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SCIENCE COMPETENCIES IN HEALTH OCCUPATIONS EDUCATION

Judith A. Davis'

Abstract: Health Occupations Education students and teachers recognize the relationship between life and physical sciences and the health occupations curriculum. To verify this relationship, the Division of Vocational Education, North Carolina Department of Public Instruction, funded a project for North Carolina State University's Health Occupations Teacher Education faculty to study the relationship of science and health occupations and to analyze the science **competencies** taught in health occupations courses in secondary schools. A teacher panel and technical advisory panel assisted with the study. A survey of teachers verified the relationship of health occupations and science **competencies**. Results of the survey formed the basis for matching health occupations competencies with science competencies, developing health occupations learning modules stressing science health occupations courses. Each of six modules developed for use by health occupations teachers included both health occupations and matching science **competencies**. Modules were developed for anatomy, immunity, metrics, nutrition, respiration, and health risk awareness.

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Because of the extensive system of 58 community and technical colleges in North Carolina, specialization in health professions occurs only in **postsecondary** programs. Many of North Carolina's high school graduates attend health professions' programs in the community college system. Students find their background in Health Occupations Education (HOE) prepares them well to pursue (a) associate-degree programs including dental hygiene, medical assisting, medical laboratory technology, nursing, radiography, and respiratory therapy; and (b) one-year, diploma programs in the community college system in dental assisting, medical assisting, practical nursing, and surgical technology. Most of these students are better served by taking three years of HOE in high school than by foregoing one year of HOE to take additional science courses. Some of these students **may** want to earn science credit for health occupations courses.

In order to verify and support the science competencies included in the HOE curriculum, North Carolina State University's Health Occupations Teacher Education faculty conducted a project funded by the North Carolina Department of Public Instruction, Division of Vocational Education . (hereafter referred to as State Department).

Background and Need for the Study

Health occupations teachers are faced with the problem of meshing related studies with the specialty education they offer. One critical relationship for HOE teachers is due to existing redundancies between science education and vocational specialty education. However, each vocational specialty seems to require its own set of associated science competencies.

Graduation requirements have increased during the 1980's and much of the increase has come in science and mathematics (National Commission on

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Excellence in Education, 1983). This trend to include more science should strengthen vocational education. It can have its major impact when the specific science competencies needed for success in HOE or other vocational programs and in the working world are identified and classified. Moreover, science competencies of many students can be enhanced through certain vocational education courses including HOE.

Review of Related Literature

In the 1960's, vocational education leaders identified the relationship between general education and vocational specialty education. Kemp (1966) emphasized that basic skill education should be closely tied to vocational offerings to make both more meaningful to students. Kemp clearly documented the utility of such endeavors in programs designed for students plagued with various kinds of disadvantages. Osipow (1969) indicated that efforts must be made to show how skills acquired in school are useful in work. In stressing the need for the educational system to assume responsibility for preparing all students to move on to their next educational or occupational step, Venn (1964) stated that no one can be successful in occupational education without the basic tool skills of reading, writing, listening, and computing. Venn indicated that "separation of occupation from **general** education at any level increases the possibility of limiting the individual's future development because of a lack of related knowledge and general education" (p. 169).

In the 1970's, **Marland** (1971) supported career education for elementary and secondary students by citing a need for structuring basic subjects, in grades one through twelve, around the theme of career development and the requirements of the world of work. During the early 1980's, most states planned or approved increased science content in the curriculum, but

vocational education was not considered as a prescribed unit. By 1985, only 13 states allowed vocational education as part of the prescribed units for graduation (Dyrenfurth, 1985). Dyrenfurth's study affirmed that strengthened links with science education and vocational education have increased and that a focus has been made to use vocational courses to meet high school requirements in science. According to Action in the States (Task Force, 1984), several states strengthened vocational teaching by providing grants to increase science skills of vocational teachers.

According to **Mracheck** (1984), a science curriculum for **vocational-technical** education should include courses in physical sciences and the components should be integral to the student's major area of study (e.g., HOE). **Mracheck** presented a matrix of related math and science course outlines from vocational courses. **Truxal** (1984) reiterated **Mracheck** by stating that lengthening of diploma requirements by including more science and math for high school graduation would not necessarily be effected by teaching science in the usual way. **Truxal** called for a national effort to modify both vocational and science courses including more practical science in vocational courses and more technology in science courses.

