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**A programmed instruction course in
introductory food science**

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Gabriel F. Kassab

1968

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A PROGRAMED INSTRUCTION COURSE

IN

INTRODUCTORY FOOD SCIENCE

BY

GABRIEL F. KASSAB

A THESIS

Submitted to the
AMERICAN UNIVERSITY OF BEIRUT

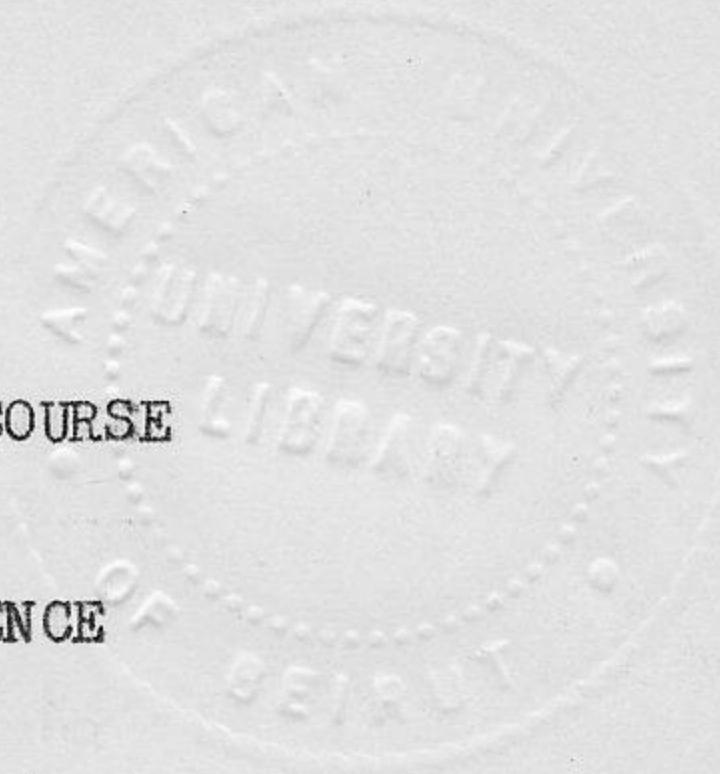
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In partial fulfillment of
the requirements for the
degree of

MASTER OF SCIENCE IN
AGRICULTURE

June 1968

A PROGRAMED INSTRUCTION COURSE
IN
INTRODUCTORY FOOD SCIENCE



By
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PROGRAMED FOOD SCIENCE

KASSAB

ACKNOWLEDGMENTS

The author wishes to extend his thanks and gratitude to Dr. Raja Tannous for his guidance, advice and great help during this study, and for the correction of this manuscript.

Particular thanks are due to Drs. J. Cowan and P. Pellett for their initiative in recommending this study and for the review of the course.

The author is also indebted to Mr. John Moubayyed, who acted as a sample student for the purpose of testing the course.

Valuable assistance was rendered by Mr. & Mrs. Raphael Calis in the proof-reading and editing of the thesis.

AN ABSTRACT OF THE THESIS OF

Gabriel F. Kassab for Master of Science in Agriculture

Major: Food Technology and Nutrition

Title: A programed instruction course in introductory food science

Programed instruction is a new method of self-teaching, that was developed in the U.S.A. during the last decade and has spread to other parts of the world.

The present study aimed at testing the efficiency of this new technique of instruction in the teaching of food science at the preparatory and university levels. It was intended to program an introductory course in food science that could act as a basis for more advanced courses in the same field.

The program was divided into three units; namely food chemistry, food spoilage and food preservation. The course as programed consisted of 1080 frames and was programed in the linear type of programs with a minor modification to include some frames with two alternative responses, one of which is the correct one.

The whole program was revised by members of the thesis committee and then was evaluated by being tested on a sample student, who satisfied particular qualifications namely, a high school graduate with basic knowledge of science and a good knowledge of English.

The present form of the program is not final. Its feasibility and success could only be determined when it is tested actually in the classroom. In the light of the results then procured, further evaluation of the program should be made.

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I. INTRODUCTION

Programed instruction or programed learning is the youngest of the different methods of teaching. It is a growing child and many educationists believe it to be a promising one. It originated in the United States of America and it is gaining ground now in many other countries. Many magazines and journals on programed instruction are now published in the U.S.A., the United Kingdom and other countries.

Programed instruction is an autoinstructional method or a self-teaching method of education, which is considered a sort of a revolution in the conventional methods of teaching. It is based on the "Theory of Reinforced Learning". This theory states that actions which are rewarded or reinforced are more easily and more likely to be repeated. Therefore learning which is a form of communication will be most effective when there is a reward or reinforcement.

The purpose of the study was to program an introductory course in food science, which could act as a basis for more advanced courses in the field of nutrition and food technology. It was thus intended to give the basic principles in food science, including the composition of foods, their spoilage and preservation and the application of these principles.

The other purpose of the study was to compare the efficiency of this new method of teaching with the other conventional methods in the teaching of sciences.

This study, to the knowledge of the author, is the first of its kind in Lebanon. It was intended to be an attempt in introducing programmed instruction in the teaching of science in Lebanon.

