (Appendix B) contains directions for completing it, as well as a statement of the purpose and intent of this study. The latter assured the students that this material would not be graded. A nine page answer sheet followed in latent image printing ("answer" is used to designate the writer's reply to any response selected by the student).

The answer sheet contained the number and letter of each question and response in visible type. An answer for each response followed printed in latent image (see MEDIA below). If the correct response was selected, development of the corresponding area of the answer sheet would reveal a positive reinforcement (e.g., "Very good!", Excellent work!"). Many answers contained a brief reiteration of the concept or principle tested to provide remediation in the case of "guessing" the correct answer. If an incorrect response was selected, development of the corresponding area of the answer sheet would reveal a negative reply (e.g., "No.", "Incorrect.") followed by one of two reply types. The majority briefly explained why the selected response was incorrect. The remainder directed the student to a specific reference in the required or optional readings or prepared hand-outs. Students were instructed to develop additional answers until the correct response was selected.

MEDIA

Written corrective feedback can be provided to students by various methods. Latent image printing was selected for this study. The technique as devised commercially by the A. B. Dick Company (West Touhy Avenue, Chicago, Illinois, 60648) was used.

The answer sheet was prepared as follows. Visible material (e.g., question numbers) was typed on a standard ditto sheet. The carbon backing was then replaced with a Latent Image Transfer Sheet®. The answers were then typed as with the ditto. A wax-based lettering is transferred to the ditto. This is invisible when the sheets are duplicated in the normal ditto manner. The words will appear when touched with a Latent Image Developer®. This is a felt-tipped pen impregnated with a special chemical which develops the invisible lettering. Each latent image spirit master can make 120 copies. An offset printing technique is available for commercial use(131)

LECTURE

Material included in the study guide was derived from the course content and behavioral objectives of MET-302 (Hematology), Hemostasis sub-unit, in the Department of Medical Technology at Virginia Commonwealth University. The writer developed and presented seven one-hour lectures with corresponding objectives (Appendix C) and reading assignments for the course unit. Two laboratory sessions were also included. Each study quide question related to a behavioral objective.

SUBJECTS

Twenty-six students in the junior class in the Medical Technology program at Virginia Commonwealth University were enrolled in MET-302. Following the third hemostasis lecture (2 December 80), all were asked to participate in this study by completing the study guide prior to the hemostasis examination on 12 December 80. Each received a copy of the study guide, answer sheet with directions, and a Latent Image Developer®. An explanation of the purpose and intent of the study was prefaced by a discussion of the positive benefits of corrective feedback utilized in a non-graded situation as perceived by the writer. An appeal for compliance was issued and the students responded with enthusiasm.

EVALUATION

An objective-related examination in short-answer format was administered on 12 December 80. This exam consisted of 15 questions (some with sub-parts) related to all or portions of the 70 behavioral objectives. An extra-credit question was included resulting in a total of 105 possible points. All 26 students completed the exam. The students were informed of the exam format on at least two separate occasions so that they would not expect multiple choice questions similar to those of the study guide. All copies of the study guide and answer sheet were returned to the writer prior to the exam.

STATISTICAL ANALYSIS

Multiple Time Series Design

Data consisted of the hemostasis examination grades, the four prior exam grades of each student in this course, and the final comprehensive score. The same exam grades in this course for the three previous classes were also collected. Analysis of the data was by the quasi-experimental multiple time series design of Campbell and Stanley(30).

This design involves a comparison of several values of a dependent variable (exam grades) prior to an experimental treatment (administration of corrective feedback during a student's independent studying), and values of the variable following treatment. The data are then plotted on a graph to depict the examination grade trend of each class and examined to see if the treatment resulted in a positive shift of the trend.

Test of Significance

A test of significance was selected to compare the gains illustrated by the positive peaks in the examination grade contunuum of all four classes. The test of choice was the unpaired t-test. The null hypothesis was that no difference existed between the gains of each of the four classes.

The means were calculated by summing the differences between Exam 4 and Exam 5 scores and dividing the sum by the total number of students in each class. Standard deviations were calculated on the variation of grades about the appropriate mean(57).

The unpaired t-value was calculated from the following formula:

$$t = \frac{\overline{D}_A - \overline{D}_B}{\sqrt{s^2 \frac{N_A + N_B}{N_A N_B}}}$$

where: $\overline{D}_A$ = the mean of the differences of the first sample population

$\overline{D}_B$ = the mean of the differences of the second sample population

N_A = the number of individuals in the first sample population

N_B = the number of individuals in the second sample population

s^2 = the pooled estimate of the population variance formulated by:

$$s^2 = \frac{(N_A - 1)s^2A + (N_B - 1)s^2B}{N_A + N_B - 2}$$

where: N_A = the number of individuals in the first sample population

N_B = the number of individuals in the second sample population

$s^2{}_A$ = the standard deviation of the first sample population

$s^2{}_B$ = the standard deviation of the second sample population

$N_A + N_B - 2$ = the degrees of freedom allowed for the two populations to be representative of the true population.

The unpaired t-test was used to compare means of the differences between exam grades 4 and 5 between all four classes. The hypothesis was tested at the significance level of $P = 0.01$.

ATTITUDINAL SURVEY

An Attitudinal Survey (Appendix D) concerning the Hemostasis Study Guide was distributed to the students on 9 February 81. The format consisted of 17 attitudinal questions dealing with the length, format, types of responses, etc. of the study guide. Comments, criticisms, and suggestions were solicited.

CHAPTER IV

RESULTS

STATISTICAL EVALUATION OF DATA

Class averages for each of the six exams are listed in Table I. Shown also are the averages for the three previous classes (controls) in the same course. The Class of 1980 took a combined form of the first and second exams. Therefore, only five averages are listed for this class in Table I.

Figure 1 depicts the examination grade trend of the four classes. The letter "X" represents the beginning of the hemostasis subunit taught by the writer in which the students utilized the study guide prior to the fifth exam. The graph is after the method of Campbell and Stanley(30). A positive peak was observed for all four classes between the fourth and fifth exams. The clases demonstrated fairly similar trends throughout the course.

Tables II, III, IV, and V list the grades of the fourth and fifth exams for the Classes of 1982, 1981, 1980, and 1979 respectively. The unpaired t-test was performed on the mean differences between the grades.

The results of the unpaired t-tests are shown in Table VI. All t-values were checked for significance at 50 degrees of freedom at a significance level of P=0.01. The table t-value for these parameters was -2.40 (39). The calculated t-values between the Class of 1982 and each of the three other classes exceeded the table value; thus, there was a significant difference in the gain between the fourth and fifth exams for the experimental class at a confidence level of 99%. Differences between the three control groups were not significant at this level.

STUDENT REACTION TO THE STUDY GUIDE

Twenty-one students (81%) completed and returned the Attitudinal Survey. All questions were answered by all students. A tabulation of student responses is seen in Table VII.

The majority of respondants (81%) spent one to three hours completing the study guide. Only 9.5% worked longer than three hours, and 9.5% worked less than one hour. Student comments will be discussed in Chapter V.

TABLE I

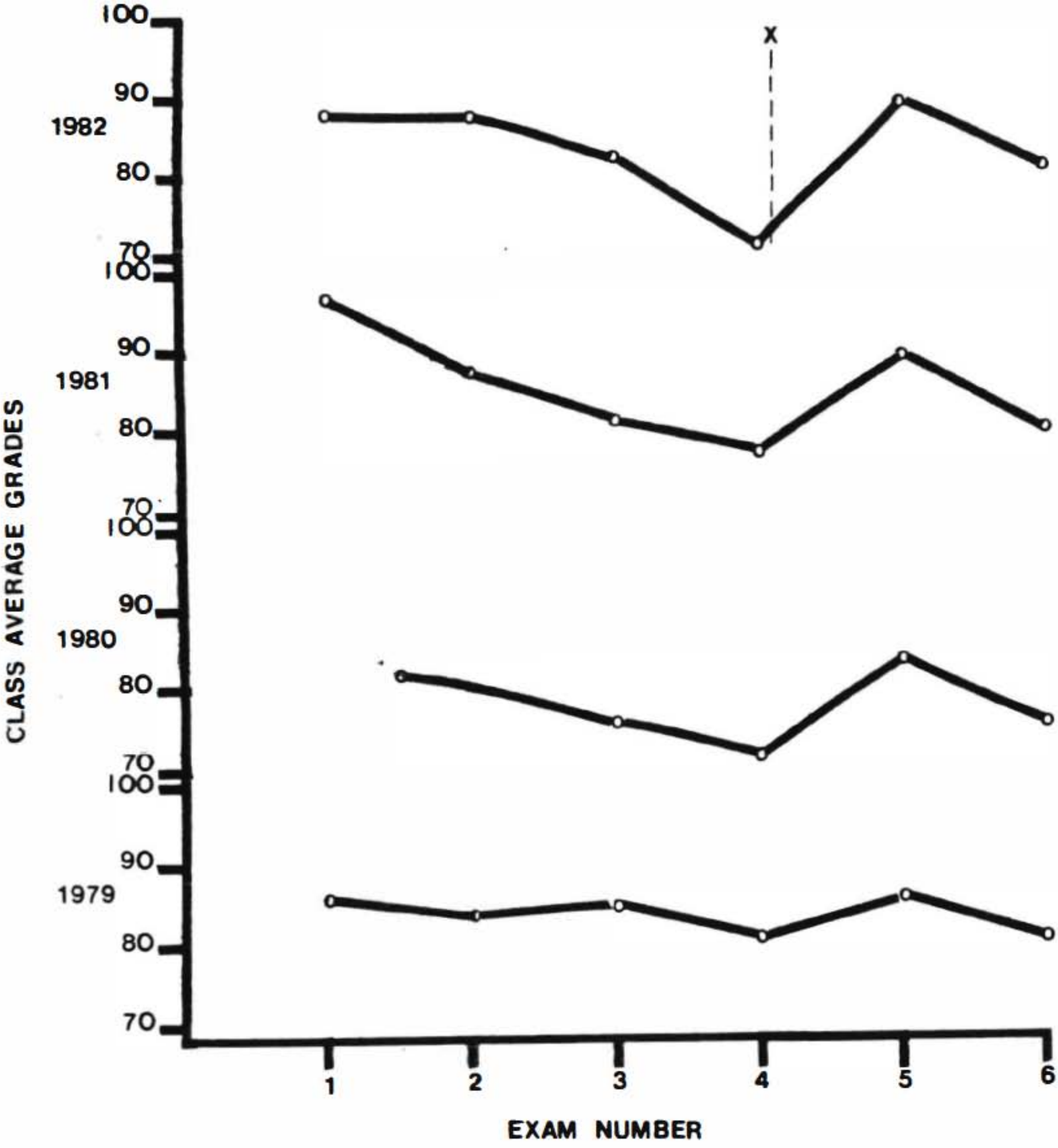
CLASS AVERAGES BY EXAM

CLASS	EXAMINATION NUMBER 1	2	3	4	5	6
1982	88	88	83	72	90	82
1981	97	88	82	78	90	81
1980	*82		76	72	84	76
1979	86	84	85	81	86	81

*Class of 1980 took a combined form of exams 1 and 2.

