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Helping Students Learn and Learn How to Learn in the Context of Health Occupations Instruction

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Abstract: Students are rarely taught how to learn. They are taught content such as science and math but rarely how to learn such content. In health occupations, as in all areas, instructors can help students learn by embedding strategy instruction within their courses. To do so, instructors must first understand a few learning principles. With these principles, *instructors* can design instruction consistent with the ways learners should learn. Using these learner-compatible methods, instructors can teach students how to learn. This instruction is accomplished by overtly modeling learner strategies, describing their benefit, and providing students with opportunities to practice the strategies across settings. Producing learners who can learn *is an important* part of preparing health occupations students to meet the expectations and demands awaiting them as health occupations providers.

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Health occupations teachers spend considerable time preparing to teach their students, but how many prepare their lessons to ensure that students actually learn the content? Going one step further, how many teachers teach their students how to learn this content? We think that effective instruction should have two components. One, it should be learner-compatible, presented in a manner commensurate with how students learn. When this occurs, students are apt to learn in spite of themselves. Two, effective instruction should also teach learners how to learn, such that they become autonomous learners capable of learning regardless of the nature of instruction. In order for instructors to teach in a learner-compatible way and to teach students how to learn, they must understand several principles of learning. This article presents several important learning principles and their implications for designing learner-compatible instruction. The article concludes with a discussion of how instructors can teach their students how to learn within the context of health occupations courses.

Principles of Learning

Several principles guide effective learning. These learning principles, of course, have implications for developing learner- compatible instruction. In this section we describe each principle and explain its implications for instruction.

Principle 1: Learning is Controllable

Both teachers and learners have considerable influence over how information is learned. Figure 1 shows how one aspect of learning--perception--is controllable. Read the message in

Figure 1 aloud, then look at it a second time and count each word. Most people originally read, "I love Paris in the spring," and then count seven words. But the phrase, "I love Paris in the spring," has only six words. What happens in such a case? Look back to Figure 1 and you will notice that the word *the* appears twice. Perception/learning of the information is influenced by the instructions received.

On the first occasion, the instructions are to read. In this reading, many readers do not focus on individual words, but seek to extract meaning. They do just that when they miss the extra *the*. On the second occasion, however, the instructions are to count the words, which forces readers to pay attention to each word individually. Although there is only one message, it can be perceived two different ways according to the instructions.

Figure 1

A demonstration that learning is controllable

I LOVE
PARIS IN THE
THE SPRING

In educational settings, students and teachers continually influence how information is learned. For example, a teacher who provides students with behavioral objectives prompts them to focus on selected aspects of the presented information. Also, students who study information over several settings rather than in mass learn more information. Certain methods of learning and instruction are more compatible with our learning system than others and therefore lead to greater learning. The remainiig principles have implications for improving instruction and student learning.

Principle 2 Attention is Selective

Imagine being at a party and talking to a colleague. As you talk, your attention shifts about the room. You notice someone with a lampshade on his head. You see another person inadvertently drop a potato chip, look around, and then quite advertently squash it into the carpet with the heel of his shoe so that no one will notice it. You smell the host's dog, which needs bathing. You hear that Bob is splitting from Carol; Ted is leaving Alice; Bob is not interested in Alice; Carol is intrigued by Ted, and Ted is interested in Bob. There are, however, many more available conversations and observable incidents that you do not notice at this party.

Whether at a party, a ball game or in a classroom people are confronted with a host of possible stimuli (i.e., incidents, messages). Some stimuli are selected for processing, such as the person with the lampshade, but most encountered stimuli are not selected for our attention. Information that is selected is further processed and committed to memory (i.e., learned). For example, you might think that the lampshade person looks and acts like your Uncle Harvey. Making this connection helps you remember the incident. Alternatively, information that is not selected for attention is forever lost and never learned

In a classroom there are many stimuli competing for students' selective attention. Like the party, a student can switch his attention from the teacher to a conversation between other students to a poster on the wall to a swinging leg in the chair in front of him. An effective instructor can do several things, however, to command students' selective attention. One, an instructor can use distinctive stimuli. For example, occasionally using different colored chalk or speaking in *a* near whisper is likely to command students' attention. A photograph of decaying teeth and gums is also likely to command the attention of health occupation studetns learning about oral hygiene. Two, familiar *stimuli can be used.* Relating new information to students or to famous people is attention-producing. An instructor describing a human's recuperative power can relate the story of cyclist Greg LeMond who recovered from a near fatal hunting accident and subsequently won the grueling Tour de France bicycle race. Three, movement commands attention. It is virtually impossible not to follow movement. Effective teachers move about the classroom and use hand and facial gestures. They discourage other types of movement in the classroom and encourage students to sit toward the front where less potential distractions exist.