II. REVIEW OF LITERATURE

The tremendous amount of knowledge that has accumulated in the last 50 years has called on educators and psychologists to re-evaluate the conventional methods of teaching and learning.

The Science of Human Behavior:

Behaviorists psychologists led by B.F. Skinner and his associates of Harvard University believe that science can also apply to human behavior and that the science of human behavior is possible. Skinner (1953, pp. 6-20) said: "that human behavior is lawful and determined. We must expect to discover that what a man does is the result of specifiable conditions and that once these conditions have been discovered, we can anticipate and, to some extent, determine his actions."

We are thus able to extend the results of laboratory experiments to interpret human behavior for either theoretical or practical purposes. Science advances from the simple to the complex. Therefore, the extensive results of laboratory study of behavior of animals are of valuable importance in explaining human behavior, though the latter is distinguished by its variety, complexity and greater accomplishment. But, the basic processes are not different.

This school of psychologists was not very concerned with the inner physiological changes that take place inside the human body,

but what concerned them was the actual reactions of the body. Critics called them "black box" psychologists because it seemed that for them the world was composed only of stimuli to which the organism made responses. The organism represented simply as a black box with stimuli entering one end and responses leaving at the other end.¹

All human behavior, then, could be resolved to the simple forms of actions known as "Reflex Action" or "S - R Bonds."

Skinner and the Science of Learning and the Art of Teaching:

In 1954, Skinner published his famous paper entitled "The Science of Learning and the Art of Teaching," which really promulgated the present movement of programmed instruction. In this paper, Skinner described the results of experiments, carried by him and his associate J. G. Holland at Harvard University, on the learning process of lower animals and the laboratory techniques that could produce modifications in the behavior of experimental animals. He discussed in detail the characteristics and principles involved and their direct application to classroom learning and classroom teaching, and how these studies of animal learning could be brought to bear on the practical problems of education (Deterline, 1962, p. 11 and Skinner, 1959, pp. 145-157).

1. Rath, J. 1966. Programed Instruction. Speech delivered at the conference on Modern Methods of Teaching at the American University of Beirut, Beirut, Lebanon.

The Theory of Reinforced Learning:

While studying the behavior of rats and other animals it was found that their learning was greatly strengthened by what is called a "reward" or "reinforcement." This theory states that learning, which is a form of communication, will be most effective when it is rewarded or reinforced. Behaviors which are rewarded are more likely to recur under similar circumstances. However, to be most effective, reinforcement should follow immediately the desired behavior.

If a child recites a poem or sings a song and is rewarded immediately by a piece of chocolate or applause, he will more likely be ready to repeat the recitation more frequently and more willingly. When you are given a problem in mathematics to solve and after you have tried to solve it, if you learn immediately the correct answer, that particular knowledge will remain with you almost indefinitely.

Water, food, or sexual contacts can act as rewards for lower animals. As for human students, these rewards could be food, money, approval, affection, grades, diplomas, or merely the knowledge of being "right". All these things can serve as reinforcers. In programmed instruction this final type of reinforcements is emphasized. The theory of reinforcement has sprung from laboratory observation and analysis of the learning behavior of lower animals. Nevertheless, a projection of the conclusions to human beings provide new insight into educational problems of teachers and psychologists alike.

(Lysaught and Williams, 1963, pp. 6-7; Skinner, 1953, pp. 73-79; and

and Fry, 1963, pp. 155-162).

Lysaught and Williams (1963, p. 7) generalize the theory of reinforcement as it pertains to programmed instruction 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 delay of reinforcement following an action weakens the probability that the act will be repeated."
6. "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."
7. "A student's behavior can be developed into complex patterns by shaping the simple elements of the pattern and combining them with a chainlike sequence."

For the behaviorist psychologists this theory provides a rational basis for learning. If a complex body of knowledge is split into very small components, the student will learn the subject matter by reinforcing or not reinforcing his responses to successive steps, according to the accuracy or inaccuracy of his replies. The act of not reinforcing an erroneous response is known as extinguishing. By the

discriminating use of reinforcement and extinction, the learning program enhances the likelihood that correct responses will be repeated, whereas incorrect responses will be eliminated (Lysaught and Williams, 1963, p. 8).

Programed Instruction and Programed Learning:

Programed learning is the practical application of this theory of reinforcement. The material, when learned, is presented in a series of small steps in a logical sequence, starting with the simple and leading to the more complex. A description of the method can be summarized as follows:

1. A relatively small unit of information is presented to the student at a time as a statement to be completed or a question to be answered. This is referred to as a stimulus.
2. The student is asked to complete the statement or answer the questions about the particular bit of information. This is referred to as a response to the stimulus presented.
3. The student is then immediately informed whether his response is correct or not. If it is wrong, he may be told why. This is the feedback or reinforcement.
4. The student is next presented with the second unit of information and the cycle of presentation — answer — feedback; or, technically speaking, stimulus — response — reinforcement of the correct answer, is repeated.