FIGURE 1

EXAMINATION GRADE TREND
HEMATOLOGY EXAMS (MET-302)



*Exams 1 and 2 were combined.

X: Hemostasis subunit begins; use of study guide.

After Campbell + Stanley (30).

TABLE II

CLASS OF 1982

GRADES ON EXAMS 4 AND 5

STUDENT	EXAM 4	EXAM 5
1.	75	101.5
2.	74.5	94.5
3.	71.5	95.5
4.	69	94
5.	71.5	95
6.	66	83.5
7.	66	80
8.	73	70
9.	65.5	79.5
10.	74.5	79
11.	79	100
12.	54.5	84
13.	58	90
14.	70	81
15.	85	102
16.	67.5	74
17.	75.5	98.5
18.	87	102
19.	62.5	98
20.	69	81.5
21.	69	91.5
22.	88	101.5
23.	69	89.5
24.	74	97
25.	85	96
26.	72	85.5

TABLE III

CLASS OF 1981

GRADES ON EXAMS 4 AND 5

STUDENT	EXAM 4	EXAM 5
1.	62	95.5
2.	96	99.5
3.	77	97.5
4.	63	94
5.	79.5	87.5
6.	81.5	90.5
7.	91	99
8.	82	80
9.	75	85.5
10.	88.5	88
11.	74.5	83
12.	84	103
13.	62.5	85.5
14.	88	89.5
15.	73	83
16.	81	72.5
17.	70.5	87
18.	75.5	94.5
19.	78	98
20.	82	89
21.	67.5	86
22.	88.5	99
23.	81.5	89.5
24.	88	98.5
25.	74.5	89.5
26.	70	80.5
27.	84	80

TABLE IV

CLASS OF 1980

GRADES ON EXAMS 4 AND 5

STUDENT	EXAM 4	EXAM 5
1.	78	89.5
2.	81.5	91.5
3.	68	92
4.	67.5	68.5
5.	70.5	81
6.	89	96.5
7.	82	91.5
8.	55.5	76
9.	86	103
10.	69	86.5
11.	72.5	85
12.	66.5	86
13.	73.5	90
14.	52	61.5
15.	54.5	54.5
16.	67	79.5
17.	75.5	81.5
18.	87	99.5
19.	69	52.5
20.	69.5	74.5
21.	50.5	77
22.	74	77.5
23.	85.5	91
24.	60.5	84.5
25.	67	75.5
26.	83.5	90.5
27.	77.5	92.5
28.	69.5	97.5
29.	76.5	90
30.	90	101.5

TABLE V

CLASS OF 1979

GRADES OF EXAMS 4 AND 5

STUDENT	EXAM 4	EXAM 5
1.	80.5	85.5
2.	79.5	80.5
3.	70	85
4.	89.5	102.5
5.	73	88
6.	91.5	102.5
7.	72.5	63.5
8.	86	76.5
9.	89	83.5
10.	88.5	92
11.	78	85.5
12.	76.5	68.5
13.	68.5	92
14.	91.5	94
15.	73	66.5
16.	97	93.5
17.	60	71.5
18.	79.5	89
19.	70.5	79.5
20.	88	96.5
21.	92	97
22.	77.5	90.5
23.	80	80.5
24.	81.5	99.5
25.	74	77.5
26.	84.5	99
27.	83.5	94
28.	70.5	79.5
29.	85	93
30.	85	92.5

TABLE VI

UNPAIRED t-TEST VALUES

t values were calculated on the mean gain between exams 4 and 5 for each class, and the gains tested between each of the classes for significance.

CLASS	1982	1981	1980	1979
1982		S -2.65	S 2.96	S 5.68
1981	S 2.65		-0.03	2.18
1980	S -2.96	0.03		2.38
1979	S 5.68	-2.18	2.38	

Degrees of freedom = 50

p = 0.01

Table t value = 2.40

S = significant calculated t value

TABLE VII

ATTITUDINAL SURVEY RESULTS

(21 RESPONDANTS)

STUDENT OPINION	YES	NO
1. Liked the study guide	21	0
2. Enjoyed latent image	19	2
3. Prior use of latent image	1	20
4. Spent adequate time on study guide	17	4
5. Developed each entire answer	12	9
6. Completed entire study guide	18	2
7. Study guide helped learning	21	0
8. Better prepared for test due to study guide	20	1
9. Helpfulness of study guide justified time spent with it	21	0
10. Develop more for other classes	21	0
11. Liked immediate knowledge of results	20	1
12. Study guide format would made a good test	12	9
13. 50 questions = good length	18	3
14. Good questions	21	0
15. Preferred answers which directed to reference	* 1	
16. Preferred answers with immediate remediation	*16	
17. It was fun	19	2
18. It was well done	21	0
19. It was clear	21	0
20. It was helpful	21	0
21. It was informative	21	0
22. It was practical	21	0

* = Remaining four liked both types equally.

CHAPTER V

DISCUSSION

INTRODUCTION

This project was designed to study the effects of corrective feedback on learning. Feedback has historically been provided to students in the format of programmed instruction. However Grundin(52) reviewed 13 studies on programmed instruction and found that not one showed increased learning due to feedback. Tait(168) stated that when the error rate is maintained at a very low level, as it is in self-instructional packages, the beneficial effects of feedback have very little chance of appearing. This correlates with earlier findings which stated that the major effective function of feedback is a corrective one (e.g., 9). Thus, feedback enhances learning when it allows students to replace misinformation with the correct data.

The writer selected another vehicle for the presentation of feedback to students. The Hemostasis Study Guide developed for this study attempted to utilize as many positive effects of corrective feedback as possible. Latent image printing lowered presearch availability. The majority of answers provided remediation. Several were extensive enough to act as a partial review of the material.

Some answers directed students to a reference text where a more extensive remediation than the writer could offer in a limited answer space was available.

The level of difficulty of the questions varied from simple recall through problem-solving questions. Each question was objective-related. Thus, the material was in accordance with that presented in lectures and required readings and could not be perceived as too difficult or "foreign" by the students.

The primary intent of the feedback was to act in a corrective fashion. Its purpose was to focus students' attention on areas in which they had misconceptions or incomplete knowledge. A secondary intent was to provide positive reinforcement with correct responses in an attempt to increase motivation and make the learning process fun.

EVALUATION OF RESULTS

The quasi-experimental Multiple Time Series design of Campbell and Stanley(30) was selected for use in this study. Such quasi-experimental designs "exist for situations in which complete experimental control is difficult or impossible"(171). Caporas and Ross(31) concur, adding that "this approach is characterized by an effort to use the logic of experimentation in situations which are not truly experimental". This study utilized historical data as controls and thus could not be classified as a true experiment. The Multiple Time Series design was selected because "the availability of repeated measurement makes (it) particularly appropriate to research in schools"(30).

The design lent itself well to this study. The four classes studied could not be rigidly controlled for variability. Yet the overall similarity of the groups (e.g., all first-year medical technology students selected for admission to the same program), the course content (all four classes under the direction of the same instructor), and the content of the exams (similar designs over the four years) served as general types of control between populations.

The unpaired t-test was selected as the test of significance. The t-ratio is based on the ratio of a sample mean to its standard error and it is used "to determine the probability of obtaining a difference of a given magnitude between two means as a result of sampling error"(57). Thus, we can compare the difference in means of two independent groups to determine the probability of obtaining the observed difference on a purely chance basis.

The results of the Multiple Time Series graph (Figure 1) illustrated a similar grade trend of all four classes. Also illustrated was a positive shift in the grade trend of each class between the fourth and fifth exam scores. Since each class demonstrated such a peak at the same point, the unpaired t-test was utilized to see if these gains were significant.

The results of significance testing were impressive (Table VI). The gain of the experimental group was significant when compared with the gains of each of the previous three control classes at the 99% confidence interval. Gains between the other three classes were not significant. These data suggest that learning was enhanced in the experimental group when compared with the control groups.

Variables in the Hemostasis Subunit

Each of the four classes was taught primarily by the lecture method. Three self-instructional packages were utilized for certain areas within the subunit with the Classes of 1981 and 1980.

The course content was directed by the same instructor for the four classes. That instructor taught the subunit for the Classes of 1979 and 1980. A graduate student taught the subunit for the Class of 1981 and the writer for the Class of 1982. The exams remained basically the same for all four classes.

The writer feels that these variables are balanced throughout the four classes. Two classes used self-instructional packages for some of the material which was presented in lecture form in the other two classes. Two classes were taught by the course director while two were taught by graduate students under the director's supervision. Thus no one variable can be perceived as significant.

Other Variables

Figure 1 illustrates similar grade trends among all four classes. It can be seen that Exam 4 yielded the lowest scores for all classes while Exam 5 yielded the highest. Therefore test variability should not be considered significant since all four groups showed similar results.

Instructor variability cannot be excluded. However, as mentioned above, the variability was equally distributed throughout the four classes. Personal teaching ability may have been reflected in the outcome but cannot be measured in this study.

It is impossible to state that the corrective feedback was the sole reason for the increased learning of the experimental group. O'Day(113) attempted to isolate and test each aspect of self-instructional packages to see the effect each had on learning. He could not adequately separate them for valid results. This concurs with a number of researchers who claim that feedback alone cannot be adequately studied for there is constant interaction with a number of independent variables(113, 110, 160, 139).

The effect of the feedback cannot be separated from the effect of the study guide as a whole. A simple self-correcting practice test may have yielded similar results. However, student comments indicated that the corrective feedback itself was very helpful (see STUDENT ATTITUDES).

LATENT IMAGE

There are several ways feedback can be provided to students. Some examples are: 1) answers printed on another page; 2) answers printed on the same page as the question but upside down; 3) answers printed on the same page in a margin which the reader conceals; 4) "scrambled text" printing; and 5) latent image printing(131).

