Teaching Biology to Limited English Proficient (L.E.P.) Students

Ovid K. Wong

Ovid Wong is assistant director of the Asian Studies Program at the National College of Education, Evanston, Illinois. His address is 740 New Mexico Trail, Elk Grove Village, IL 60007. Formerly an education consultant and member of the advisory council at the Illinois Medical Training Centers in Chicago, Wong holds a B.S. in Biology from the Univ. of Alberta, an M.Ed. in Curriculum and Instruction from the Univ. of Washington, Seattle and a Ph.D. in Curriculum and Instruction from the Univ. of Illinois, Urbana, Champaign. He has worked as an education consultant for Phipps & Bird, Inc. and written curriculum, taught and served as vocational advisor and talent assessment manager for the Chicago Board of Education.

In recent years, because of the increased enrollment of students with non-English backgrounds, many schools are changing their instructional strategies. Many of these non-English speaking students are now identified as limited English proficient (L.E.P), which refers to any member of a national origin minority who does not speak and understand the English language in an instructional setting (Bilingual Vocational Project 1979). Non-English speaking students in some large school districts are fortunate to be serviced by transitional classes that help them to acquire English as well as the content of academic subjects in a bilingual instructional setting. Unfortunately, students in many smaller schools that do not have the transitional classes do have difficulty with some of the instructional materials and teachers. Many science teachers, and in particular biology teachers, are frustrated in teaching a subject that had a traditional reputation for difficult vocabulary-based concepts for students with only limited English ability. I am offering an instructional model for teaching biology to limited English speaking students.

Many students when they first came to the United States from a foreign country had at least one thing in common—a deficient command of the English language. The following recommendations from linguists and counselors indicate some language difficulties that prevent many L.E.P students from doing well in an academic subject such as biology:

- The student does not yet possess the skills that are necessary for success in a class where the primary teaching methods are lecture and/or discussion. Academic courses are probably still too difficult for him at this time.
- The student will need to identify large quantities of vocabulary in the book in order to grasp the idea.
- When writing on an unfamiliar topic, however, the student still relies too heavily on models.
- The students comprehension grade possibly indicates only a cursory understanding of the course content.

What one gathers from these recommendations is the general conclusion that deficient English ability handicaps meaningful learning for the students and effective teaching by the teachers.

Let us examine a situation in a biology class in which an L.E.P student has been requested to describe the process of photosynthesis.

> *"Photosynthesis is carbon dioxide, water, light, cholorophyll to make sugar, oxygen."*

An interesting feature about the above response is that the student omitted words that would normally be used by a native English speaker. Such omissions do not seem to be random. Students leave out words like "to", "the", "with", and "and", which to them do not effect the meaning of the description. Let us compare another response by a native English speaking student.

> *"Photosynthesis is a process used by the green plants to use carbon dioxide and water with the light energy and cholorophyll to produce sugar and oxygen."*

The abbreviated speech pattern can be described as telegraphic. Such a speech pattern has been found to be remarkably similar among children from many different cultures (Sobin 1973). The production of a word combination often is ambiguous. "Carbon dioxide, water, light, cholorophyll" has a very confusing relationship. The identity of the raw materials of photosynthesis (carbon dioxide, water), the catalyst (chlorophyll) and the energy (light) are not specified and the final interpretation of the relationship and content can only be guessed. To understand fully what the L.E.P student is trying to express, the teachers often need to know the context in which the speech is occurring. If a biology teacher is given a telegraphic answer to a question, how can he fairly assess the response? Should the teacher overlook the grammatical errors that affect the meaning of the content with unclear relationships? When such a question is taken into consideration many biology teachers might come to a point where activities requiring a heavy usage of English are kept to a minimum. Techniques in the lower cognitive domain (e.g. identification, simple classification) are used more frequently. Unfortunately, this approach confuses the L.E.P students further by misleading them to think of biology as a collection of factual knowledge which has to be memorized and not learned (Wong 1983).

Let us consider a lesson about protein synthesis, a subject that is comparable in difficulty to photosynthesis. At the high school and even college level this rather complicated topic is treated traditionally with lectures and discussions. With limited English ability how can a student tackle the subject matter effectively without losing the content? The following instructional strategy is offered to shed some light on a teaching model for L.E.P students, assuming that bilingual teaching is not available and the curriculum content can not be changed economically to suit the needs of different language groups. (Wong 1977).

As a preparation to the protein synthesis activity, the students were introduced to the cell and its components. Then the activity started by giving each student an envelope containing paper cuts (made from construction paper) in different sizes, shapes and colors. The paper cuts represented different cell components and chemicals which take part in protein synthesis. A chart of identification that explained the content of the envelope was shown to the students (see Figure 1). The instructions on it said:

Inside the envelope you will find all the cell components and chemicals for making protein. Follow each step carefully.

Step 1— Put a piece of blank white paper on the desk. This paper represents a cell.