A Nation at Risk (National Commission on Excellence in Education, 1983) stimulated educational reform and review of high school graduation requirements. The Commission on **Excellence** and others stimulated increased requirements for graduation (**Phipo & Flakus-Mosqueda**, 1984). Vocational **educators** in Virginia took a proactive approach to the recommendations of A Nation at Risk and developed an action plan to fit vocational education in the schools in spite of an increase in science requirements for graduation. As a result, **the** Virginia State Department approved health occupations courses as an alternative to additional science requirements (Brown, 1984).

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A 1987 study showed that 45 states or territories had increased requirements for high school graduation and only 15 states or territories required vocational education for graduation. In 28 of those states and territories studied, vocational education courses were considered appropriate alternatives for mathematics and science (Frantz, Strickland, & Elson, 1987). As in North Carolina, several states have provided that the decision about science credit for health occupations or other vocational programs be a decision of local school boards.

Purposes of the Study

As descriptive survey research, this study was designed to (a) identify HOE courses in which success depends on knowledge of a substantial amount of science, (b) identify and classify science skills needed in two HOE courses, (c) analyze science skills showing the highest relationship to HOE, and (d) develop prescriptive training modules for HOE competencies which could facilitate achievement in both vocational and science courses.

Methodology

Identification of Courses

The project team (Health Occupations Teacher Educators at North Carolina State University) selected the areas of concentration jointly with consultants in Health Occupations at the North Carolina State Department. They selected Health Occupations Education I (HOE I) and Health Occupations II (HOE II). Introduction to HOE was not selected since it is prerequisite to HOE I. The project team and HOE consultants agreed that HOE I and HOE II contained a substantial amount of science. Following the selection, consultants from the State Department and a panel of teachers verified the courses to be appropriate.

The project team organized an advisory board and teacher panel. Seven advisory board members were selected from professionals serving on the Wake County Health Occupations Education Advisory Board. Some board members also served on the State Advisory board for HOE. The advisory board included a hospital administrator, nursing educator, dean of allied health of a community college, educational services coordinator of a local hospital, consultant from the State Department, graduate of the HOE program at North Carolina State University and a doctoral student, a registered nurse from the University. The teacher panel had four HOE teachers, two science teachers, one science teacher educator, and one HOE teacher educator.

Preliminary Identification of Science Competencies

The project team reviewed lists of HOE and science competencies published by the State Department for use in secondary programs. By reviewing all HOE I and II **competencies** and science competencies for grades 9-12, the project team compiled a list of science competencies which matched the HOE **competencies**. The advisory board and teacher panel reviewed the lists and made comments about a possible relationship between the two sets of competencies. The Chair of Science Education and the Chair of Health Occupations Teacher Education at North Carolina State University also reviewed the lists of both **competencies** as did the Chief Consultant for HOE at the State Department.

Instrumentation

Following preliminary identification and approval of the two competency lists, the project team compiled a questionnaire asking for perceived relationship of science and HOE competencies. The instrument was mailed to eight Regional Leadership Councils (**RLCs**), HOE chairpersons, and two local

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HOE teachers for review. This group formed a pilot population for the questionnaire. The pilot group reviewed **the lists** and returned them. The project team formulated a final questionnaire based on the responses. The pilot group was asked to indicate agreement (by a Likert scale) of the relationship of the science **competencies** to the HOE **competencies**. The revised questionnaire was approved by the Advisory Board and Teacher Panel and became the survey instrument which was then sent to a random sample of six HOE teachers in **eight** regions, for a total sample of 48.

The survey instrument listed HOE competencies in four units and included below each of those units' **competencies** a listing of science **competencies** in five categories. The four units of HOE competencies were (a) Orientation to the Health Care Occupations and Agencies, (b) Interpersonal Communication and **Human** Relations, (c) Nutrition and Diet Therapy, and (d) Basic Sciences. The five Science categories were (a) Life Sciences, (b) Living Things, (c) Elementary Science, (d) Matter and Energy, and (e) General Science.