Latent image printing was utilized for this study. It is most commonly used in written simulations(97). Its use in medical technology education has been confined to written simulations(145).

Latent image printing was selected for use in this study for a number of reasons: 1) the materials are easily obtained; 2) the process of preparing the answer sheet is not overly difficult; 3) it provides lower presearch availability than many other methods; and 4) the novelty could possibly be viewed as reinforcing.

Three disadvantages were encountered with the latent image format: 1) the materials are expensive; 2) the prepared material has a limited shelf life (10-20 months); and 3) some students had a negative reaction to the process. One student expressed frustration in getting the answers to appear. Another student stated that when all the answers had to be developed to locate the correct one, it was both frustrating and time-consuming.

The majority of the students enjoyed the latent image. Only one had ever used it before. The novelty may have increased student study time. It did appear that the novelty contributed to the high compliance rate in completing the study guide. Many students described the experience as fun.

STUDENT ATTITUDES

Table VII is a compilation of student opinion concerning the study guide. One hundred per cent of respondents liked the study guide. Their major reasons are summarized as follows: 1) it served as a good review for the exam; 2) it helped them locate their weak points and clarify misconceptions; and 3) it was a fun way to study.

Specific comments were enlightening and suggestive of the value of the corrective feedback. One student stated: "I think the study guide with immediate answers gave me a chance to reinforce weak areas and cut down on some of the misconceptions I sometimes pick up in studying, and because I know the right answers immediately I will remember the wrong answer I gave and why it is wrong thus doubly stressing the right answer". Another student said: "I feel the most effective part of using...the study guide is that you can quickly reveal the correct answer which will either reinforce that fact in your brain or it will immediately correct a misunderstood concept".

Most students preferred the answer type which provided immediate remediation rather than the reference-directing type. One student said: "I also thought that an explanation of incorrect answers helped to clear up confusion on certain concepts". Another stated: "When I missed a question I liked knowing why I missed it, and knowing immediately". Finally, a student explained that "someone else's reasoning may help you see more clearly than rereading the text". The majority stated that they preferred immediate remediation simply because they were "lazy" and did not want to look up the references.

These comments suggest that the feedback was responsible for improved quantity and quality of study. If only study questions were provided, a student with a tendency to be lazy (as many of these students admitted) would not enjoy the full benefit of guided study. Since all students spent 1-3 hours with the guide, their study was quantitatively improved also.

There is strong evidence to suggest that the use of the study guide which provided immediate corrective feedback was a major factor in the enhanced learning demonstrated by the experimental group. The writer feels that the corrective feedback played an integral role in the success of the study guide.

CONCLUSIONS AND RECOMMENDATIONS

Knowledge of correct results has been shown to enhance learning. It is felt that if utilized in the proper setting, this type of feedback can be beneficial to the learning process.

The students in the experimental group enjoyed the study guide and felt it helped them learn the material and gave them confidence for the examination. Many said it was fun to use. This fact may have increased motivation.

Use of the study guide led to a better directed study of the material. It also increased the amount of study time for many students.

The study guide format can be easily developed for any area of medical technology education. It can decrease the amount of time spent in class by students and teachers in answering questions and correcting practice test questions. It could also be reused by the students in studying for a national certification examination. The study guide combines the benefits of programmed instruction (e.g., learning at an individual rate, remediation of incorrect answers, reinforcement for correct answers) with the dynamic interaction of the lecture-discussion method of teaching.

The results of this study indicate that use of the study guide may have been the significant factor influencing the higher exam grades seen following its use. Future research should expand upon this study. The study guide should be tested against a contemporary control group which does not utilize a study guide. Also, the study guide questions alone should be used as a practice test and tested against a group with the same study questions plus corrective feedback. Certainly the quantity of individuals tested must be increased before more valid conclusions can be drawn.

The writer feels that the results presented in this study justify further trials with both the study guide and corrective feedback. It is felt the results obtained here are suggestive of the learning facilitation possible through the use of such media.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Adams, J. 1975. "Slide-Tape Sequence: A Teaching Aid in Instrumentation". Am. J. Med. Tech. 41(10): 370-376.

2. AECT Task Force on Definition and Terminology. 1977. Educational Technology: Definition and Glossary of Terms. Washington, D.C.: Association for Educational Communications and Technology.

3. Allender, J. 1964. "The Programming of Instructional Materials for Medical Education." J. Med. Ed. 39(4): 346-354.

4. American Society of Clinical Pathologists. 1971. Board of Schools Newsletter. No. 10, Aug. 19. Chicago: American Society of Clinical Pathologists.

5. Ammons, R. B. 1956. "Effects of Knowledge of Performance: A Survey and Tentative Theoretical Formulation". J. Gen. Psych. 54: 279-299.

6. Anderson, R. C. 1970. "The Control of Student Mediating Processes During Verbal Learning and Instruction". Rev. Ed. Res. 40: 349-370.

7. Anderson, R., Kulhavy, R., and Andre, T. 1971. "Feedback Procedures in Programmed Instruction". J. Ed. Psych. 62(2): 148-156.

8. Anderson, R. C. and Myrow, D. L. 1971. "Retroactive Inhibition of Meaningful Discourse". J. Ed. Psych. 62(1): 81-94.

9. Anderson, R., Kulhavy, R. and Andre, T. 1972. "Conditions Under Which Feedback Facilitates Learning from Programmed Lessons". J. Ed. Psych. 63(3): 186 188.

10. Angell, G. W. and Troyer, M. E. 1948. "A New Self-Scoring Device for Improving Instruction". School and Society. 67(1727): 84 85.

11. Angell, G. W. 1949. "The Effect of Immediate Knowledge of Quiz Results on Final Examination Scores in Freshman Chemistry". J. Ed. Res. 42: 391-394.

12. Atkinson, R. C. 1968. "Computer Based Instruction in Initial Reading", in Proceedings of the 1967 Invitational Conference on Testing Problems. Princeton, NJ: Educational Testing Service.

13. Balija, J. J. (ed.). 1980. Allied Health Education Directory, 9th ed. Chicago: American Medical Association.

14. Beard, M., Sesney, J., Stringham, R., and McDonald, J. 1975. "Developing an Integrated, Competency-Based Medical Technology Program". Am. J. Med. Tech. 41(9): 333-338.

15. Beeson, R. O. 1973. "Immediate Knowledge of Results and Test Performance". J. Ed. Res. 66: 224-226.

16. Belanger, G. A., Chandler, L., Dabicci, G., Carrol, J., and Kennedy, J. 1978. "The Effects of Written Corrective Feedback on Graded Quizzes for Students in a Personalized System of Instruction". U.S. Department of Health, Education, and Welfare, Washington, D.C. ED173711.

17. Betz, N. E. 1977. "Effects of Immediate Knowledge of Results and Adaptive Testing on Ability Test Performance". Appl. Psych. Meas. 1(2): 259-266.

18. Bierbaum, W. B. 1965. "Immediate Knowledge of Performance on Multiple-Choice Tests". J. Prog. Instr. 3: 19-23.

19. Bisbicos, E. 1965. "A Test of a Simplified Technique for Implementing Looping Programs". J. Prog. Instr. 3: 15-20.

20. Block, J. and Tierney, M. 1974. "An Exploration of Two Correction Procedures Used in Mastery Learning Approaches to Instruction". J. Ed. Psych. 66(6): 962-967.

21. Bourne, L. E. 1957. "Effects of Delay of Information Feedback and Task Complexity on the Identification of Concepts". J. Exp. Psych. 54(3): 201-207.

22. Brackbill, Y., Bravos, A., and Starr, R. 1962. "Delay-Improved Retention of a Difficult Task". J. Comp. Physiol. Psych. 55(6): 947-952.

23. Brackbill, Y. and Kappy, M. S. 1962. "Delay of Reinforcement and Retention". J. Comp. Physiol. Psych. 55(1): 14-18.

24. Brackbill, Y., Wagner, J., and Wilson, D. 1964. "Feedback Delay and the Teaching Machine". Psych. in the Schools. 41: 148-156.

25. Briggs, L. J. 1958. "Two Self-Instructional Devices", in Lumsdaine, A. and Glaser, R. 1960. Teaching Machines and Programmed Learning: A Source Book. Washington, D.C.: National Education Association of the U.S.

26. Broski, D. C. 1976. "Curriculum Development", in Ford, C. W. and Morgan, M. K. (eds.). 1976. Teaching in the Health Professions. St. Louis: The C. V. Mosby Company.

27. Bryan, G. and Rigney, J. 1956. "An Evaluation of a Method for Shipboard Training in Operations Knowledge". University of So. California Report #18, Los Angeles, University of So. California.

28. Bunning, R. L. 1977. "Human Relations Training for Medical Technology Students". Am J. Med. Tech. 43(3): 276-279.

29. Buss, A., Braden, W., Orgel, A., and Buss, E. 1956. "Acquisition and Extinction with Different Verbal Reinforcement Combinations". J. Exp. Psych. 52(2): 288-295.

30. Campbell, D. T. adn Stanley, J. C. 1963. Experimental and Quasi-Experimental Designs for Research. Chicago: Rand McNally and Co.

31. Caporaso, J. A. and Roos, L. L. 1973. Quasi-Experimental Approaches: Testing Theory and Evaluating Policy. Chicago: Northwestern University Press.

32. Carr, W. J. 1959. "A Functional Analysis of Self-Instructional Devices", in Lumsdaine, A. and Glaser, R. 1960. Teaching Machines and Programmed Learning: A Source Book. Washington, D. C.: National Education Association of the U.S.

33. Cicarelli, S. M. 1971. "Education - An Incident or an Experience". Am. J. Med. Tech. 37(3): 106-108.

34. Conwell, M. J. 1976. "Contract Method of Individualized Instruction Applied to Clinical Bacteriology". Am. J. Med. Tech. 42(4): 124-129.

35. Crum, J., Brown, W., and Biterman, M. 1951. "The Effect of Partial and Delayed Reinforcement on Resistance to Extinction". Am. J. Psych. 64(2): 228-237.

36. Curtis, F. and Woods, G. 1929. "A Study of the Relative Teaching Values of Four Common Practices in Correcting Examination Papers". School Rev. 37: 615-623.

37. Davies, M., Gale, J. and Clarke, W. 1977. "Audio Tape and Booklet Self-Instructional materials in Physiology: An Evaluation of Their Effectiveness and Acceptability in the Pre-Clinical Curricullum." Med. Ed. 11(6): 370-373.

