1978

The Cognitive Ability Requirements of Vocational Education: A Role for Elementary Industrial Arts

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THE COGNITIVE ABILITY REQUIREMENTS OF VOCATIONAL EDUCATION: A ROLE FOR ELEMENTARY INDUSTRIAL ARTS

Presented to

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In Fulfillment of

the Requirements of ECI 536

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August 1978

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INTRODUCTION

This paper relates the origins of the idea that vocational education is an alternative to the acquisition of basic educational skills. The effect of putting the idea into practice is examined in relation to the disadvantaged student, the most likely victim of the practice. Evidence is presented which shows the dependence of vocational success upon a firm base of general knowledge.

In conclusion, suggestions are made for using Industrial Arts in the elementary schools to enhance the education of disadvantaged students.

The term "vocational education" is used loosely in this work. It is most often intended to relate only to that section of vocational education dealing with crafts and trades.

The Problem

When the Russians announced their first satalite in late 1950, Americans became alarmed about a seeming deficiency in scientific and technical knowledge in the school population.

The fear of the "education gap", coupled with the conviction of post-war, post-depression parents that their children should have an improved socio-economic position, led to a structuring of American education which concentrated on college preparation to the virtual exclusion of any other educational outcomes. (Apsler, 1975)

Members of that generation report that there was never any question either among their family, their peers, or their counselors as to whether or not they should attend college, but rather that all attention was given to what college they would attend and what course of study they would pursue.

Vocational alternatives were not discussed. In fact, there seems to have been a distinct feeling; communicated by parents, teachers, administrators, and students, that vocational education was for the "failures." (National Advisory Council for Vocational Education, 1969) To be tracked into a vocational program involved a loss in esteem among the peer-group and often a visible loss in self-esteem as well. Several occurences in the last fifteen years have caused positive changes to take place in these attitudes.

First among these was the large number of post-secondary education degree holders finding themselves out of work.

Large numbers of established professionals began to show up in unemployment lines when cut backs in government aerospace and aviation contracts occurred. Many recent college graduates were having tremendous difficulty securing employment in their area of specialization. In simple arithmetic, a large majority of the students were being encouraged to pursue education which would qualify them for 20% of the jobs in the nation. A second educational problem showed up in the early 1970's which has caused many school systems to jump to an unfortunate conclusion.

This problem was the existence, among the "educational produce" of the most prosperous nation in the world, of the illiterate high school graduate. The distressing media coverage of lawsuits by students against their schools in truth represented the surfacing of an educational problem which had existed quietly for years. What should be done about the disadvantaged or low-achieving student?

In the past, these students, as dropouts, had been absorbed by the labor market . A sufficient number of unskilled jobs were available to attract them away from school before they became an embarrassment to the school system. While dropout statistics have always bothered concerned educators, for far too many school administrators they were a "paper" problem and had lost their human dimensions. When events of the past decade forced dropouts and unskilled graduates from the ranks of the employed, school boards became uncomfortably aware of their existence.

A combination of events closed the labor market to these young people. Foremost among them was the fact that unskilled employment opportunities actually decreased during that period. (Department of Labor, 1968) The great influx of unemployed professionals and an increase in the number of women in the work force reduced the total availability of work still more. As fewer and fewer of these students quit school to seek work, they became more and more visible to the tax payer. Much of the public indignation was expressed in economic terms, the lack of accountability was wasting their tax dollars. It is indeed unfortunate that many people failed to relate to the human tragedy involved.

Regardless of any personal judgement over the motive behind the public reaction, it must be admitted that economic threats struck a nerve. School administrators across the country responded with various guarantees that incompetent students would not be graduated. The established minimum criterions for graduation and promotion were treatments of the symptom but not the disease. The problem still existed. What should be done with the disadvantaged student?

In Virginia it was mandated that statewide objectives be formulated for basic educational skills and that all students identified as deficient should be given remedial help. It has been left up to the local education agency how to deal with those who don't measure up. (Standards of Quality 77-78)

During the same period of time that poor educational performance was at issue, interest revived in vocational education as a right and just alternative to a college education. The Virginia General Assembly responded with a standard of quality requiring the availability of vocational education for all students.

Vocational education had been part of the curriculum in many Virginia school systems long before it was called for by the General Assembly. The mandate was necessary because many school divisions, either from lack of resources or lack of genuine commitment, had failed to offer comprehensive vocational classes of their own.

By an accident of fate many localities have been required to develop a vocational program and minimum criterion at the same time and far too many educational leaders are jumping to the conclusion that one is the natural alternative to the other. An examination of the needs of vocational education students will show why this conclusion is false.

Ability and Vocational Education

The problem associated with substituting vocational education for general education is examined in three areas: (1) the vocational development patterns of Americans students, (2) the skills necessary for occupational success, (3) the skills required for vocational training.