Step 2— Put the NUCLEUS inside the cell. The nucleus is the control center for protein synthesis.

Step 3— Put the RIBOSOME inside the cell but outside the nucleus. The ribosome is the factory for making protein.

Step 4— Place the DNA (Deoxyribose Nucleic Acid) inside the nucleus. DNA carries information for making protein.

Step 5— Place the mRNA (messenger RiboNucleic Acid) along the side of the DNA. mRNA copies the protein synthesis information directly from the DNA.

Step 6— mRNA then leaves the nucleus.

Step 7— mRNA joins the surface of the ribosome. mRNA carries the information from the nucleus to the ribosome.

Step 8— Put the tRNA (transfer RiboNucleic Acid) outside the nucleus close to the ribosome. tRNA is a carrier of AMINO ACID.

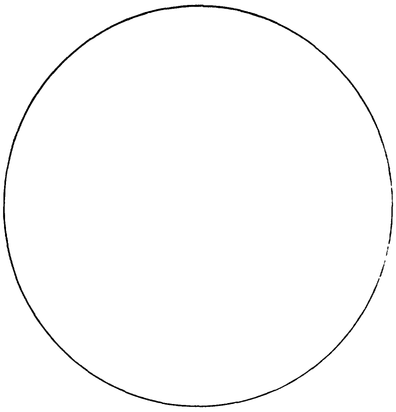
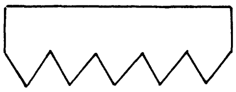
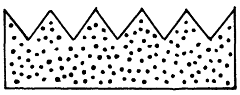
Step 9— tRNA with the amino acid combines with the mRNA on the ribosome.

Step 10— The amino acids are linked in a chain.

Step 11— The amino acid chain leaves the ribosome to become PROTEIN.

When the cell components were introduced to the L.E.P students, the names of the components were given in English as well as in the students' native language (Figure 1). In our instructional model, the translation of Chinese characters were given. It was interesting to see that the Chinese translation of amino acid does not familiarize the students with the chemical any better than the English counterpart. In other words, the concept of an amino acid was new to the students both in English and Chinese. It is interesting to note also that many students would prefer to learn the name of amino acid in English than in Chinese. Although the making of protein described in the teaching model is given in rigid steps, the final arrangement of the paper cuts to show the synthesis process by students can be very different. The graphical arrangement may be different from student to student but that should not be used as a sole base for evaluation. Instead more accurate evaluation should be based on the proper placement of the cell components, the chemicals and the relationships among them. As long as the relationship of the components are clear the arrangement is a valid one. Figure 2 shows protein synthesis as perceived and constructed by an L.E.P student.

One important characteristic of the instructional model is that abstract information is delivered basically in tangible visual form. Relationships between the components are expressed by different positions of the cell components, chemicals and arrows. For example, the long arrow from the nucleus to the ribosome in Figure 2 means "mRNA leaves the nucleus . . . joins the surface of the ribosome . . . mRNA carries the information from the nucleus to the ribosome." It is found that the activity, if conducted properly, should reflect some of the basic ingredients of a learning process. These ingredients are: (a) symbols of information; (b) basic concepts of a subject; (c)