Each unit or step is called a frame. Each frame then comprises presentation of material, response and reinforcement. A frame = stimulus — response — reinforcement or feedback (Hughes, 1962, pp. 2-3). The information to answer is contained in the same frame or in the preceding one or in both. The material in the frames builds up cumulatively. A series of such frames is called a program (Green, 1962, p. 117). Programs can run into hundreds or even thousands of frames.

According to Milton and West (1961, pp. 9-25) programmed instruction has four important features which make it more effective and efficient than the conventional methods of teaching and learning.

These are:

1. The learner makes active response; that is, he actively participates in the learning process.
2. The subject matter is presented in a series of small steps and in logical order.
3. The presentation of subject matter is paced at a rate appropriate to each individual learner.
4. Immediate knowledge of results is given in order to reinforce correct response. Knowing that the response is wrong does not reinforce that wrong response. Instead, it may lead the learner to avoid repeating that wrong response later. Immediate knowledge of results reinforces only correct responses.

Physical Forms of Programs:

The two main physical forms of a program are the teaching machine in its various forms, and the programmed textbook.

Programs can also be constructed in the form of tapes or strips of paper or a series of microfilmed slides. Any one of these instruments can be used to construct a program on the same principle of stimulus — response — reinforcement (Green, 1962, p. 117).

Types of Programs:

Two types of programs have been developed and are already in use. One type is Skinner Linear Program developed by Skinner and his associates at Harvard University. It is also known as the write-in, constructed-response or extrinsic program. In this type, the responses are already constructed by the programmer and the sequence of frames is rigidly established. It is based on the Skinnerian theory that learning is most effective when the student writes the correct responses and is immediately reinforced by the correct answer (Hughes, 1962, p. 9; Deterline, 1962, p. 43, and Fry, 1963, pp. 169-170).

The second form of programs is the Crowder multiple choice intrinsic program. Here, the student is presented with a number of responses from which he has to choose the correct one. In this type, different from the Skinnerian type, the student himself determines

the sequence of frames, depending upon the response he makes, hence the name intrinsic programing. If the student chooses the correct response, he is led to another page for new material. If, on the other hand, he chooses an incorrect response, he will be led then to another page where he is told why his response is incorrect and is referred back to the original for a second trial. If he finally chooses the correct response, he moves to the next unit of information. All students do not proceed through the same sequence of frames. This routing and branching is made to meet possible misunderstanding by the student. Students who make errors are directed to other frames which are never seen by students who do not make any error or make different kinds of errors (Deterline, 1962, p. 43).

In the branching program, a program may include periodical questions which, if correctly answered, the learner skips several steps or frames; hence the term "scrambled" book. The learner proceeds to the page indicated by the answer he gives; he either skips a number of pages or is referred to more advanced steps or is referred to remedial steps to learn why his response was wrong.¹

"It is Crowder's belief that no program writer can specify a single sequence of frames that will be the best for all students. Skinner on the other hand, believes that an experienced writer can construct a satisfactory sequence of frames through the use of repeated tryouts and revisions." (Hughes, 1962, p. 14).

1. Rath, J. 1966, Programed Instruction. Speech delivered at the Conference on Modern Teaching Method at the American University of Beirut, Beirut, Lebanon.

Skinner linear type is thus based on discovery, while Crowder branched type is based on recognition. Deterline (1962, p. 43) believes that all linear programs cannot be constructed perfect to all students, therefore, some branching must be provided. To Green (1962, pp. 146-147) however, the development of an effective linear program is a "more challenging" task than the development of an effective branching one. If it is the aim of education to teach the student to discover new things for himself, then the linear program is by far the more satisfactory instrument.

Types of Text Format:

In writing a programmed textbook, a number of formats are in use. In the linear programs, the format may be horizontal or vertical. In the horizontal format, the page is divided into a number of rows. The first frame appears on the top row of the first page and its response appears alone on the top row of the second page. The second frame then follows on the top row of the third page and its response appears on the top row of the fourth page and so on.

In the other horizontal format, the first frame appears on the top row of the first page and its response appears to the left side of the second frame which appears on the top row of the second page.

This proceeds until the top row is complete. Then the student returns to the first page and begins with the second row as shown in the figures 1 and 2.