Patterns of Vocational Development

Certain patterns seem to be common to all the various theories of career development. Foremost among them is the idea that vocational choice is a process of matching ones self-concept with an occupation the "fits" its characteristics. Researchers are beginning to discover information relevant to many of the independent theories.

In testing part of Holland's theory of vocational choice Hollander (1972) showed that occupational choices in adolescents are related in part to a positive relationship between their self-discriptions the various occupational stereotypes they hold. Gottsfredson (1975) discovered a high degreee of congruence between students aspirations and their subsequent employment. In a few areas where people were not employed in their "chosen" occupation it appeared that a faulty stereotype, leading to undereducation, was the cause.

Several studies have related to the accuracy of the occupational stereotypes expressed by students.

Banducci (1970) tested the accuracy of stereotypes among a group of 12th grade boys and found that overall accuracy of occupational perceptions showed a positive relationship to academic achievement. Similar patterns show a positive relationship between academic achievement (Cognitive Ability) and realism of choice (Kelso 1975) and academic achievement and educational aspiration (Kerckhoff 1977). In each case realism or congruence between real job aspects and "self" was seen to increase with intellegence. Hollender (1971) also showed that vocational decisiveness had the same relationship with intellegence. Each of these three studies also dealt with another influence on vocational decisions, that of the expected stage of leaving school.

In all of the above studies students were shown to be more apt to make vocational decisions at the end point of their educational career, regardless of where it fell in the time frame projected by the school system.

Kelso noted that dropouts exemplified this behavior but that they exhibited less maturity and intellegence in their decisions than other students.

Banducci and Shertzer (1971) Both relate that students from low socio-economic backgrounds (who also tend to be low - performers) exhibit less accurate occupational perceptions. This could be expected to lead to incongruent vocational choices, especially when related to an early point of leaving school. Other research (Shappell 1970) reported strong concern about aspects of employment expressed by poorly motivated ninth graders.

This suggests anxiety about being forced to make an early choice.

When the situation of a low-achieving disadvantaged student tracked into a vocational program is viewed in light of the above research it is easy to visualize potential problems. A student of poor intellectual ability and with poor perceptions of occupational characteristics, will be required to make a decision that many college students fail to make well.

The development and implementation of comprehensive career education programs should help alleviate the weaknesses of disadvantaged students in vocational decision making. The use of scientific methods to develop self-awareness, develop positive work attitudes, to increase knowledge of occupations and to develop problem solving and planning skills, have, among other things, led to significant improvement in that capacity. (Hamdani, 1977)

Whether a school division which failed to support vocational education until it was mandated by law will have developed such a comprehensive career education program in time for it to be useful, is open to doubt.

Factors of Vocational Success

> "No person can be successful in occupational education unless he has the basic tool skills of reading, writing, listening, and computing." (Venn, 1964)

This forthright statement by Venn is amply backed up by evidence from the world of work. It is becomming increasingly apparent that vocational success is more and more dependent upon those basic skills.

The worker requirements set forth in the Dictionary of Occupational Titles for "craftmanship and related work" (the area most often associated with "vocational education") back up Venn's statement well. In describing the jobs commonly referred to as "skilled", "hands on", "doing" jobs the list begins:

> "Ability to learn and apply...
> Ability to use independent judgement...
> Ability to apply shop mathematics..."

The abilities most often associated with craftmanship and related work, those of eye-hand coordination, manual dexterity and finger dexterity, are last to be mentioned on the job discription.

In reviewing the qualifications profile one discovers some more important information. The general education development level specified on the D.O.T.'s six level scale is the range 4 to 3.

Significant features of this level of educational development in the areas of (1) reasoning, (2) mathematics, and (3) language, are:

(1) Reasoning..."Interpret a variety of instructions furnished in written, oral, diagramtic or scheduled form".

(2) Mathematical (Level 4)..."Perform ordinary arithmetic, algebraic and geometric procedures in standards, practical applications."

(Level 3)..." Make arithmetic calculation involving fractions, decimals, and percentages".

(3) Language..."Comprehension and expression to a level to interpret technical manuals as well as drawings and specifications, such as layouts, blue prints, and schematics."

The indicated level of vocational preparation for jobs in "craftmanship and related work" ranges from one to ten years with one to two years being the most common.

In the areas of aptitude, the average required is as much or more than 50 to 60 percent of workers in general for all abilities except verbal (40%) and color discrimination (10%).

It must be remembered that the Labor Department developed its worker traits from the sample of practitioners of the trades, while vocational schools are directed towards only entry level skills. It appears, however, that little in the area of cognitive skills could safely be dropped from the vocational curriculum.

Similar data to that of the D.O.T. was produced by Desmond (1975) in a survey of worker estimations of the ability requirements of their jobs. Bakamis (1966) working from a list of worker tasks was able to produce a detailed list of task and knowledge clusters associated with the performances in major building trades areas.