Last, and most importantly, effective instructors can tell students what to select. Oftentimes students try to learn, but fail to select the most important ideas for further processing. Writing crucial information on the board or supplying it on a handout helps students know what is important. Behavioral objectives and prequestions also point students toward important ideas. Skeletal notes--an outline of the lecture's main points with space between ideas for note taking--

also aid attention and result in more complete note taking (Kiewra & Frank, 1988). Finally, instructors can train students to focus on *alert words* in lecture and text that signal importance (e.g., the words *primary* and *significant)* and relations among ideas. Words such as *first, next, then,* and *phases* signal sequential relations among ideas. Words such as *types, parts, components,* and *kinds signal* hierarchical relations among ideas. Words like *similar, different, contrast,* and *whereas signal* coordinate relations among ideas. Instructors should incorporate alert words when teaching. Speaking about teeth, for example, the instructor might say, "There are three *types* of teeth: incisor, cuspid, and molar. Each of these can be *compared* with respect to location, appearance, number, and purpose." This statement alerts students to important ideas and their relations.

Principle 3: Working Memory is Limited

Information that is attended to selectively is stored momentarily in what is called working memory. The function of working memory is to hold temporaril y the attended information while it is being considered,/manipulated along with other incoming information and with past knowledge stored in long-term memory. For example, a health occupations student who is roughly determining a patient's caloric intake for a meal must store in working memory each of the foods eaten (incoming information) and the average calories per food item (information retrieved from long-term memory), then calculate in working memory the number of calories consumed.

This and similar tasks are difficult because of the limited capacity of working memory. Working memory is limited in the amount of information that can be stored and worked on. Students are limited to working with approximately five to seven bits of information at any one time. However, these bits of information can be quite large. For example, a chess novice quickly exposed to 10 pieces on a chess board has difficulty remembering the locations of those 10 pieces. An expert, meanwhile, does not see 10 distinct bits of information but instantaneously recognizes two or three larger *patterns. The* expert, who *has the same* working-memory capacity as the novice, uses that capacity more efficiently by chunking the pieces into a few familiar patterns.

The relation between working-memory capacity and background knowledge is also seen in the task of reading. If a student reading a passage about diabetes is unfamiliar with terms such as *insulin shock, carbohydrate* and *acetone,* then she must use working-memory capacity for determining the meaning of individual words rather than for higher-level processes such as relating ideas to one another the way a more knowledgeable student is apt to do.

It is evident, then, that limited working-memory capacity is less of a problem for students with sufficient knowledge than for those without. Instructors should, therefore, be certain that students have adequate knowledge and skills to approach the new learning task A student who cannot automatically classify foods into categories such as protein, carbohydrate and f at when planning a weekly menu uses valuable working-memory resources classifying foods instead of orchestrating a balanced and satisfying menu.

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More directly, instructors can aid students by providing them with organized knowledge. Students, then, do not have to allocate memory resources organizing the information themselves. In the next section, specific suggestions are given for aiding organization.

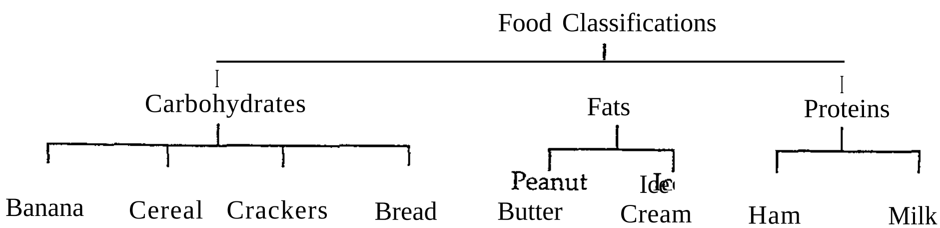
A final way that instructors can help students compensate for the limits of working memory is by encouraging them to record complete notes and/or by supplementing student notes with notes provided by the instructor (Kiewra, 1985). Because working-memory capacity is limited to only a few bits of information, new information entering working memory "pushes out" the old information which is then forgotten. That is why students must realize the limits of their memory system and record complete lecture notes. It is difficult, however, for a student to attend simultaneously to both the lecture and note taking. Therefore, instructors can minimize demands on students' working memory by providing lecture notes or at least critical tables, figures, and graphs that need not be copied while they are being explained. It is virtually impossible, for example, for students to copy a graph depicting increases in drug usage, that is projected on a screen, while simultaneously recording the lecturer's statements about a drug's effects. In this case, the instructor should provide a copy of the graph that can be studied after the lecture when time is available for committing the information to long-term memory.