HORIZONTAL PROGRAMED TEXT FORMAT

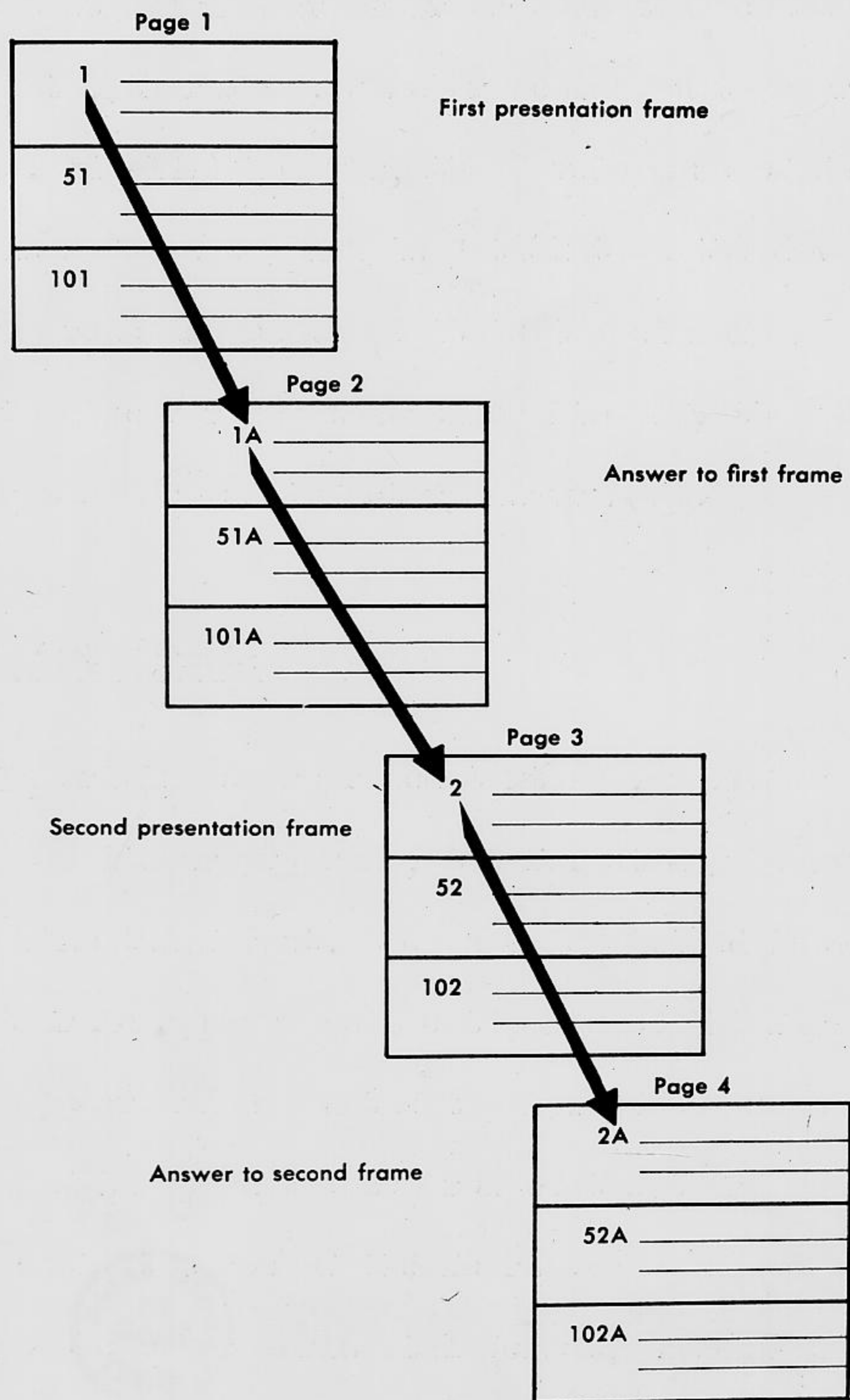


Figure 1. First type of horizontal format. (After J.L. Hughes, Programed Instruction for Schools and Industry, S.R.A., Inc., Publishers, Chicago, 1962)