38. Department of Health, Education, and Welfare. 1967. "Manpower for the Medical Laboratory: A Report of a Conference of Government and the Professions in Washington, D. C." ED021517.

39. DeSanto, C., Porreca, W. and Totoro, M. 1973. Statistics Through Problem Solving. New York: Mathematical Alternatives Inc.

40. Doerr, R. E. 1978. "Individualized Teaching and Learning in Dentistry." Internat. Dent. J. 28(2): 108-115.

41. Dombal, D., Horrochs, F., Staniland, J., and Guillou, P. 1971. "Production of Artificial 'Case Histories' By Using a Small Computer." Br. Med. J. 2(761): 578-581.

42. English, R. and Kinzer, J. 1966. "The Effect of Immediate and Delayed Feedback on the Retention of Subject Matter". Psych. in the Schools. 3: 143-147.

43. Feldhusen, J. F. and Birt, A. 1962. "A Study of Nine Methods of Presentation of Programmed Learning Material". J. Ed. Res. 55: 461-466.

44. Fiel, N. J. and Ways, P. O. 1972. "Development and Evaluation of Self-Instructional Materials". J. Med. Ed. 47: 822-824.

45. Fink, W. and Carnine, D. 1975. "Control of Arithemetic Errors Using Informational Feedback and Graphing". J. Appl. Behav. Anal. 8(4): 461.

46. Fitch, M. L., Drucker, A. F., and Norton, J. A. 1951. "Frequent Testing as a Motivating Factor in Large Lecture Classes". J. Ed. Psych. 42: 1-20.

47. French, R. 1969. "Knowledge Explosion and Medical Technology Education". Am. J. Med. Tech. 35(7): 438-445.

48. Fritsma, G. 1977. "Urinalysis by Modular Learning". Am. J. Med. Tech. 43(6): 563-567.

49. Gilman, D. A. 1969. "Comparison of Several Feedback Methods for Correcting Errors by Computer-Assisted Instruction". J. Ed. Psych. 60(6): 503-508.

50. Glaser, R., Homme, L, and Evans, J. 1959. "An Evaluation of Textbooks in Terms of Learning Principles", in Lumsdaine, A. and Glaser, R. 1960. Teaching Machines and Programmed Learning: A Source Book. Washington, D.C.: National Education Association of the U.S.

51. Green, E. J. 1967. The Learning Process and Programmed Instruction. New York: Holt, Rinehart, and Winston, Inc.

52. Grundin, H. 1969. "Response Mode and Information About Correct Answers in Programmed Instruction: A Discussion of Experimental Evidence and Educational Decisions", in Mann, A. and Brunstrom, C., (eds.). 1969. Aspects of Educational Technology. London: Pitman.

53. Guthrie, J. T. 1971. "Feedback and Sentence Learning". J. Verb. Learn. Verb. Behav. 10: 23-28.

54. Hamstra, R. D. 1973. "Medical Technology Education - A Program With Maximum Use of Student Classroom-Laboratory Facilities". Am J. Med. Tech. 39(6): 245-251.

55. Hanna, G. S. 1976. "Effects of Total and Partial Feedback in Multiple-Choice Testing Upon Learning". J. Ed. Res. 69(5): 202-205.

56. Hanna, G. S. 1977. "A Study of Reliability and Validity Effects of Total and Partial Immediate Feedback in Multiple-Choice Testing". J. Ed. Meas. 14(1): 1-7.

57. Hardyck, C. D. and Petrinovich, L. F. 1976. Introduction to Statistics for the Behavioral Sciences, 2nd ed. Philadelphia: W. B. Saunders Co.

58. Heald, H. M. 1970. "The Effects of Immediate Knowledge of Results and Correction of Errors and Test Anxiety Upon Test Performance". Diss. Abstr. Inter. 31: 1621A-1622A.

59. Hedrick, W. H. 1968. "Correlating Theory and Experience to Increase Efficiency in Medical Technology Education". Am J. Med. Tech. 34(11): 679-689.

60. Heinemann, R. 1969. "The College and University in Medical Technology Education". Am J. Med. Tech. 35(8): 491-501.

61. Henderson, M. J. and Love, B. F. 1972. "The Status of Medical Technology Education". J. Med. Ed. 47(6): 479-483.

62. Hovde, R. F. 1957. "A Medical Technology Training Program Study". Am J. Med. Tech. 23(3): 184-196.

63. Hovde, R. F. 1963. "The Dynamics of Education in Medical Technology". Am J. Med. Tech. 29(2): 61-75.

64. Hull, C. L. 1943. Principles of Behavior. New York: Appleton-Century-Crofts.

65. Hull, C. L. 1952. A Behavior System. New Haven, CN: Yale University Press.

66. Jensen, B. 1949. "An Independent-Study Laboratory Using Self-Scoring Tests". J. Ed. Res. 43: 134-137.

67. Jones, H. E. 1923. "Experimental Studies of College Teaching". Arch. Psych. 10(68): 5-70.

68. Kaess, W. and Zeaman, D. 1960. "Positive and Negative Knowledge of Results in a Pressey-type Punchboard". J. Exp. Psych. 60(1): 12-17.

69. Kaufman, R. 1963. "Experimental Evaluation of the Role of Remedial Feedback in an Intrinsic Program". J. Prog. Instr. 2: 21-30.

70. Keller, F. S. 1943. "Studies in International Morse Code: A New Method of Teaching Code Reception". J. Appl. Psych. 27(4): 407-415.

71. Keller, F. S. 1968. "Good-Bye, Teacher..." J. Applied Behav. Anal. 1(1): 79-89.

72. Kerraker, R. J. 1967. "Knowledge of Results and Incorrect Recall of Plausible Multiple-Choice Alternatives". J. Ed. Psych. 58: 11-14.

73. Krumboltz, J. and Weisman, R. 1962. "The Effect of Intermittent Reinforcement in Programmed Instruction". J. Ed. Psych. 53(6): 250-253.

74. Kulhavy, R. and Anderson, R. 1972. "Delay-Retention Effect with Multiple-Choice Tests". J. Ed. Psych. 63(5): 505-512.

75. Kulhavy, R. W. and Parsons, J. A. 1972. "Learning-criterion Error Perseveration in Text Materials". J. Ed. Psych. 63(1): 81-86.

76. Kulhavy, R. W. and Swenson, I. 1975. "Imagery Instructions and the Comprehension of Text". Br. J. Ed. Psych. 45(1): 47-51.

77. Kulhavy, R. W. 1977. "Feedback in Written Instruction". Rev. Ed. Res. 47(1): 211-232.

78. LaCroix, K. 1975. "Developing Slide Tape Units for Medical Technology". Am J. Med. Tech. 41(2): 41-45.

79. Lam, J. W. and Farina, J. P. 1980. "Personalized Competency-Based Instruction Applied to Medical Technology Education". Am J. Med. Tech. 46(3): 173-178.

80. LaCrone, C. and Hamernyik, P. 1969. "Coordination of University and Private Hospital Educational Programs". Am J. Med. Tech. 35(5): 311-319.

81. LaCrone, C. N. 1976. "An Undergraduate Medical Technology Clinical Elective Program". Am J. Med. Tech. 42(7): 243-247.

82. Lewis, D. J. 1960. "Partial Reinforcement: A Selective Review of the Literature Since 1950". Psych. Bull. 57(1): 1 28.

83. Light, I. 1970. "Growth and Development of New Allied Health Fields". Am. J. Med. Tech. 36(2): 75-88.

84. Little, J. K. 1934. "Results of Use of Machines for Testing and for Drill Upon Learning in Educational Psychology". J. Exp. Ed. 3: 45-49.

85. Locke, E. A., Cartledge, H. and Koeppel, J. 1968. "Motivational Effect of Knowledge of Results: A Goal-Setting Phenomenon". Psych. Bull. 70: 474-485.

86. Love, B. F. 1963. "Development of the Curriculum in Medical Technology at West Virginia University". Am J. Med. Tech. 29(4): 207-212.

87. Love, B. F., Conn, R. B., and Sleeth, C. K. 1969. "Evolution in Medical Technology Education". J. Med. Ed. 44(6): 533-540.

88. Lublin, S. C. 1965. "Reinforcement Schedules, Scholastic Aptitude, Autonomy Need, and Achievement in a Programmed Instruction Course". J. Ed. Psych. 56(6): 295-302.

89. Lumsdaine, A. A. 1959. "Teaching Machines: An Introductory Overview", in Lumsdaine, A. and Glaser, R., (eds). 1960. Teaching Machines and Programmed Learning: A Source Book. Washington, D.C.: National Education Association of the U.S.

90. Lumsdaine, A. A. 1959. "Some Issues Concerning Devices and Programs for Automated Learning", in Lumsdaine, A. and Glaser, R. 1960. Teaching Machines and Programmed Learning: A Source Book. Washington D.C.: National Education Association of the U.S.

91. Lundeen, D. J. 1975. "An Investigation of the Utility of a Self-Correcting Test". Colo. J. Ed. Res. 15(1): 2 4.

92. Lynch, B. L. 1974. "The Concept of Educational Objectives - A Review". Am. J. Med. Tech. 40(20: 71-78.

93. Lysaught, J. P. and Williams, C. M. 1963. A Guide To Programmed Instruction. New York: J. Wiley and Sons, Inc.

94. Lysaught, J., Sherman, C., and Williams, C. 1964. "Programmed Learning: Potential Values for Medical Instruction." J. A. M. A. 189(11): 803 807.

95. Mayer, M. 1961. The Schools. New York: Harper and Brothers.

96. McDonald, F. and Allen, D. 1962. "An Investigation of Presentation, Response, and Correction Factors in Programmed Instruction". J. Ed. Res. 55: 502-507.

97. McGuire, C., Solomon, L., and Bashook, P. 1976. Construction and Use of Written Simulations. Chicago: The Psychological Company.

98. McGuire, C., Solomon, L., and Forman, P. 1976. Clinical Simulations: Selected Problems in Patient Management, 2nd ed. New York: Appleton-Century-Crofts.

99. McKeachie, W. J. and Hiler, W. 1954. "The Problem Oriented Approach to Teaching Psychology". J. Ed. Psych. 45: 224-232.

100. Mellan, I. 1936. "Teaching and Educational Inventions", in Lumsdaine, A. and Glaser, R., (eds.). 1960. Teaching Machines and Programmed Learning: A Source Book. Washington, D.C.: National Education Assocaition of the U.S.