Respondents were asked to indicate the degree to which they considered the HOE **competencies** related to the science competencies. A modified Likert scale formed the basis for rating with the following ratings: 0 = unrelated, 1 = somewhat related, 2 = related, and 3 = clearly related. Directions in the survey instrument were to "circle the number beside the Science Competency that most closely describes your knowledge of the relationship of that competency to the Health Occupations Competency it follows."

An example of the items was the HOE Unit I. 02 competency, Interpret health agencies' functions. One Science competency listed was, "The learner will understand the nature of communities." from Unit 5, general science.

The Likert scale was listed with the science competency and respondents

circled the degree to which they thought that particular science competency related to that particular HOE competency. Every science unit did not have competencies applicable to every HOE unit. Thus, some HOE competencies did not include a matching science competency, for example, matter and energy.

Validity and Reliability

Validity of the instrument was assessed by using HOE and science competencies published by the State Department for use by HOE and science teachers. In addition, the teacher panel and advisory board determined content validity. Reliability of the survey instrument was calculated by split-half reliability on both the pilot sample and the entire sample. Split-half reliability from the pilot sample of 10 showed a Spearman Brown correlation coefficient of .86, $N=10$. Spearman Brown split-half reliability of the entire sample was .86, $N = 36$.

Analysis of Data

Descriptive statistics were appropriate for the study since one purpose was to develop modules for those HOE competencies with high science ratings. Mean ratings, names and descriptions of modules are shown in Tables 1 and 2, respectively.

Results and Discussion of Survey

Seventy-five percent of the 36 HOE teachers returned the survey instrument. Teachers were in general agreement that the science areas were conceptually similar to the HOE units. The survey instrument did not include all science units with all HOE units. Every science unit did not relate to every HOE unit. Table 1 shows mean ratings by HOE teachers

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Table 1

Mean Ratings by North Carolina HOE Teachers (N = 36) of Degree of Relationship Between Health Occupations Competency Units and Science Competency Categories

Health Occupations Units Science Competency Categories	I	II	III	IV
Life Sciences	2.39	2.62	-	
Living Things	2.11	-	3.00	-
Elementary Science				2.73
Matter and Energy				2.59
General Science		2.06	-	

Note: The Likert scale ranged from 0 to 3, with 3 being highest. Each mean represents a score of all 36 respondents. Cells with "-" had no science competencies in this category listed with HOE competencies on the survey. HOE Units: I = Orientation to Health Care Occupations and Agencies; II = Interpersonal Communication and Human Relations; III = Nutrition and Diet Therapy; IV = Basic Sciences.

indicating their judgment of the degree of relationship between HOE competencies and Science competencies.

Results of the survey showed that each HOE unit related to at least one science unit. Because of that agreement, the teachers encouraged the project team to develop training modules which would incorporate those science competencies into HOE units.

Development of Modules Based on High Ratings

Since several of the HOE units had high mean ratings on the survey, those units and their related science competencies were considered in developing the modules. Each HOE unit had related science competencies. The highest mean rating was for HOE Unit III, Nutrition and Diet Therapy,

Table 2

Names and Descriptions of Health Occupations Education Modules Developed Using Science Competencies

Name of Module	Content Area	Type HOE I/II* Unit
Health Risk Awareness	Health Care	CAI I, II**
Eat It	Nutrition and Communication	LAP III/IV
Metrics in Medicine	Health Care	LAP I, IV
Respiration, Energy for Life	Basic Science	ST IV
Pin the Part on the Person	Anatomy	LAP IV
Body's First Line of Defense	Basic Science	LAP IV

Note: *Course, HOE I or HOE II
 **Unit numbers for the courses HOE I/HOE II.

and Living Things (science category). The second highest rating was for Unit IV, Basic Sciences and science category, Elementary science. With advice of the advisory board and teacher panel, the project team agreed to develop at least four modules which would reinforce science **competencies** in HOE units and which would be useful in both HOE and science classes.

The project team evaluated commercially available materials applicable to both HOE and science classes. After discussion with the advisory board and teacher panel about development of modules and the results of reviewing commercial materials, the project team agreed to develop six modules. The advisory board and teacher panel served as a reaction panel for formative evaluation of each module. The HOE RLC Chairpersons agreed to pilot test each module with their classes. As each module was developed, the **RLC**

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Chairpersons provided minor suggestions (i.e., module too difficult, not enough worksheets, need clearer directions, etc.) which the team used to develop the final modules. Each module contained health occupations and science **competencies** as well as objectives.