HORIZONTAL PROGRAMED TEXT WITH ANSWERS ON LEFT

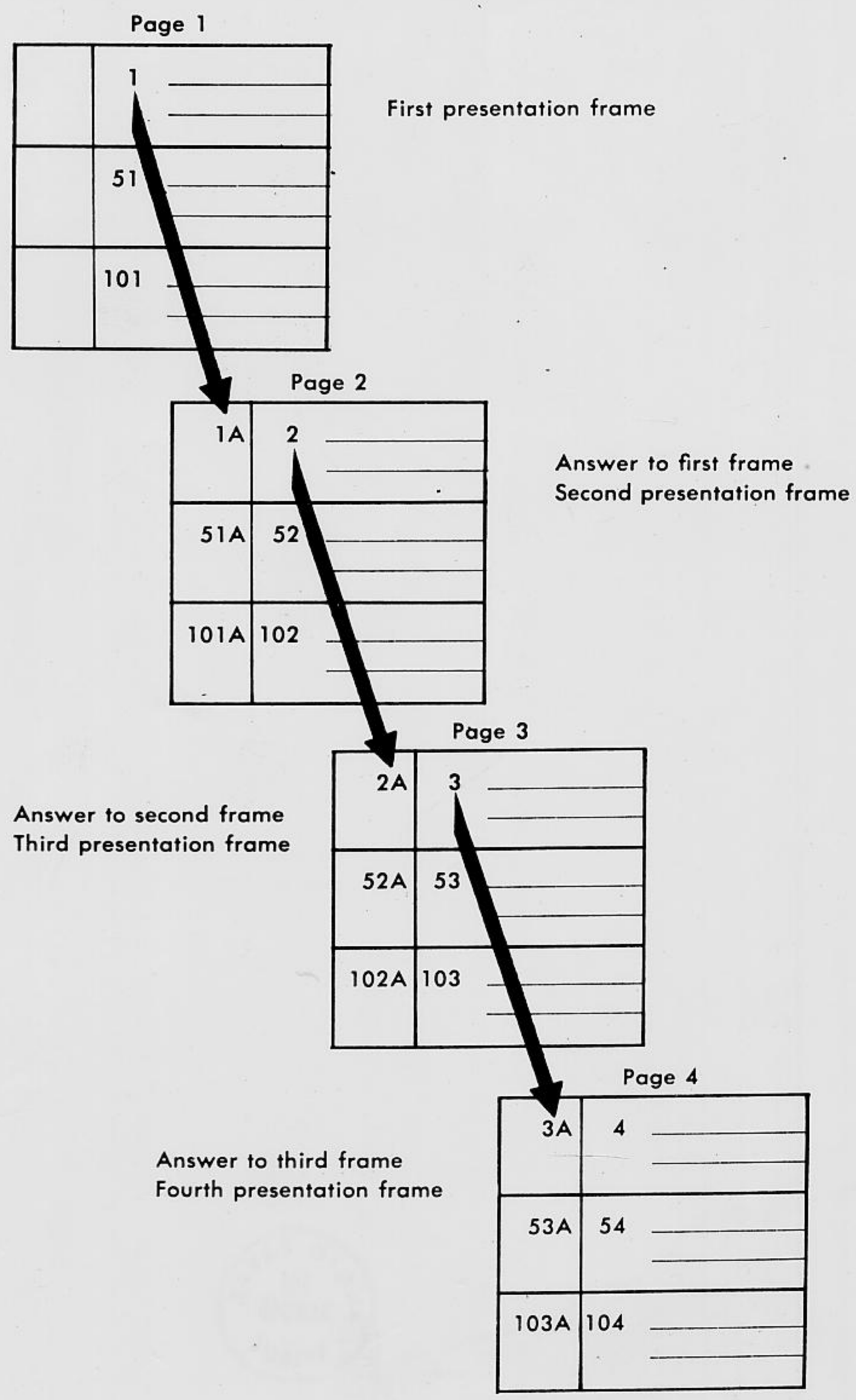


Figure 2. Second type of horizontal format. (After J.L. Hughes, Programed Instruction for Schools and Industry, S.R.A., Inc., Publishers, Chicago, 1962).

In the vertical format, the frames proceed in sequence on the same page as shown in fig. 3. Where the response is given at the top of the next proceeding frame. For other forms of vertical format, the frames also follow in sequence on the same page but the responses are given on the right side of each frame. When using the vertical type of formats, the student shields the feedback by a special card as shown in figures 3 and 4.

The scrambled back type is shown in figure 5. Each frame is presented on one page with the multiple responses below each frame. The student is led to the next page and frame depending upon his answer (Hughes, 1962, pp. 32-38).