Principle 4 Internal Connections Facilitate Learning

In order for students to understand and remember information, they must identify or build relations among presented ideas (Mayer, 1984). These relations are called internal connections because they exist within the learning material- For example, suppose a student had to learn the following list of foods: peanut butter, banana, ice cream, cereal, ham, milk, crackers, and bread. his list is learned more easily ifit is organized in such a way that the items are related to each other. One method involves relating them by eating preference. You might group peanut butter and crackers; cereal, bananas, and milk; ham and bread; with ice cream for dessert. Alternatively, you might group them by their predominant classification: carbohydrate, fat, or protein as was done in Figure 2.

Figure 2

A hierarchical classification of foods



Organizing information has three advantages. One, the information is stored more economically in memory. Two, the information is easier to retrieve from long-term memory because there are multiple retrieval pathways for locating it. For example, recalling the superordinate category carbohydrate helps in recalling the term bread. Similarly, the term milk, having been previously associated with ham, aids in the recall of ham. Three, the information is better understood. You know, for example, that bananas, cereal, crackers and bread are all carbohydrates and therefore share certain properties. In addition, these finds are different from the other foods falling under the classification of fats or proteins.

A most effective organizational device for identifying and understanding similarities and differences among ideas is a matrix (Kiewra, DuBois, Christian, & McShane, 1988; Kiewra, DuBois, Christian, McShane, Meyerhoffer, & Roskelley, 1991). A man-ix, like the one presented in Figure 3 on diabetes, is a more effective structure for presenting comparative information than an outline which lists information sequentially and discourages comparisons between topics.

One advantage of the matrix is that notes are always well organized regardless of the original learning material. Organized information is generally easier to learn. Second, the matrix structure encourages students to build both vertical within-topic connections and horizontal across-topic connections. For example, in the diabetes matrix you can study information about the topic, diabetic coma, vertically and see that several aspects associated with diabetic coma are slow, including onset, behavior, pulse, and response. Furthermore you might relate the fact that overeating could generally slow the activities of the diabetic approaching coma. In terms of horizontal (across-topic) connections, it is evident that many factors relating to hypoglycemia (e.g., onset, behavior, pulse, and response) are rapid and easy to detect whereas factors associated with hyperglycemia are slower and harder to detect. A third advantage of the matrix structure is that missing information is evident such as the missing information about breathing in Figure 3.

Instructors can present information to students in a matrix form. Alternatively, instructors can provide students with a matrix framework prior to a lecture or an assigned reading and have students complete the matrix. An example is seen in Figure 4. This latter method probably boosts attention too as students become more involved in selecting critical information.

Figure 3

A matrix showing symptoms of diabetic insulin shock and diabetic coma

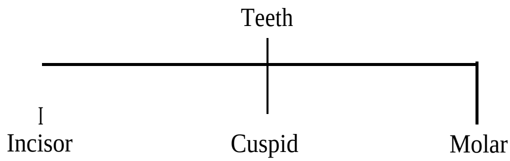
	Diabetic Insulin Shock (hypoglycemia)	Diabetic Coma (hyperglycemia)
Possible Causes:	I. Too much insulin	1. Too little insulin
		2. Infection
	2.Excessive exercise	
	3. Insufficient carbohydrate intake	
		3. Overeating
Onset:	Sudden	slow
Behavior:	Irritable, excited, hungry	Sluggish
skin:	Cold, clammy, pale	Hot, dry, flushed
Breathing		Deep, fmity odor
Pulse:	Rapid, thready	Normal to slower
Urine:	No glucose, no acetone	Acetone present
Treatment/Response	Sugar given—fast	Insulin given-slow