101. Merrill, M. 1965. "Correction and Review on Successive Parts in Learning a Hierarchical Task". J. Ed. Psych. 56: 225-234.

102. Merrill, M. and Stolurow, L. 1966. "Hierarchical Preview vs. Problem Oriented in Learning and Imaginary Science". Am Ed. Res. J. 3: 251-262.

103. Meyer, S. R. 1960. "Report on the Initial Test of a Junior High School Vocabulary Program", in Lumsdaine, A. and Glaser, R. 1960. Teaching Machines and Programmed Learning: A Source Book. Washington, D.C.: National Education Asociation of the U.s.

104. Moore, J. W. and Smith, W. I. 1961. "Knowledge of Results in Self-Teaching Spelling". Psych. Reps. 14: 407 423.

105. Moore, J. W. and Smith, W. I. 1964. "Role of Knowledge of Results in Programmed Instruction". Psych. Reps. 14: 407-423.

106. Moore, A. J. 1969. "Delay of Feedback and the Acquisition and Retention of Verbal Materials in the Classroom". J. Ed. Psych. 60(5): 339-342.

107. National Accrediting Agency for Clinical Laboratory Sciences. 1977. Essentials and Guidelines of an Accredited Educational Program for the Medical Technologist. Chicago: National Accrediting Agency for Clinical Laboratory Sciences.

108. National Council on Medical Technology Education. 1967. "National Correlations in Medical Technology Education. A Report of a Study of Medical Technologists". Washington, D.C.: Department of Health, Education, and Welfare. ED034845.

109. Neel, A. 1977. Theories of Psychology: A Handbook. New York: Schenkman Publishing Company.

110. Newman, M. Williams, R., and Hiller, J. 1974. "Delay of Information Feedback in an Applied Setting: Effects on Initially Learned and Unlearned Items". J. Exp. Ed. 42(4): 55-59.

111. Nicholas, J., Tiel, D., and Ways, P. 1972. "Development and Evaluation of Self-Instructional Materials." J. Med. Ed. 47(10): 822-824.

112. Nye, R. D. 1979. What Is B. F. Skinner Really Saying? Englewood Cliffs, NJ: Prentice-Hall, Inc.

113. O'Day, E., Kulhavy, R., Anderson, J., and Malczynski, R. 1971. Programmed Instruction: Techniques and Trends. New York: Appleton-Century-Crofts.

114. Peterson, J. C. 1930. "A New Device for Teaching, Testing and Research in Learning". Trans. Kansas Acad. Sct. 33: 41-47.

115. Peterson, J. C. 1931. "The Value of Guidance in Reading for Information". Trans. Kansas Acad. Sci. 34: 291-296.

116. Phye, G. and Baller, W. 1970. "Verbal Retention as a Function of the Informativeness and Delay of Information Feedback: A Replication". J. Ed. Psych. 61(5): 380-381.

117. Plowman, L. and Stroud, J. 1942. "Effect of Informing Pupils of the Correctness of Their Responses to Objective Test Questions". J. Ed. Res. 36: 16-20.

118. Porter, D. 1958. "Teaching Machines", in Lumsdaine, A. and Glaser, R. (eds.). 1960. Teaching Machines and Programmed Learning: A Source Book. Washington, D.C.: National Education Association of the U.S.

119. Postlethwait, S. and Novak, J. 1967. "The Use of 8-mm Loop Films in Individualized Instruction". Ann. NY Acad. Sci. 142(2): 464-470.

120. Pressey, S. L. 1926. "A Simple Apparatus Which Gives Tests and Scores - and Teaches". School and Society. 23(586): 373-376.

121. Pressey, S. L. 1927. "A Machine for Automatic Teaching of Drill Material". School and Society. 25(645): 549-552.

122. Pressey, S. L. 1950. "Development and Appraisal of Devices Providing Immediate Automatic Scoring of Objective Tests and Concommittant Self-Instruction". J. Psych. 29: 417-447.

123. Rausch, V. and Hovde, R. F. 1970. "An Undergraduate Medical Technology Clinical Elective Program". Am. J. Med. Tech. 42(7): 243-247.

124. Rausch, V. L. 1974. "Does 2 + 2 = 3 + 1? A Comparison of Graduates From Two Curricula in Medical Technology". Am. J. Med. Tech. 40(6): 285-301.

125. Rausch, V. L. 1977. "Five Years Later: A Longitudinal Study of Medical Technology Graduates". Am. J. Med. Tech. 43(11): 1034-1039.

126. Reed, J. P., Fike, D. J., Page, S. D., Sullivan, A. M., and Breen, M. E. 1980. "A Model Career Ladder Approach to Medical Technology Education". Am. J. Med. Tech. 46(2): 96-101.

127. Renner, K. E. 1964. "Delay of Reinforcement: A Historical Review". Psych. Bull. 61: 341-361.

128. Roderick, M. C. and Anderson, R. C. 1968. "A Programmed Introduction to Psychology Versus a Textbook-Style Summary of the Same Lesson". J. Ed. Psych. 59(6): 381-387.

129. Roe, A. 1962. "A Comparison of Branching Methods for Programmed Learning Instruction". J. Ed. Res. 55: 407-416.

130. Roe, I. L. 1963. "Development of a Master's Degree Program for Teaching Supervisors in Medical Technology". Am. J. Med. Tech. 29:(1): 1-7.

131. Rogers, J., Harden, R., Murray, T., and Dunn, W. 1979. "The Use of Latent Image Printing in Problem Solving and Self-Assessment Exercises". j. Audiovis. Media Med. 2(1): 27-29.

132. Rogers, J., Harden, R., Murray, T., and Dunn, W. 1980. "'Instant Feedback': Patient Management Problems for General Practioners Using Latent Image Printing." J. Audiovis. Media. Med. 3(2): 72-75.

133. Rosenstock, E., Moore, J., and Smith, W. 1965. "Effects of Several Schedules of Knowledge of Results on Mathematical Achievement". Psych. Reps. 17(2): 535-541.

134. Rothkopf, E. Z. 1966. "Learning from Written Instructive Material: An Exploration of the Control of Inspection Behavior by Test-Like Events". Am. Ed. Res. J. 3: 241-249.

135. Roulund, M. 1969. "Structural Development of a School of Medical Technology in an Affiliated Hospital". Am. J. Med. Tech. 35(4): 239-250.

136. Rust, J., Strang, H., and Bridgemen, B. 1977. "How Knowledge of Results and Goal Setting Function During Academic Tests". J. Exp. Ed. 45(4): 52-55.

137. Salzberg, B., Wheeler, A., Devar, L., and Hopkins, B. 1971. "The Effect of Intermittent Feedback and Intermittent Contingent Access to Play on Printing of Kindergarten Children". J. Appl. Behav. Anal. 4(3): 163-171.

138. Sassenrath, J. and Yonge, G. 1968. "Delayed Information Feedback, Feedback Cues, Retention Set, and Delayed Retention". J. Ed. Psych. 59(2): 69-73.

139. Sassenrath, J., Yonge, G., and Schnable, K. 1968. "Immediate and Delayed Feedback on Exams and Immediate and Delayed Retention". Calif. J. Ed. Res. 19: 226-231.

140. Sassenrath, J. and Yonge, G. 1969. "Effects of Delayed Information Feedback and Feedback Cues in Learning on Delayed Retention". J. Ed. Psych. 60(3): 174-177.

141. Sassenrath, J. M. 1975. "Theory and Results on Feedback and Retention". J. Ed. Psych. 67(6): 894-899.

142. Sax, G. 1974. Principles of Educational Measurement and Evaluation. Cambirdge, MA: The Wadsworth Publication Company.

143. Schoeff, L., Maturen, A., Fritsma, G., and Srugys, K. 1979. "A Career Mobility Option Within a University Integrated Medical Tehnology Program". J. Allied Health. 8(2): 96-106.

144. Schumacher, L. C., LaDuca, A., Engel, J., and Rasley, E. 1978. "Criterion-Referenced Testing in Medical Technology Education: Professional Performance Situation Model". Am. J. Med. Tech. 44(10): 1033-1044.

145. Schwabbauer, M. 1975. "Use of the Latent Image Technique to Develop and Evaluate Problem-Solving Skills". Am. J. Med. Tech. 41(12): 457-462.

146. Seibert, M. L. 1979. "Establishing Criteria for Competency-Based Education". Am. J. Med. Tech. 45(5): 368-371.

147. Shafer, J. A. 1970. "A Programmed Course of Instruction in Red Cell Morphology". Am. J. Med. Tech. 36(1): 17-32.

148. Shafer, J. A., Johnson, W. and Weed, R. I. 1972. "Learning and Teaching RBC Morphology: Self-Instruction vs. Conventional Instruction". Am J. Med. Tech. 38(10): 394-400.

149. Shafer, J. A., Weed, R. I., and Johnson, W. 1973. "Evaluation of a Self-Instructional Program in Red Cell Morphology". J. Med. Ed. 48: 1135-1139.

150. Skendzel, L. P. and Green, D. 1968. "Workshop Plan for Teaching Medical Technology". Am. J. Med. Tech. 34(4): 227-230.

151. Skinner, B. F. 1954. "The Scinece of Learning and the Art of Teaching". Harvard Ed. Rev. 24(2): 86-97.

152. Skinner, B. F. 1957. Verbal Behavior. New York: Appleton-Century-Crofts.

153. Skinner, B. F. 1968. The Technology of Teaching. New York: Appleton-Century-Crofts.

154. Smith, A. M. 1979. "Developing Self-Instructional Learning Materials - A Case Study". Am. J. Med. Tech. 45(12): 1013-1017.

155. Spence, K. W. 1956. Behavior Theory and Conditioning. New Haven, CN: Yale University Press.

156. Spencer, M. 1979. "Did the Student Learn? A Comparison of Different Study Methods." Nurs. Times. 75(1): 35-37.

157. Spitzer, H. F. 1939. "Studies in Retention". J. Ed. Psych. 30(8): 641-656.

158. Strang, H. R., and Rust, J. O. 1973. "The Effects of Immediate Knowledge of Results and Task Definition on Multiple-Choice Answering". J. Exp. Ed. 42(2): 77-80.

159. Sturges, P. T. 1969. "Verbal Retention as a Function of the Informativeness and Delay of Informative Feedback". J. Ed. Psych. 60(1): 11-14.

160. Sturges, P. T. 1972. "Informative Delay and Retention: Effect of Information in Feedback and Tests". J. Ed. Psych. 63(1): 32-43.