VERTICAL PROGRAMED TEXT

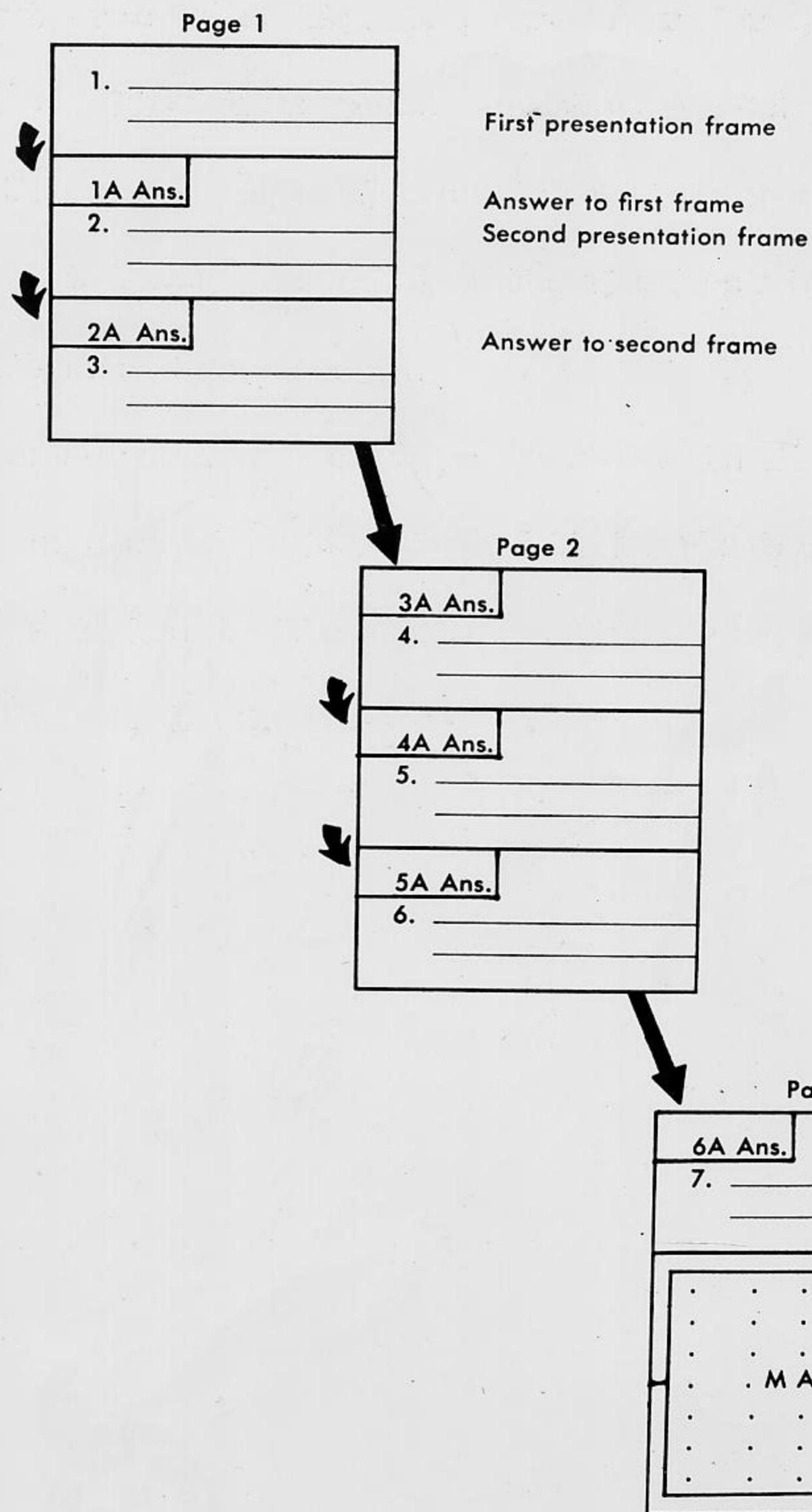


Figure 3. First type of vertical format. (After J.L. Hughes, Programed Instruction for Schools and Industry, S.R.A., Inc., Publishers, Chicago, 1962).

1. We all live on food; man cannot survive without

_____.

food

2. All plant and animal products that we _____, or
drink are called foods.

eat

3. The _____ we eat or drink is used to build our
bodies, repair our tissues and furnish us with
energy.

food

4. The foods we consume, besides being used to
build and repair our _____ and yield
energy, they also regulate body processes.

Mask

Figure 4. Second type of vertical format.

OPERATION OF A SCRAMBLED BOOK

1. First presentation frame on page 1.

p. 1

Ans. A p. 12
B p. 16
C p. 8 (correct)

2. Student chooses wrong answer (A), is branched to page 12, and is returned to page 1.

p. 12
Ans. A
(incorrect)

3. Student chooses right answer (C), turns to page 8 for second presentation frame.

p. 8 Ans. C (correct)

Ans. A p. 17 (correct)
B p. 4
C p. 20

4. Student chooses right answer (A), goes on to page 17 for next presentation frame, and so on.

p. 17 Ans. A
(correct)

Ans. A p. 3
B p. 15 (correct)
C p. 8

Figure 5. Multiple choice scrambled book. (After J.L. Hughes, Programed Instruction for Schools and Industry, S.R.A., Inc., Publishers, Chicago, 1962).

The Art of Programing:

Programing comprises three main stages: the planning stage, the actual writing stage or writing technique, and finally the test and evaluation stage. Writing a program requires close guidance and coaching by experienced writers who have had a long experience in the field and who have produced a number of programs (Hughes, 1962, p. 58).

The Planning Stage:

Before actual writing of a program, the terminal or the ultimate and immediate objectives of the program should be defined as well as the specific behavior that would be expected from the learner. What must the learner be able to do or perform to demonstrate his or her mastery of the objective. (Magor, 1963, pp. 2-49; and Lysaught and Williams, 1963, pp. 52-53). These objectives are to be determined in the light of the student's background and his environment. This is usually done by preparing an outline that will cover the areas of subject matter to be covered, expanding it until the very detailed statements of program content. This is known as the "blue print." (Fry, 1963, pp. 37-41; Hughes, 1962, pp. 60-64; Lysaught and Williams, 1963, pp. 2-49; and Leedham and Unwin, 1965, pp. 96-99).

Other factors to be considered are the span of the course or

the number of teaching hours allowed to cover the course and the cost of production. This last factor is of importance when the program will be built into a teaching machine.

The Technique of Writing a Program:

The programmer decides first on the type of program to construct, whether it will be a linear type or a branched one. He begins by writing short and small statements not more than fifty at a time, covering materials to be presented. He then converts these statements into frames. The frames will serve also to check the validity and soundness of the statements. This is done alternatively in a cycle. The statements and the frames are preferably to be written on 3" x 5" cards so that the sequence can be easily changed when needed (Hughes, 1962, pp. 67-69). Deterline (1962, p. 14) advocates short frames not exceeding 20 to 30 words. Fry (1963, p. 131) reports that in recent Crowder's programs, some frames fill a full page of the text, but the tendency is towards frames made up of one or two sentences; one sentence to present the material and the second one to build the student's response. A compound sentence can serve also.

These frames divide usually into three categories or sequences: presentation frames, practice frames, and review frames.