Principle 5: External Connections Facilitate Learning

External connections involve relating the new information to previous knowledge stored in memory. This process makes the new information more meaningful and aids retrieval because additional pathways to the information are developed. For example, students learning the

Figure 4

Matrix framework for noting information about teeth



Location:

Appearance:

Number:

Purpose:

information about diabetes might relate diabetic symptoms to symptoms previously learned about heart attacks. Students might also list names of people/patients known to have diabetes. These connections impose further meaning on the new material by relating it to familiar information. The new material can also now be accessed via information about heart attacks and names of people who have diabetes.

External connections are incorporated readily into a matrix representation. The matrix appearing in Figure 3, for example, can be extended horizontally by adding the topic of “heart attack,” and extended vertically by adding the subtopic “patients” (see Figure 5). Information about the causes, onset, and behavior. . . of heart attacks is included in the right-most column of

Figure 5

A matrix for making external connections for insulin shock and diabetic coma

	Diabetic Insulin Shock (hypoglycemia)	Diabetic Coma (hyperglycemia)
Possible causes:	1. Too much insulin	1. Too little insulin
	2. Excessive exercise	2. Infection
	3. Insufficient carbohydrate intake	3 . Overeating
Onset:	Sudden	slow
Behavior:	Irritable, excited, hungry	Sluggish
skin:	Cold, clammy, pale (Abet-to Salazar)	Hot, dry, flushed
Breathing		Deep, fruity odor
Pulse:	Rapid, thready	Normal to slower
Urine:	No glucose, no acetone	Acetone present
Treatment/ Response:	Sugar given—fast	Insulin given-slow
Patients:		

Figure 5 where it is easily compared to the symptoms of diabetes. The names of patients who have experienced diabetic insulin shock or diabetic coma are included in the figure's first two columns, respectively. In addition, information within the cells of the matrix can also be connected to familiar information. For instance, the cold and clammy skin characteristics associated with hypoglycemia can be related to personal knowledge about marathon runner Alberto Salazar. After winning the Boston Marathon, Salazar's body temperature dipped below 90 degrees and his skin was described as clammy and pale. Salazar was suffering from hypoglycemia.

Teachers can help students build external connections in several ways. Instructors can provide a variety of examples, generate analogies and metaphors, relate material to past learning, and draw conclusions and implications. Students can also be instructed to raise and answer "why" questions about what is being learned (Pressley, Wood, Woloshyn, Martin, King, & Menke, 1982). For instance, when learning that a fruity odor occurs when a hyperglycemic patient breathes, the student should ask why this is so rather than memorize this information as a fact.

Principle 6 Prior Knowledge is the Basis for New Learning

One of the keys to effective learning and memory is the hooking of new information to prior knowledge. This premise, of course, presupposes that prior knowledge exists. For instance, students may be asked to read the following passage and to remember as much of it as possible.

> After checking the log it was obvious that I had been doing far too much LSD. As a result my max $V0_2$ was bound to suffer. It was obviously a time to attempt some fartleking.

Although students have no difficulty reading this passage, chances are they do not know what it is about. They might be able to memorize it word-for-word with sufficient time, but would still be unable to recall it in a meaningful fashion. For example, they probably would not know how the log revealed too much LSD. If they have difficulty remembering this passage about running it is because they lack the prior knowledge in memory necessary to form meaningful external connections. One must understand, for example, that a log is a journal in which workout records are kept; LSD is the acronym for long, slow distance; and that *fartleking is a* Swedish word meaning speed play. With prior knowledge, students can now understand that this particular runner was aware she had been running too slowly and was perhaps losing her stamina. She planned a fartlek workout (involving a combination of slow and fast running) to boost aerobic fitness.

Instructors not only should be sure students have relevant background knowledge, but should help them to use such knowledge. This can be accomplished by providing learners with overviews in advance of reading assignments and lectures (Mayer, 1979), reviewing previous ideas or basic skills before presenting new knowledge or skills (Gagne, 1977), or by using frequent testing as a means for keeping students' background knowledge current and usable. Instructors should encourage students to review their lecture notes regularly, read corresponding text materials concurrently with lectures, and ask questions of teachers and fellow students when they need more information. Students reading a passage about exercise, for example, should inquire about vocabulary such as *aerobic capacity* and *maximum oxygen intake* if these terms are not clearly defined in the text.