161. Sturges, P. T. 1978. "Delay of Informative Feedback in Computer-Assisted Testing". J. Ed. Psych. 70(3): 378-387.

162. Sullivan, A. and Lorenz, R. 1973. "Designing and Audio-Tutorial Learning Experience in Medical Technoloty". Am. J. Med. Tech. 39(3): 97-101.

163. Sullivan, H., Baker, R., and Schutz, R. 1967. "Effects of Intrinsic and Extrinsic Reinforcement Contingencies on Learner Performance". J. Ed. Psych. 58(3): 165-169.

164. Suppes, P. 1966. "The Uses of Computers in Education". Sci. Am. 215(2): 206-221.

165. Surber, J. R. and Anderson, R. C. 1975. "Delay-Retention Efect in Natural Classroom Settings". J. Ed. Psych. 67(2): 170-173.

166. Sutman, F. X. 1968. "Student Involvement in Laboratory Teaching". Am. J. Med. Tech. 34(9): 529-535.

167. Sweet, R. C. and Ringness, T. A. 1971. "Variations in the Intelligence Test Performance of Referred Boys of Different Racial and Socio-economic Backgrounds as a Function of Feedback or Monetary Reinforcement". J. School Psych. 4: 399-409.

168. Tait, K., Hartley, J., and Anderson, R. 1973. "Feedback Procedures in Computer-Assisted Arithmetic Instruction". Br. J. Ed. Psych. 43(2): 161-171.

169. Thorndike, E. L. 1932. Fundamentals of Learning. New York: Bureau of Publications, Teachers College, Columbia University.

170. Travers, R., VanWagenen, R., Heygood, D., and McCormick, M. 1964. "Learning As a Consequence of the Learner's Task Involvement Under Different Conditions of Feedback". J. Ed. Psych. 55(3): 167-173.

171. Tuckman, B. W. 1972. Conducting Educational Research. New York: Harcourt, Brace, Jovanovich, Inc.

172. UCLA Allied Health Professions Project. 1972. "A Model of Individualized Instruction for the Clinical Laboratory Occupations". Los Angeles: University of California. ED069897.

173. Vojir, C. P. and Hamstra, R. D. 1976. "Medical Technology Education II: Evaluation of a Classroom-Laboratory Program". Am. J. Med. Tech. 42(2): 47-53.

174. Watson, J. B. and Rayner, R. 1920. "Conditioned Emotional Reactions". J. Exp. Psych. 3(1): 1-14.

175. Weiss, R. and Green, E. 1962. "The Applicability of Programmed Instruction in a Medical School Curriculum." J. Med. Ed. 37(8): 760-766.

176. Wentling, T. L. 1973. "Mastery Versus Nonmastery Instruction With Varying Test Item Feedback Treatments". J. Ed. Psych. 65: 50-58.

177. White, L. B. 1965. "Thirty-Five Years of Medical Technology". Am. J. Med. Tech. 31(4): 295-299.

178. Williams, M. R. 1963. "Quality Control in Medical Technology Education". Am. J. Med. Tech. 29(6): 341-348

179. Williams, M. R. 1965. "An Experiement in Programmed Instruction (Teaching Machine)". Am. J. Med. Tech. 31(3): 197-206.

180. Williams, M. R. and Lindberg, D. S. 1979. An Introduction to the Profession of Medical Technology, 3rd ed. Philadelphia: Lea and Febiger.

181. Withers, J. and Fryer, M. 1969. "Development of a Medical Technology Degree Program in a Liberal Arts College". Am J. Med. Tech. 35(12): 770-779.

182. Woodworth, M. E. 1965. "The Application of Programmed Learning to Medical Technology Education". Am. J. Med. Tech. 31(5): 317-330.

183. Yeazell, M. 1969. "Excellence in Medical Technology Education". Am. J. Med. Tech. 35(7): 428-437.

184. Zimmerman, B. J. and Rosenthal, T. L. 1973. "Conceptual Rule Acquisition and Retention by Young Children: The Effects of Modeling, Age, and Corrective Feedback". Arizona Center for Educational Research and Development, Tucson, Arizona. ED 128065.

APPENDIX A

HEMOSTASIS STUDY GUIDE

Constance A. Bak

December 1980

Richmond, Virginia

1. The process by which vascular breaks are rapidly repaired while maintaining the fluidity of the blood is called:

   a. coagulation
   b. homeostasis
   c. hemostasis
   d. platelet adherence

2. All of the following are components of blood vessel structure EXCEPT:

   a. cartilage
   b. basement membrane
   c. endothelial cells
   d. collagen fibers

3. Resistance to vessel disruption is known as:

   a. hemostasis
   b. vasoconstriction
   c. vasodilation
   d. vascular integrity

4. Vasoconstriction is a process by which:

   a. blood vessels dilate to allow more blood, platelets, and procoagulants to reach the site of injury.
   b. blood vessels constrict to slow down the flow of blood at the site of injury.
   c. blood vessels have a tendency to resist vessel disruption.
   d. blood vessels are repaired while maintaining the fluidity of the blood.

5. The major components of the hemostatic mechanism include all of the following EXCEPT:

   a. coagulation cascade
   b. fibrinolysis
   c. platelets and blood vessels
   d. complement activation

6. One of the following groups of platelet structures contains an incorrect structure. This group is:

   a. marginal tubular system, nucleus, mitochondria
   b. alpha granules, cell membrane, ribosomes
   c. dense tubular system, glycogen bodies, dense granules
   d. canalicular system, microtubules, exterior coat

7. A contractile protein of platelets especially important in clot retraction is:

   a. thrombosthenin
   b. serotonin
   c. platelet factor 4
   d. epinephrine

8. Platelet attachment to a foreign surface is called:

   a. coagulation
   b. aggregation
   c. adhesion
   d. cohesion

9. All of the following substances may cause platelet aggregation EXCEPT:

   a. ADP
   b. serotonin
   c. ristocetin
   d. fibrin

10. Which of the following statements is correct concerning platelet aggregation:

    a. primary aggregation requires calcuim
    b. secondary aggregation is irreversible
    c. primary aggregation is irreversible
    d. secondary aggregation does not require calcium

11. Stabilization of the fibrin clot requires adequate amounts of:

    a. Factor X
    b. Factor XIII
    c. thrombin
    d. fibrinogen

12. Generation of thrombin by way of the extrinsic pathway requires the presence of adequate amounts of:

    a. Factor I
    b. Factor IX
    c. Factor VIII
    d. Factor VII

13. In the intrinsic pathway, Factor X activator is a complex composed of:

    a. VIIIa, IXa, PF3
    b. XIIa, XIa, IXa, VIII
    c. IV, VIII, IXa, PF3
    d. III, IV, VII

14. Fibrinopeptide A is formed as a result of the action of:

    a. Factor XIII on fibrin
    b. fibrin monomer polymerization
    c. thrombin on fibrinogen
    d. plasmin on fibrinogen

15. The factors involved in the common pathway, in correct sequence, are:

    a. X, VII, V, II, I, XIII
    b. X, V, II, I, XIII
    c. V, X, II, I, XIII
    d. X, V, I, II, XIII

16. PTA is activated by:

    a. Hageman factor
    b. Stuart-Prower factor
    c. PTC
    d. AHG

17. All of the following are roles played by thrombin in the clotting cascade EXCEPT:

    a. activates Factor XIII
    b. acts as a platelet aggregator
    c. splits fibrin degradation products from fibrin
    d. splits fibrinopeptides A and B from Factor I

18. Prekallikrein is also known as:

    a. Fletcher factor
    b. SPCA
    c. tissue thromboplastin
    d. Fitzgerald factor

19. All of the following are properties of the contact factors EXCEPT:

a. not dependent on vitamin K
b. synthesized by the liver
c. not adsorbed by $BaSO_4$
d. present in serum

20. Which of the following factors is NOT dependent on vitamin K for synthesis:

a. II
b. V
c. VII
d. IX

21. One of the following factors is NOT consumed during clotting. It is Factor:

a. I
b. II
c. VIII
d. X

22. All of the following are components of the fibrinolytic system EXCEPT:

a. plasminogen
b. plasminogen activators
c. thrombin
d. plasmin

23. The correct order of appearance of fibrin breakdown products is:

a. X, Y, D + E + D
b. X, Y + D, D + E + D
c. Y, X + D, D + E + D
d. X, Y + D, D + E

24. All of the following are effects of FSP EXCEPT:

a. form weak and easily removed clots
b. inhibit thrombin activity
c. inhibit fibrin monomer polymerization
d. inhibit RES removal of formed clots

25. Antithrombin-III does NOT inactivate:

a. thrombin
b. plasmin
c. prothrombin
d. Factor VII

26. All of the following factors contribute to the maintenance of vascular integrity EXCEPT:

    a. ascorbic acid
    b. fibrin
    c. platelets
    d. architecture of the vessels

27. Thrombocytopenia is NOT caused by:

    a. megaloblastic anemia
    b. marrow damage
    c. splenomegaly
    d. Glanzmann's disease

28. Round, hemorrhagic pinpoint discolorations in skin and mucous membranes which usually result from capillary bleeding are known as:

    a. petechiae
    b. purpura
    c. ecchymoses
    d. bruises

29. Idiopathic thrombocythemia is a disorder characterized by all of the following EXCEPT:

    a. a qualitative platelet defect resulting in hemorrhagic episodes
    b. a quantitative platelet defect resulting in thrombotic episodes
    c. a myeloproliferative disorder that is autonomous or related to other disorders such as polycythemia vera
    d. a reactive disorder secondary to inflammatory conditions or trauma

30. A disorder characterized by anemia, thrombocytopenia, and hemorrhagic manifestations whose etiology is unknown but there is platelet aggregation in the smaller blood vessels is known as:

    a. Glanzmann's disease
    b. thrombotic thrombocytopenia purpura
    c. idiopathic thrombocytopenia purpura
    d. reactive thrombotic thrombocytosis

31. All of the following are qualitative platelet disorders EXCEPT:

    a. thrombocytopathy
    b. von Willebrand's disease
    c. reactive thrombocytosis
    d. thrombasthenia

32. The test which is not useful in the measurement of platelet/vascular function is:

   a. activated partial thromboplastin time
   b. Duke bleeding time
   c. Lee-White clotting time
   d. clot retraction

33. A patient with von Willebrand's disease is most likely to have an abnormal:

   a. Lee-White clotting time
   b. platelet count
   c. bleeding time
   d. prothrombin time