Presentation frames teach the student new materials in small segments, starting with the known and simple and build up to the more

complex and less known. These frames are followed by practice frames which emphasize the presentation frames by repeating the same information in a different context. The review frames review the two or more frames so as to strengthen the learning process and help the student to make correct responses. The three categories can sometimes be combined in one frame (Hughes, 1962, p. 67).

Cueing and Prompting, Fading and Enrichment:

Cueing and prompting techniques are used to help the student discover the correct response. These are either in the form of the first or last letter or syllabus of the response or by the length of the blank or other mechanical means. They are usually used in presentation frames. They are gradually removed when the student has learned to give the correct response. This latter technique is called fading.

Review frames contain usually no cueing. (Hughes, 1962, pp. 71-76; Fry, 1963, pp. 134-140; Leedham and Unwin, 1965, p. 66; and Lysaught and Williams, 1963, pp. 110-112).

Enrichment is another technique whereby some nonessential information is sometimes included in both presentation and practice frames to keep interest of the student and stimulate his thoughts.

After every 25 frames or so a number of review frames are constructed to assure retention.

Time Estimate:

According to Hughes (1962, pp. 87-88), the number of frames that a writer can produce ranges between 100 and 350 frames per month or an average of 175 frames. Every fifty frames are considered equivalent to one hour of conventional classroom work.

Other Features of the Program:

These may include page layout, illustration and textbook cover, table of contents and direction to students on the use of the program.

The page layout is arranged to insure optimum between economy and crowding. The illustrations can either be placed in their appropriate section or can be set up in a separate book.

Attractive cover with color if possible will add to the physical value of the program.

A table of content is to be included at the beginning of the text, together with a forword giving definite directions to the student on how to proceed in the use of the course (Hughes, 1962, pp. 91-95).

Evaluation of the Program:

This is perhaps the most critical stage for a programmer. Fry (1963, p. 172) believes that "the only feasible way is to try the

program with students; this is the standard technique used in programing."

However, before a program is tested or tried, it usually passes to a co-worker or another program writer to check any omissions or ambiguities. The students tests follow. These are carried in two steps. The first trial will be on a single student. The student, in the presence of the programer, goes through the frames one after the other. He notes down his responses, records the frames that give him difficulties and comments on the others. After each sitting, the program is adjusted, some frames are revised, new ones are added to clear up any ambiguity or difficulty. These sittings are repeated until that particular student finds no more difficulties in understanding or responding to each frame.

When a section or a block of the program is well clarified and polished it would be now tested on a group of students in a classroom. In this trial each student in the group, which should be a homogeneous one with regard to academic standard, age, and environment, records his own responses and these are collected for analysis to determine the error rate of each frame.

Finally to determine whether the program fulfills its ultimate educational objectives, achievement tests could be designed to measure these educational values.

To give it a final touch and eliminate any rough spots in content or language, the program is referred to a subject-matter

specialist and finally to an expert in language skill (Hughes, 1962, pp. 80-81, 98-100; Green, 1962, pp. 171-173; and Fry, 1963, pp. 172-178).

This process of trials and reviews is an essential part of the programing procedure which may consume as much time as the writing operation.

While trying new programs on students, the user should record the completion time for each student in order to estimate the average time needed for a typical group of students (Hughes, 1962, pp. 108-109).

The appreciation of a good program depends upon the learner's background and his proficiency in that particular field. To Skinner (1968) "even a good program may be misleading to any one who is already proficient in a field because he cannot easily appreciate its effect on a new learner. Anyone who wants to get the feel of programmed instruction should try his hand at a good program in an unfamiliar subject."

III. MATERIALS AND METHODS

The purpose of the study as stated earlier was to program an introductory course in food science. The procedure, therefore, was twofold; one was to develop the subject matter of the course or its content and the other involved the art or technique of programing.

The procedure of programing was comprised of three stages, the planning stage, the writing stage and the testing and evaluation stage.

The Planning Stage:

The objective of the present work was to present in a programmed instruction form the fundamental principles of food science, which could afterwards be used as a basis for developing more advanced and specialized courses in the field.

The academic standards of the students who will ultimately use the course were defined as high school graduates with a basic knowledge in science and a good knowledge of English.

On this basis an outline of the course was prepared. This was composed of three units; each unit in turn was divided into a number of chapters, to cover the area of that particular unit. It was intended that the first unit will cover basic principles in food chemistry. The second unit was to deal with food spoilage and the third and last unit was to deal with food preservation.

After preparation of the outline an extensive study of literature covering these different subject areas of the text was completed. A list of references that were used in preparing the subject matter of the course is given at the end of the text. The author also made use of the courses in food science that were attended during graduate study.

As to the other phase of the study, which is the programing of the subject matter assembled, a careful study of the theories of programed instruction and learning and the procedures followed in programing was done. In this particular phase of the study, the author had to depend solely on literature available as no specialists in programed instruction and program writing were available.

On the basis of examining the literature collected a more detailed outline of each chapter was prepared. This was to include the particular material or information to be presented in the different frames.

The Writing Stage:

The Skinner or linear type of programs was used, with a minor modification to include some frames with responses of the alternate type, in which two answers were given in the frame, one of them being the correct one. It is believed that this technique would be more suitable to students that have limited proficiency of the English language. It combines the two theories of programing; the

one advocated by Skinner based on discovery and the other advocated by Crowder and based on recognition.