Principle 7: Retrieval is Cue Dependent

Information is likely to be learned when it is selected for further attention, when internal connections are made among to-be- learned ideas, and when external connections are made between the to-be-learned information and previous knowledge. A rich store of background knowledge helps in forming external connections. Although these ideas are central to learning information, oftentimes the problem is not learning information but later retrieving it from memory. Fortunately, teachers can do things to facilitate retrieval among their students.

Retrieving information from memory depends upon having an appropriate cue to activate the memory, just like a certain key is needed for opening a particular lock. The following demonstration suggests what type of cue will best aid retrieval.

Suppose students were instructed to learn a long list of paired associates like the following:

skunk	--	Table
tree	--	Pillow
spoon	--	Radio

A few days later they are asked to recall the capitalized words. As cues for retrieval they are either given the original unassociated cue words (skunk, tree, spoon) or semantically related cues such as chair (for table), sleep (for pillow), and music (for radio). In which of these cases would recall of the capitalized words be best? Contrary to popular belief, experimental results have confined that recall is best when the original retrieval cues are provided (Tulving & Osler, 1968; Tulving &

Thomson, 1973). Recall from memory is facilitated when the cues originally associated with the information are made available at recall.

This principle is the basis for a person tying a string around his finger in order to remember picking up the dry cleaning after work. When first placed around the finger, the string is associated with the dry cleaning. Later, the string is a retrieval cue for remembering the dry cleaning. This principle also explains why one readily recognizes his dentist in her office, but not in the grocery stem. The dentist is learned among cues associated with dentistry and subsequently recalled best when these same cues are reinstated at retrieval.

In academic settings, however, students do not always have effective retrieval cues available *at* testing. The obvious danger is that test questions will fail to *cue* learned responses just as the dentist herself did when witnessed in the grocery store. Research has demonstrated (Barclary, Bransford, Franks, McCarrell, & Nitsch, 1974), for example, that students who learn the sentence, “The man tuned the piano,” can generally recall that sentence when later given the retrieval cue, “Do you remember hearing about something that makes nice sounds?” The retrieval cue, “Do you remember hearing about something heavy?” however, is ineffective, even though every one knows that a piano is heavy. If students instead learn the sentence, “The man lifted the piano,” then the cue “. . . something heavy?” is effective; whereas the cue, “. . . makes nice sounds?” is ineffective. In both cases, students learned, but learning was only observed when a cue consistent with the method of learning was available.

The same sort of retrieval problem can easily occur among health care professionals. We know a young doctor who was unable to diagnose his own case of shingles. His inability to diagnose the disease occurred because he originally learned to diagnose the disease in its more advanced stages and among elderly patients where it is more common.

Because students must be able to recall information in a variety of situations and in connection with multiple cues (e.g., among young and elderly patients and in early and late stages), it is important for students to build multiple pathways to the information while learning it. Students who build internal and external connections whale learning are, by definition, creating multiple retrieval pathways to the new information. The ability to diagnose shingles, for example, is maximized by having studied shingles among related skin disorders such as chicken pox and herpes, and by encountering a range of examples showing shingles among varying aged patients and in vatying stages.

Instructors can also help students build more appropriate cues by providing them with knowledge about the testing situation. Students preparing for a test on diabetes, for example, could be told whether they will be given a learned symptom and asked to state the associated complication of diabetes, or whether they will be required to simply name all symptoms given a complication of diabetes. These two tests offer vety different retrieval contexts and suggest different learning strategies. In the first test, the critical information itself is offered as cues for recognizing diabetic insulin shock or diabetic coma. Learning, therefore, involves matching each symptom to its superordinate category. In the second, more difficult test, the superordinate categories (diabetic insulin shock and diabetic coma) are the retrieval cues for recalling the subordinate information. Learning here involves practicing the recall of symptoms given the superordinate categories. Of course, a third test might involve presenting previously unencountered descriptions of patients' symptoms (as retrieval cues) and having students identify the complication of diabetes. This still-more-difficult test requires students to practice identifying a range of examples for each symptom.