	NUCLEUS 細胞核
	DNA 去氧核糖酸
	mRNA 傳信核糖酸
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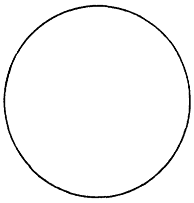
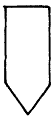
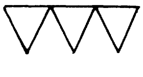
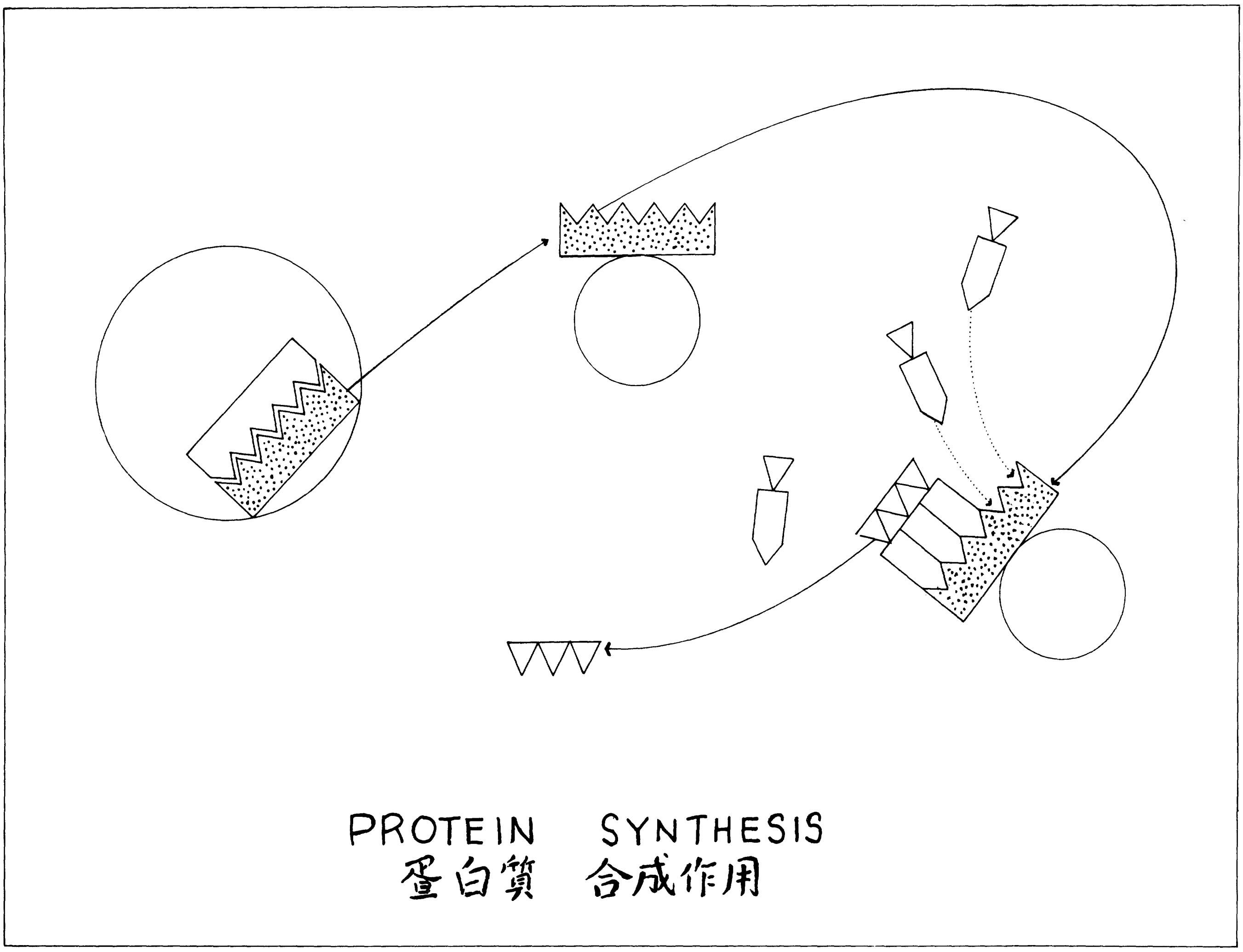
	RIBOSOME 核糖體
	tRNA 轉送核糖酸
	PROTEIN 蛋白質



development strand of a concept, and (d) problem solving (Broudy 1982). For the L.E.P students the basic linguistic symbols are being substituted by graphic symbols (paper cuts, lines, arrows). The substituted graphic symbols are not meant to short change the proper learning and usage of the English language but to facilitate the students to express themselves better even with limited language ability. If the overall arrangement of the paper cuts, lines and arrows are examined carefully the basic underlying concept of protein synthesis is revealed. When the process is traced following the arrows from the nucleus to the protein molecule a developmental concept from the information given by the nucleus to the final assembly of protein from amino acids is evident. At a higher level of problem solving, the protein synthesis activity can be described in a short simple paragraph without giving any instruction in the arrangement of the cell components and chemicals. For the more advanced students, it would be a problem solving process. They have to manipulate the paper cuts, drawing lines and arrows to represent accurately the given description like fitting pieces of a jig saw puzzle together. It is also found that the activity when implemented correctly has the following advantages for the L.E.P students: (a) helps the students to express better with little help from the language symbols; (b) the subject matter is encountered in a nontraditional way (e.g. the game approach) to stimulate interest and motivation; (c) by manipulating the paper cuts repeatedly to attain a final arrangement the students are exposed to the materials again and again to foster learning and retention, and (d) directions are given in small discreet steps to maximize success and reinforcement.

Recently attention has been drawn toward the education of L.E.P students in many academic areas. L.E.P students are identified and instructional materials developed particularly for their needs. The Chicago Board of Education has developed courses in bookkeeping, typing, woodshop drafting and health services. All the courses are written in a level of English which L.E.P students in different instructional levels will be able to understand. The health services program in particular is developed and constructed in a vocational curriculum similar to the instructional model described above. The content of the health program covers such areas as measurements, solutioning, microscopy, medical records, vital signs, blood tests, vision analysis, urinalysis, spirometry, microbiological techniques and cardiopulmonary resuscitation.

It is proposed that a variety of vocational skills in the health field can be taught effectively if a curriculum can provide opportunities for the L.E.P students to engage actively in, and to deal wholeheartedly with, the materials that interest and give them a maximum chance of success. (Wong 1982) We have begun to explore a few possibilities in instructional materials and strategies that can satisfy the needs of the L.E.P students. I hope further that the model can be adapted and used with regular biology students for additional insights into the art and science of teaching.

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