Before actually writing any frame of any chapter, a number of sequence of statements, between twenty and thirty statements were prepared. Each statement presenting a particular information or concept of the subject matter. These statements after being reviewed a number of times, were converted into frames. The frames were written on cards of 3 x 5 in. in size. On one side of the card was written the statement which constituted the stimulus and on the back of the card was written the feedback or reinforcement.

The frames were constructed as short as possible; the maximum number of words was not to exceed fifty words, with the majority of frames ranging between twenty and thirty words.

Test and Evaluation:

The program, before taking its final form, underwent a number of revisions. When fifty or more frames were prepared, they were presented to the advisor for review and correction. In the light of the remarks of the advisor, the frames were corrected, adjusted or rewritten. Some new frames were sometimes added.

This was followed by a trial test on a sample student who satisfied our definition already referred to. Each chapter was tried separately. The student wrote out his responses to each frame. The author met with the student after each test and discussed the difficulties

encountered by the student. The frames were further readjusted to eliminate these difficulties.

The frames were then presented to two members of the thesis committee for further review and readjustment.

The scores of the student's tests are given under appendix B.

Text Format:

In order to comply with the thesis manual and the typing regulations, the first form of horizontal format shown in fig. 1 was adopted.

IV. RESULTS AND DISCUSSION

The results of this study which resulted in the preparation of the text of an introductory course in food science, are presented in appendix A, enclosed under separate cover. The text comprises 1080 frames; 459 frames covering the first unit dealing with food chemistry; 200 frames covering the second unit dealing with food spoilage and 421 frames covering the third unit dealing with food preservation.

Programed Textbooks and Conventional Textbooks:

It could be noticed perhaps from what was exposed in both the literature review and methods sections that the writing and preparation of a programed text is different from the writing and preparation of conventional textbooks. After the completion of every section or block of frames, the programmer should refer back to the student for the testing trial of that particular point before proceeding any further. This reverse procedure is necessary to give the writer an estimate of the value of what has been prepared.

It shows whether the program is proceeding in the proper manner or not. This procedure makes program writing a time consuming operation. As stated earlier, these repeated trials consume if not more as much time as it does to write the program.

Experience and Guidance:

During the preparation of this program, the author gained experience gradually in the process of programing. However the absence of a specialist in program writing to coach the study was an inconvenience.

Evaluation:

To consider the writing of a program successful, a program should score not less than 90 per cent of the responses correct when tried. Appendix B shows the scores of the different tests carried out on the sample student giving an average of 97.8% which is higher than the minimum for a successful program. However, the value of the program, its feasibility and success could only be assessed when it is actually applied in a classroom.

Subject Matter:

On examining the text for its subject matter, it would be seen that it presents the different basic principles of food science in its three main fields; composition, spoilage and preservation. This text would act then as an initiation course to prepare students for more advanced studies in this field.

V. SUMMARY CONCLUSIONS AND RECOMMENDATIONS

This programmed instruction course is the first of its kind in Lebanon, covering the subject matter of food science. The subjects covered in the course, as they appear in Appendix A, included three main units; food composition, food spoilage and food preservation.

In the first unit dealing with food composition, the different components of food were discussed, giving their composition, properties, and importance. These components include carbohydrates, fats, proteins, minerals and vitamins. To the above, a discussion of water and the organoleptic factors and properties of food namely, flavor and odor, both natural and synthetic, with a short discussion of spices and condiments, was added.

The second unit dealing with food spoilage, discussed the perishability of foods, causes and types of food spoilage, whether biological, enzymatic, chemical or physical. The control of these different forms of spoilage was also discussed.

The third unit dealing with food preservation, gives the principles, methods, advantages and disadvantages of food preservation. Three main methods of food preservation, namely, thermal processing, refrigeration and freezing, drying and dehydration were discussed in more detail to illustrate the different principles of food preservation.

This course is only an attempt aimed at testing the efficiency of this new technique of instruction in the teaching of food science at

the preparatory and university levels.

The tests carried out on the sample student were rather encouraging. However the present form of the text is not final. It is suggested that the next step would be an actual trial in a classroom on a group of students who should satisfy the definition of the students whose background was used as a basis in the construction of this program.

In the light of results then procured, the text could then be reevaluated and revised to give it a more final and polished form.

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A P P E N D I X

Appendix A

See text presented under separate cover.

Appendix B

Scores of Student's Test

	Chapter	No. of Responses	No. of Errors	% of Correct Responses
Unit One	I	50	1	98
	II	86	2	97.7
	III	125	2	98.4
	IV	92	2	97.8
	V	135	5	96.3
	VI	336	5	98.5
	VII	97	4	95.9
	VIII	133	4	97
Unit Two	I	75	2	97.3
	II	207	-	100
	III	185	1	99.46
Unit Three	I	116	1	99.14
	II	237	6	92.5
	III	42	1	97.6
	IV	218	3	98.6
	V	179	5	97.2
			Average	97.9