Teaching Learners to Learn

To this point, key aspects of learning have been discussed along with their implications for instruction and learning. The hope is that instructors will design instruction so that students learn in learner-compatible ways. Although these suggestions will aid student learning, they will not necessarily teach students how to learn. In fact, a student provided with a matrix might do better on a forthcoming test, but not understand how the matrix helped nor be able to generate a matrix subsequently.

The importance of teaching students how to learn is recognized in the health occupations community. Employers want employees who know how to learn in order to meet the changing requirements of their jobs (The Secretary's Committee on Achieving Necessary Skills, 1992). Unfortunately, learning skills are often unsatisfactory among high school and college graduates

(Lynton, 1989; The Commission on the Skills of the American Workforce, 1990). There is a growing need to teach students how to learn.

Fortunately, instructors who teach in learner-compatible ways are just a few simple steps from teaching learners how to learn. Teaching students how to learn can occur simultaneously with learner-compatible instruction over a period of time. An instructor teaching in a learner-compatible way simply explains what he is doing, why he is doing it, and provides classroom opportunities for students to acquire the skill gradually. For example, when providing students with information in a matrix form, the students are told explicitly about how the matrix was formed (i.e., the topics were placed on top, the subtopics along the left side, and the details within the matrix cells), and why it is beneficial (i.e., for seeing relations both within and across topics). In subsequent situations the students might be given only the framework of the matrix (i.e., topics and subtopics) and asked to fill in the details. Later, students might be prompted to find topics, subtopics, and details for a given unit of information. Through these experiences the skill of generating matrices is gradually transferred from the instructor to the students until the students can spontaneously and autonomously generate a matrix and identify the within-topic and across-topic relations. In summary, an effective instructor teaches learners how to learn by teaching in a learner-compatible manner and by making his techniques and rationales explicit through talking aloud, The effective instructor also provides multiple opportunities for students to learn and automatize the skills/principles gradually through successive exposure and practice. Practice should occur in multiple contexts (e.g., with various content in various courses).

This approach to teaching learners how to learn is similar to that used by a tradesperson to teach an apprentice on the job. As a job is being carried out by the tradesperson, she explains to the apprentice how and why it is done in this way. Then the apprentice is gradually given opportunities to apply the skills under the watchful eye of the tradesperson who now supplies helpful feedback about the apprentice's performance. When learning strategies are taught in this way, there is no need for a separate class in how to learn. Learning how to learn occurs on the job as the instructor presents course content.

If students are to be autonomous learners, then there is one last skill that must be learned beyond those mentioned previously. Students must monitor their own learning. Good instructors, teaching in a learner-compatible way, monitor student learning by asking such questions as, "What did you record in your notes? How did you read your textbook? Why did you use that technique? How will you learn that information? Did you make effective internal and external connections? Do you have adequate background knowledge? Do you understand?" Ultimately, however, if students are to be autonomous, they must monitor their own learning as would an effective instructor. The problem is that learners typically do not ask themselves about their own learning. They wait for instructors to ask them. Until they are tested, many students do not know that they do not know. Of course, then, it is too late.

This self-monitoring skill is also taught to students by embedding it into the context of the course. When teaching students content through the use of a matrix, for example, the instructor can model self-monitoring by asking such things as: "Have I found all the topics and subtopics? Do I see how these topics are similar and different? Can I think of novel examples for these new concepts?" The instructor should explicitly draw students' attention to self-monitoring behavior and explain how and why it is done.

Self-monitoring cannot be fully valuable unless the student knows the learning principles discussed previously. What good is it for a student to know that she does not understand a reading passage, for example, unless she knows why she does not understand (e.g., internal connections among ideas are not yet apparent) and is able to do something about it (e.g., generate a matrix set of notes)? Therefore, it is best to teach learning principles/strategies and self-monitoring simultaneously.

Conclusion

The goals of education should be to teach students content and how to learn such content-Health occupations instructors who understand learning principles and who teach in learner-compatible ways are likely to meet the goal of teaching content effectively. When health occupations instructors make learning principles apparent to students and have students practice strategies derived from learning principles, then health occupations instructors are likely to meet the second goal of teaching learners how to learn. Learners who can learn will perform at a high level in school and be prepared to meet the expectations and demands of employers in the health care industry.

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