34. Which of the following statements is consistent with classical hemophilia:

   a. abnormal PTT; hemarthrosis; prolonged whole blood clotting time in severe cases
   b. intramuscular hemorrhages; prolonged bleeding time; sex-linked inheritence
   c. spontaneous epistaxis; deficiency of Factor VIII; low platelet count
   d. bleeding following tooth extraction; abnormal prothrombin time; abnormal prothroubin consumption test

35. In the coagulation work-up you are doing, the Lee-White clotting time, the bleeding time, and the prothrombin time are all in the normal range. The PTT is prolonged but you have been able to correct it with aged serum. Adsorbed plasma shows no correction of the PTT. The probable factor deficiency is:

   a. Factor IX
   b. Factor VIII
   c. Factor XI
   d. Factor XII

36. A lack of clinical bleeding, even after surgery or trauma, is characteristic of which of the following factor deficiencies:

   a. Stuart-Prower factor
   b. Hageman factor
   c. Christmas factor
   d. PTA

37. The major classes to which most acquired coagulation disorders belong include all of the following EXCEPT:

a. interference with mechanisms of factor synthesis
b. presence of immunological agents which inactivate factors
c. induction of intravascular coagulation
d. destruction of circulating factors by oral anticoagulants

38. The best test to detect a Factor XIII deficiency is:

a. euglobulin lysis time
b. clot lysis
c. clot retraction
d. clot solubility

39. Disseminated intravascular coagulation is NOT a complication associated with:

a. hemophilia
b. amniotic fluid embolism
c. burns
d. progranulocytic leukemia

40. Laboratory tests which aid in the differentiation of DIC from primary fibrinolysis include all of the following EXCEPT:

a. platelet count
b. clot lysis
c. paracoagulation tests
d. fibrinogen level

41. The test of choice to depict extrinsic system abnormalities is:

a. prothrombin consumption test
b. bleeding time
c. prothrombin time
d. thromboplastin generation test

42. Which of the following statements does NOT characterize fibrinogen:

a. normal value is 200-400 mg/dl
b. present in plasma and adsorbed plasma but absent from serum
c. depressed by oral anticoagulants
d. converted to fibrin in the presence of thrombin

43. In your coagulation lab, an emergency arises and there is a four hour delay before you can perform a prothrombin time. Your results would be:

a. shortened time due to the breakdown of platelets
b. shortened time due to increased glass contact
c. prolonged time due to the loss of Factor VII
d. prolonged time due to the loss of Factor V

44. If excessive fibrinolysis is present, the clot will dissolve in:

a. less than 24 hours
b. 72 hours
c. 48 hours
d. 36 hours

45. All of the following prolong the thrombin time EXCEPT:

a. hypofibrinogenemia
b. prothrombin deficiency
c. therapeutic hyperheparinemia
d. increased fibrin split products

46. Vitamin C deficiency would manifest itself in which of the following tests:

a. bleeding time
b. platelet count
c. fibrinogen level
d. prothrombin time

47. A mixture of adsorbed normal plasma, normal aged serum, platelet substitute, and calcium chloride shows no clot. The reason is that it lacks:

a. Factor I
b. Factor II
c. Factor VIII
d. Factor X

48. All of the following are requirements for specimen collection and handling to yield accurate coagulation test results EXCEPT:

a. correct ratio between blood and anticoagulant should be carefully maintained
b. clean (i.e. non-traumatic) venipuncture
c. specimen stored at room temperature for no longer than 4 hours
d. hemolyzed plasma should not be used

49. A standard laboratory test involves adding reagent thromboplastin and calcium to a test serum and recording the time it takes fibrin to form. This is the principle of the:

a. TGT
b. APTT
c. prothrombin time
d. thrombin time

50. The length of time required for a measured amount of blood to clot *in vitro* under certain specified conditions is known as:

a. Lee-White clotting time
b. Duke bleeding time
c. tourniquet test
d. clot retraction test

APPENDIX B

HEMOSTASIS STUDY GUIDE

DIRECTIONS: Each of the study guide questions has one best answer. After reading the question, choose the answer which you think is best. Then take the latent image pen and develop the area on the Answer Sheet which corresponds to the answer selected. Make sure to develop the entire sentence or sentences. You will then discover if you are right or wrong. If you have selected the incorrect answer, either you will be informed as to why that answer is wrong, or you will be directed to a reference where the correct answer can be found. If you have selected an incorrect answer, SELECT ANOTHER ANSWER until you have developed the correct answer.

Remember to run the latent image pen tip lightly over the area until the response developes. Also, make sure the pen is tightly capped when not in use.

THIS WILL NOT BE GRADED IN ANY WAY. It is simply a study guide to help you select key information from the lecture and reading material. It is hoped that the class average on the hemostasis exam will be higher than previous years due to utilization of this study guide.

ANSWER SHEET

1. a. No. This is just a segment of the entire process.

   b. Close. This is a tendency to stability of all body states, not just vessel repair.

   c. Correct! You're off to a good start!

   d. No. This is just a segment of the entire process

2. a. You got it! Cartilage hangs around with bones and joints

   b. No. This is found even in the smallest vessels.

   c. No. Endothelial lining is common to all vessels.

   d. No. This is what supports larger vessels.

3. a. No. Perhaps you are confusing this with question 1.

   b. Not quite. See question 4.

   c. No. This is a relaxing of the vessel, which increases blood flow and thus does not really help in hemostasis.

   d. Bingo! Very good!

4. a. Whoops! This is just the opposite of vasoconstriction.

   b. Good! The word even sounds like its definition.

   c. No. That's vascular integrity.

   d. No. Sounds like hemostasis to me.

5. a. Yikes! This is the heart of it.

   b. No. We need to get rid of the clot once it is not needed.

   c. Sorry. These start the whole process on its merry way.

   d. Yes! Complement activation is a cascade, but not needed in hemostasis.

6. a. One the nose! Platelets have no nucleus.

   b. No. These are all true. Review SIP I, p. 8

   c. No. These are all true. Review SIP I, p. 8

   d. No. These are all true. Review SIP I, p. 8

7. a. Great! This is an important thing to remember

   b. Whoops! Serotonin is a vasoconstrictor.

   c. No. This aids in plug consolidation.

   d. Sorry. This is a vasoconstrictor.

8. a. No. Coagulation = clotting.

   b. Close. Aggregation is attachment of platelets to each other.

   c. Right! Reminds you of adhesive tape.

   d. Real close, but not quite.

9. a. No. This is an extremely potent aggregator.

   b. No. Serotonin is a vasoconstrictor and an aggregator.

   c. No. This is used to aggregate platelets in vitro as a test for von Willebrand's disease.

   d. Right! Fibrin forms after the platelets have aggregated.

10. a. No. All it requires is an aggregating agent.

    b. OK! You got it!

    c. Sorry, primary aggregation is reversible.

    d. No. Calcium is needed in secondary aggregation.

11. a. No. Review SIP II, p. 22

    b. You got it!

    c. No. Review SIP II, p. 22

    d. No. Review SIP II, p. 22

12. a. No. Review SIP II, p. 17

    b. No. Review SIP II, p. 17

    c. No. Review SIP II, p. 17

    d. Great! VIII and IX are in the intrinsic pathway, and I is fibrinogen, which comes after thrombin formation.

13. a. No. Review your cascade handout.

    b. No. Review your cascade handout.

    c. Right! IV is calcium, but you knew that!

    d. No. Review your cascade handout.

14. a. No. Review Harker, p. 24 25

    b. No. Review Harker, p. 24 25

    c. Yes! Fibrinopeptide A is one of the peptides split off of I by IIa

    d. No. Review Harker, p. 24 25

15. a. Sorry. VII is only in the extrinsic pathway.

    b. Good work!

    c. No. Review your cascade handout.

    d. No. Review your cascade handout.

16\. a. Terrific! PTA is Factor XI and Hageman factor is XII.

b. Sorry. Stuart-Prower is Factor X.

c. No. PTC is Factor IX.

d. No. AHG is Factor VIII.

17\. a. No. It indeed activates XIII in the presence of calcium.

b. No. This is correct. See Henry, p. 1112.

c. You got it! This is the role of plasmin.

d. No. Perhaps you should review the common pathway.

18\. a. Great! Good memory!

b. No. This is Factor VII.

c. Sorry, this is Factor III.

d. Close, but this is HMWK.

19\. a. No. Review Henry, p. 1131-1132

b. Right! The site of their systhesis is unknown.

c. No. Review Henry, p. 1131-1132.

d. No. They are not consumed in coagulation.

20\. a. No. This is a member of the prothrombin group, which is K-dependent.

b. Great work!

c. No. This is a member of the prothrombin group, which is K-dependent.

d. No. This is a member of the prothrombin group, which is K-dependent.

21. a. No. See the first table in Dade, "The Coagulation Factors".

    b. No. See the first table in Dade, "The Coagulation Factors".

    c. No. See the first table in Dade, "The Coagulation Factors"

    d. Right! X is not consumed and is present in serum.

22. a. No. This is the precursor to plasmin.

    b. No. These are neded to activate plasminogen.

    c. Correct! Thrombin acts on fibrinogen, not fibrin.

    d. No. This is the enzyme that attacks fibrin.

23. a. No. Review Harker, p. 35.

    b. Correct!

    c. No. Review Harker, p. 35.

    d. No. Review Harker, p. 35.

24. a. No. Review SIP III, p. 5.

    b. No. Review SIP III, p. 5.

    c. No. Review SIP III, p. 5.

    d. Yes! The RES removes FSP and weak clots from the circulation.

25. a. No. Review SIP III, p. 8.

    b. No. Review SIP III, p. 8.

    c. Yes! It inactivates thrombin, plasmin, VII, Xa, and possibly III.

    d. No. Review SIP III, p. 8.

26. a. No. Ascorbic acid is necessary for normal connective tissue.

    b. Correct! Vascular integrity is the normal state. Fibrin comes in after damage.

    c. No. Although the mechanism is unknown, platelets are important.

    d. No. The structure of the vessel is its first line of defense.

27. a. No. Low platelet counts are seen, especially with B12 or folate deficiency.

    b. No. Marrow damage due to drugs, irradiation, infection, etc. can cause thrombocytopenia.

    c. No. This is a disorder of platelet distribution. If platelets are caught in the spleen, they are decreased in peripheral blood.

    d. Right! This is a qualitative platelet disorder.