Results and Discussion of Module Development

The project team developed a list of HOE competencies analyzed for science content applicable to the health occupations units. This matched list of HOE and science competencies, in addition to feedback from those teachers surveyed, formed the basis of developing modules. The list, which is 20 pages long, shows HOE competencies for each of four units in HOE I and HOE II.

With advice from the teacher panel and advisory board, the project team focused on developing modules for HOE I. RLC Chairpersons pilot tested the modules in their classrooms and provided feedback for the project team. All RLC chairpersons agreed that the modules were useful in reinforcing science competencies in HOE.

The same process was used for developing each of the six modules. Two modules were available commercially and others were developed by the project team. Each module contained health occupations and science competencies, objectives, learning activities, and student worksheets. Table 2 lists module names and descriptions of the health occupations content area as well as HOE competency unit number. Three types of modules were developed: Computer Assisted Instruction (CAI), paper and pencil Learning Activity Packages (LAP), or Slide/Tape (ST) programs.

Descriptions of the Modules

Health Risk Appraisal. For HOE Unit I, Orientation to the Health Care Occupations and Agencies, and Unit II, Interpersonal Communication and Human

two commercially available software packages, "Health Risk Appraisal-" and "Health Awareness Games-" (Human Relations Media, 1985) for the Apple IIe microcomputer [or IBM-PC] and provided additional instructions including identification of the science competencies related to Units I and II.

Worksheets were added for student use. The State Department purchased the software program and made it available to teachers. The unit included HOE competencies, unit objectives, and science **competencies** from the matched list. The HOE competency from Unit I was to translate health concepts as related to health maintenance and health care. The HOE competency for Unit II was to evaluate the harmful effects of alcohol, drugs, and tobacco patterns related to health problems or concerns. Unit objectives included the following: (a) name the leading causes of death for your age group, gender, race, and lifestyle; (b) state what relationship exists between lifestyle and mortality rates. Science competencies for the module were to (a) have an understanding of the importance of caring for the body through proper nutrition, health, and sanitary practices, and (b) discriminate between good and bad health practices. (The project team listed science competencies exactly as published by the State Department.)

Eat It. The module developed for HOE Unit 111, Nutrition and Diet Therapy, was entitled Eat It. This unit was designed as an individual and group learning activity. HOE I competencies included (a) classify dietary foods according to nutrients, and (b) describe nutritive deficiencies. The HOE II competency was to discuss basic therapeutic diets as a means of treating major diseases/disorders. Unit objectives included the following: (a) describe the major food groups in terms of classification, functions, and sources; (b) state the importance of vitamins, minerals, and water in

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the diet, (c) name the major adverse effects of each dietary deficiency including conditions and diseases, and (d) work in a group to apply dietary principles to creating a therapeutic nutritional plan for identified clients. Science competencies were to (a) have an understanding of the importance of caring for the body through proper nutrition, health, and sanitary practices, (b) identify from a list of foods a menu which includes the four basic food groups, (c) define calorie, and (d) describe how energy can be obtained from matter such as the burning of wood and digestion of food. The Learning Activity Package included activities to help students **apply** nutritional principles to career situations, plan therapeutic diets, and solve stated problems (in a group). The unit included resource material, worksheets, and a group exercise. The module was 20 pages in length and contained drawings and text printed with a computer and graphics software program.

Metrics in Medicine. The module, Metrics in Medicine was developed for HOE I, Units I, Orientation to Health Care Occupations and Agencies, and IV, Basic Sciences. The unit was designed as an individual learning activity package to stress the metric system and basic measurement. The HOE competency was to describe the use of the apothecary and metric systems as they relate to health care and health maintenance. The following objectives were included: (a) solve basic problems of conversions between the Metric, English, and Apothecary systems, (b) state the importance of understanding the Metric and Apothecary systems, and (c) discuss ways alternate systems of weights and measures are used in Science and Health Occupations. Science competencies included (a) demonstrate the proper use of a laboratory instrument appropriate for the student's grade level or course, (b) demonstrate the ability to observe, (c) perform computations involving whole

numbers and common decimal fractions when given a problem, (d) measure within a given degree of accuracy when given appropriate measurement instruments, (e) demonstrate a knowledge of the basic units of length, mass, volume, and temperature in the metric system when given measurement problems, and (f) understand that the metric system is the preferred measuring system in science. The module was 12 pages in length with five worksheets of problems and hands-on activities for student pairs.

Respiration, Energy for Life. Respiration, Energy for Life was developed for Unit IV, Basic Sciences. A commercially available slide/tape program published by Science and Mankind (1984) was used to meet unit objectives. The program was in two parts. Part I discussed major experiments leading to today's model of cell respiration and Part II included application of the theory of understanding cell respiration and energy. The project team devised a worksheet for the program and the State Department purchased a copy for teachers to use. The HOE I competencies for Unit IV included (a) analyze the structure and function of the respiratory system as they relate to the diagnosis and treatment. of major diseases/disorders associated with the system, and (b) analyze cells, tissues, and organs as related to body systems. Objectives were to (a) state the chemical processes involved in cell respiration, (b) name two scientists who contributed to our present model of cell respiration, and (c) explain how different forms of energy relate to each other. Science competencies included (a) understand that the general structural plan of the human body is composed of various systems with specific structures and functions, (b) name and describe the major structures and functions of all the main body systems, (c) understand that life is a chemical process, and (d) understand that the basic unit of life is the cell.

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Pin the Part on the Person. Another unit developed for Basic Sciences was Pin the Part on the Person. This learning activity package was designed with individual and group activities to enhance learning anatomy in the HOE I Unit, Body Systems and Functions. The HOE competency for Unit IV of HOE I was to analyze the structure and functions of the body's system as they relate to diagnosis and treatment of the major diseases and disorders associated with that system. Unit objectives were to (a) provide experiences for identification of the structure of the body's major systems and the organs that compose those systems, and (b) present science concepts involving the structure and function of the human body that help to strengthen those concepts taught in HOE. Science competencies were (a) understand that the human body is composed of various systems with specific structures and functions, (b) name and describe the major structures and functions of all the main body systems.. ., (c) understand that the basic unit of living things is the cell, and (d) label and describe the major organs of each major system of the human body. The unit was 20 pages in length and contained worksheets and group exercises.

The Body's First Line of Defense. The final module was The Body's First Line of Defense and was designed for HOE I, Unit IV, Basic Sciences. The unit contained eight pages of worksheets for class discussion. The unit was designed to supplement the teaching unit relating to structure and function of "the integumentary system in HOE I. The HOE competency was to analyze the structure and function of the body's system as they relate to diagnosis and treatment of the major diseases and disorders associated with that system. Unit objectives were to (a) differentiate between objective and subjective observations about the skin, (b) name the main structures and functions of the skin, (c) state the protective functions of the skin, and

(d) identify five diseases/disorders of the skin. Related science competencies were to (a) describe how disease-causing organisms enter the body by water, food, air, skin; (b) name and describe the major structures and functions of all the main body systems, (c) label and describe the major organs of each major system of the human body, and (d) list the major functions of the organs composing the major human body systems.

The project team presented the study and demonstrated the modules for the HOE teachers at the annual summer workshop. The State Department provided copies of the modules for each teacher. The modules requiring audiovisual or computer applications were made available on loan to teachers. Each teacher also received a copy of the final report of the study and the list of health occupations **competencies** analyzed for science content.

Conclusions and Recommendations

Science skills are essential for successful mastery of the Health Occupations Education **competencies** published by the North Carolina Department of Public Instruction. Mastery of basic skills in science is essential to success in Health Occupations I and II. Health Occupations teachers were anxious for and have used the module designed to assist students in developing the science skills needed in HOE.

Science teachers also need modules which show practical applications of science skills. From developing modules and the matched listing of science and health occupations competencies, the project team identified a number of science skills common to both Health Occupations I and II. The modules were disseminated to Health Occupations Education and Science teachers. The team recommended that the State Department fund a more comprehensive study of science competencies common across vocational areas. A major outcome of the

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study was that some local education agencies in North Carolina allowed HOE I to be a valid substitute for the additional science requirement for high school graduation.

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