28. a. Yes! These are indicative of platelet/vascular disorders.

    b. No. Purpura is a hemorrhagic state.

    c. Close. These are large "black and blue marks".

    d. No. You really didn't think it'd be that easy!

29. a. No. The platelets produced, although in excess, do not function correctly, leading to purpura.

    b. No. It is a thrombocytosis with platelet count usually exceeding one million per cubic millimeter.

    c. No. It is a myeloproliferative disorder and it may be related to other myeloproliferative disorders.

    d. Correct! This describes reactive thrombocytosis, where increased platelets are seen secondary to other disorders.

30. a. No. The platelets' ability to aggregate is defective here.

    b. Yes! Thrombocytopenia results from the increased consumption of platelets.

    c. Close! ITP is an autoimmune disorder where platelet survival is decreased without thrombosis.

    d. Sorry Thrombocytosis is the opposite of thrombocytopenia.

31. a. No. This group is characterized by functional defects in platelets.

    b. No. Platelets aggregate abnormally in von Willebrand's disease.

    c. Great! Thrombocytosis is an increase in platelet number, and thus, a quantitative disorder.

    d. No. Glanzmann's disease is characterized by a decreased ability of platelets to adhere and aggregate.

32. a. Right! Although platelet-poor plasma is used, a platelet substitute is added and thus, platelet function is not measured.

    b. No. This measures both platelets and vessel integrity.

    c. No. This test primarily monitors heparin therapy, but since nothing is added to the patient's blood to promote clotting, platelet disorders can influence results.

    d. No. This is a good and simple test to monitor platelet function.

33. a. This is possible in very severe cases. There's a better answer.

    b. No. vWD is characterized by a qualitative platelet defect, not a quantitative one.

    c. OK! A prolonged bleeding time is due to the qualitative platelet defect.

    d. No. The protime measures the extrinsic system. The Factor VIII abnormality in vWD would be reflected in the APTT.

34. a. Very Good! All three are characteristic.

    b. No. Since platelets and blood vessels are unaffected, the bleeding time is normal.

    c. No. Platelets remain normal, the others are correct.

    d. No. The protime remains normal since the extrinsic system is unaffected.

35. a. Great! Adsorbed plasma would have corrected a Factor VIII deficiency and both would have corrected Factors XI and XII.

    b. No. Only adsorbed plasma would have corrected the PTT if it were a Factor VIII deficiency.

    c. No. Both would have corrected the PTT in a Factor XI deficiency.

    d. No. Both would have corrected the PTT in a Factor XII deficiency.

36. a. No. This is Factor X.

    b. Right! Factor XII deficiency is unique in this aspect.

    c. No. Factor IX deficiency is hemophilia B.

    d. No. This is Factor XI.

37. a. No. This is very common and includes vitamin K deficiencies and liver disease.

    b. No. Circulating anticoagulant activity is not uncommon and associated with hemophiliacs, some immunological disorders, and certain drug reactions.

    c. No. This is a fairly common disorder which is usually secondary to another event.

    d. Right! Oral anticoagulants (i.e., coumarins) do not destroy procoagulants, but affect their synthesis.

38. a. No. This tests for increased fibrinolytic activity.

    b. Not quite. This tests for increased fibrinolytic activity.

    c. No. This test measures platelet function.

    d. Right! With a deficiency of fibrin stabilizing factor, the formed clot will be soluble in 5 M urea and/or 1% monochloroacetic acid.

39. a. Correct! Hemophilia is a simple factor deficiency and/or malfunctioning factor and is not a cause of DIC.

    b. No. Obstetrical disorders are commonly associated with DIC.

    c. No. Burns and other significant trauma release tissue thromboplastin into the circulation, possibly initiating DIC.

    d. No. Granules contain tissue thromboplastins. There is a high incidence of DIC in patients with this disorder.

40. a. No. Platelets are consumed in DIC, but not in primary fibrinolysis.

    b. No. Clot lysis is very rapid in primary fibrinolysis because of elevated levels of plasmin.

    c. No. These detect the presence of fibrin monomers. They are thus not present when clotting is not activated, i.e. in primary fibrinolysis.

    d. Right! Fibrinogen is depleted in both disorders, and therefore of no value in differentiation.

41. a. No. This is for platelets and the intrinsic system.

    b. No. This is for platelet and vascular disorders.

    c. Right! It measures all extrinsic system factors.

    d. No. This is for platelets and the intrinsic system.

42. a. No. This is correct.

    b. No. It is one of the consumable factors.

    c. Right! Since it is not dependent on vitamin K, the coumarins do not affect it.

    d. No. Review the cascade handout.

43. a. No. A protime does not depend on platelet actions.

    b. No. Protimes measure the extrinsic pathway. The intrinsic pathway is not activated because the glass tubes holding the sample are specially treated.

    c. No. Factor VII is very stable.

    d. Great! Factor V is measured in a protime along with Factors VII, X, I, and II. Of these, V is most labile by far.

44. a. Right! Normal lysis time is greater than 24 hours.

    b. No. See Dade, "Laboratory Investigation of Hemostasis", p. 10.

    c. No. See Dade, "Laboratory Investigation of Hemostasis", p. 10.

    d. No. See Dade, "Laboratory Investigation of Hemostasis", p. 10.

45. a. No. A prolonged thrombin time most often indicates low fibrinogen levels.

    b. Right! The test measures reagent thrombin's effect on fibrinogen. All other preceeding factors are not tested.

    c. No. Heparin is a potent antithrombin and would prolong the test time.

    d. No. FSP have antithrombin activity and would prolong the test time.

46. a. Correct! Ascorbic acid is needed for vascular integrity.

    b. No. Platelets do not require vitamin C for normal functioning.

    c. No. Fibrinogen is not dependent on vitamin C.

    d. No. None of the extrinsic and common pathway factors require vitamin C.

47. a. No. Fibrinogen is present in adsorbed plasma.

b. Yes! Prothrombin is adsorbed by $BaSO_4$ and thus not present in adsorbed plasma; it is consumed during clotting and therefore not present in serum.

c. No. Factor VIII is found in adsorbed plasme.

d. No. Factor X is found in serum.

48. a. No. Review p. 118 of your laboratory manual.

b. No. Review p. 118 of your laboratory manual.

c. Very Good! First, plasma should be separated from cells, and secondly, either put on ice or kept in the refrigerator. Factors V and VIII are extremely labile.

d. No. Review p. 118 of your laboratory manual.

49. a. No. Review Dade, "Laboratory Investigation of Hemostasis", p. 8.

b. No. Review Dade, "Laboratory Investigation of Hemostasis", p. 8.

c. Yes! Very Good!

d. No. Review Dade, "Laboratory Investigation of Hemostasis", p. 10.

50. a. Excellent!

b. No. Review Dade, "Laboratory Investigation of Hemostasis", p. 6.

c. No. Review Dade, "Laboratory Investigation of Hemostasis", p. 6.

d. No. Review Dade, "Laboratory Investigation of Hemostasis", p. 7.

APPENDIX C

HEMATOLOGY LECTURE #33

Hemostasis: Blood Vessels and Platelets

Readings

1. Required: Henry, Lab Diagnosis: p. 1101-1104; p. 1109 1115.

   Harker, Hemostasis Manual: p. 1-8

2. Recommended: Sommer, Hemostasis Self-Study Package I: "The Role of Blood Vessels and Platelets"

Objectives

The student will be able to:

1. Define hemostasis.
2. Define vascular integrity.
3. Name the four major components of the hemostatic mechanism.
4. Describe the structure of blood vessels and explain their role in hemostasis.
5. Define vasoconstriction.
6. List three mechanisms by which vasoconstriction can occur.
7. Sketch a diagram of a platelet and label at least six structures.
8. List at least five substances found within platelet granules.
9. Define platelet adhesion.
10. Define platelet aggregation and name at least three aggregating agents.
11. Differentiate between primary and secondary platelet aggregation.
12. Describe the platelet release reaction.
13. Diagram the steps in the formation of a hemostatic plug.
14. State the function of thrombosthenin.
15. Evaluate the structure of the platelet as it relates to platelet functions.

APPENDIX D

ATTITUDINAL SURVEY: HEMOSTASIS STUDY GUIDE

The following questions relate to the study guide you used as part of the coagulation lectures in your Hematology course. Please circle your response and feel free to make any comments. Any and all comments will be greatly appreciated. You were a great group! Thanks for all your support!

Connie Bak

1. Did you like the study guide?

   YES NO

   WHY?

2. Did you think the length (50 questions) was good?

   TOO SHORT GOOD LENGTH TOO LONG

3. What did you think about the questions?

   TOO EASY GOOD QUESTIONS TOO HARD

4. Did you enjoy using the latent image format?

   YES NO

5. Have you ever used latent image before?

   YES NO

6. How much time did you spend working on the study guide?

   LESS THAN 1 HOUR 1-2 HOURS 2 3 HOURS MORE THAN 3 HOURS

7. Do you feel that you spent an adequate amount of time on the study guide?

   YES NO

8. Two types of responses were present: one which told you why an answer was incorrect, and one which directed you to a reference in your readings which explained why your answer was wrong. Which type did you prefer?

ANSWER WHICH TOLD ME WHY I WAS WRONG

ANSWER WHICH DIRECTED ME TO A REFERENCE

9. Did you develop each entire answer?

YES NO

10. Did you complete the entire study guide?

YES NO

IF NO WHY NOT?

11. Do you feel the study guide helped you?

YES NO

12. Did you feel better prepared for the test because of the study guide?

YES NO

13. Do you feel that the study guide's helpfulness justifies the time it took you to work through it?

YES NO

14. Would you like to see more study guides developed for other areas?

YES NO

15. Do you like the concept of knowing your results as soon as you answer each question?

YES NO

16. Do you think the concept of erasing answers until you selected the correct response would be effective in the actual testing situation (i.e., do you think the study guide and its format would make a good test)?

YES NO

17. In summary, please rate the study guide using the following scale: 1=definitely no; 2=no (not really); 3=yes (pretty much); 4=definitely yes:

I thought the study guide was:

FUN	1	2	3	4
WELL-DONE	1	2	3	4
CLEAR	1	2	3	4
HELPFUL	1	2	3	4
INFORMATIVE	1	2	3	4
PRACTICAL	1	2	3	4

FINALLY, I want you to add any thoughts, comments, criticisms, etc. that you want to say. Even your overall impression will help. I would appreciate remarks as candid and complete as possible. Thanks again!