In his work, Bakamis uses a team comprised of vocational educators, a physical scientist, a langauge arts instructor, a mathematician, and foremen and workers from the field, to create a checklist of knowledge required to complete the various tasks of the trades. The list was then validated by workers in the field through their rating of each knowledge as being either operationally essential, helpful, or unimportant for the performance of each task. The result was a comprehensive list of knowledge requirements covering a broad segment of the building trades.

The math, science, and communication skills listed roughly correspond to the objectives of upper junior high to lower high school work (with a few more difficult exceptions).

Any vocational program intended to serve the interest of the community and the student honestly, will have to be based on cognizence of knowledge and ability sources like those identified by Bakamis. It would appear from his report that mastery of at least eighth or ninth grade curricular material would be necessary to meet job entry level skill requirements.

In the summary of the report the author expressed the necessity for worker entering the field to have a broad base of

general knowledge and basic skills in order to be flexible and to maintain vocational mobility in the face of the rapidly changing technology in the trades area.

Employers have expressed the same sentiments in responding to a survey on their preferences for occupationally trained persons (Niss, 1977). With few exceptions, employers preferred to hire those with at least some post-secondary education (includes community college vo-tech).

Judging from past performances few disadvantaged ninth graders will possess sufficient intellectual ability to master the knowledge requirements critical to their trade area.

Skills Required for Vocational Training

This category of skills is seperated from the preceding one because of the possibility that training requirements may be artificially more difficult than actual practice in the trade.

Perhaps the worst magnification of difficulty in a vocational program is the text being used. In research comparing reading levels of students and readability of textbooks used in Mississippi vocational-technical complexes, Karnes (1977) reported that in all subject areas the text was one to four grade levels above the students reading ability.

Karnes' statistics were alarming. While the reading means of classes among the various subject areas were within the range one would expect in the average rural school system (8.57 to 11.77), the range of the means of the various texts was much higher (12.7 - 13.65).

Such a gap in reading ability and difficulty of text poses a serious problem to the student. Unfortunately, it is not necessarily an artificial problem related solely to the training situation. Many of the books are used as references in the trades. Many show a high difficulty level. Among them are:

Motor Auto Repair Manual, 37th Ed.
Louis G. Forier, Ed. Motor, New York, 1973
Reading Grade Level 14.43

National Electric Code, 1975 Ed.
National Fire Insurance Underwriters, Chicago
Reading Grade Level 12.96

To say that good reading skills are vital to maximum success is an understatement indeed.

In the area of mathematics, a skill needs survey was made in Pennsylvania vocational schools. In this survey Long (1976) identified those math skills vocational instructors thought to be critical for success in the subjects they taught. The degree of remediation needed in each area was also tabulated. The researchers expressed the hope that the work would lead to closer coordination between general and vocational education in the area of mathematics.

In specific, they recommended that teachers attempt to show students how math skills are critical to vocational success, perhaps by correlating specific vocational task to math objectives in the mathematics classroom. The authors also suggested that diagnostic test be developed to identify math deficiencies of students entering vocational programs.

The math skills identified by Long were very similar to those listed by Bakamis. This lends support to the idea that math skills have a strong relationship to success in vocational education.

In an analysis of statewide math achievement in Minnosota, Ludeman (1976) discovered some information which might indicate that some students are becomming aware of the need for math skills. He states that while affective measures indicate no significant differences in student attitude towards math, performance of vocational students was superior to the state mean performance in practical math areas.

It should be noted that the student population of Minnosota represents a more homogeneous grouping in terms of ability or socio-economic class, than is seen in populations of the rural south. My experience in a rural school system leads me to believe that even though the math scores of disadvantaged students often exceed their low reading scores, they don't begin to approach the point of exceeding the mean for the norm group.

In a test of just what relationship cognitive ability, or lack of it, has on vocational success, Frazier (1977) discovered a high correlation between cognitive ability and successful completion of vocational training. The variables of time and psychomotor skills were introduced to see if they could compensate for academic weakness. The results indicated that when students measured below a certain level of cognitive ability, little change in poor performance took place regardless of treatment.

Frazier was careful to note that the occupational programs tested offered little in the way of individualized materials, an open-time frame or any provisions for mastery learning. The value of criterion based vocation education was mentioned as the best method for meeting the students' needs. In addition, the author suggested the use of diagnostic testing and remediation for students of low indicated ability, and and careful re-evaluation of plans of those whose ability fell below a certain cut-off point on achievement tests.

He cautioned the reader that test scores should not be used to deny access to vocational programs but should be used instead to indicate deficiences and their probable effect upon potential success.

The implication of all this research for the disadvantaged student is clear. He must either master basic skills before entering a vocational program or complete successful remediation early in their course work.

Without one or the other, many disadvantaged rural students optomistically studying carpentry may end up as disillusioned carpenter's helpers. The public, the consumers of the program, may become disenchanted and withdrawn their tenuous support for their newly established vocational courses. After waiting so long for this vital alternative to a professional education to reach less afluent rural school systems, it would be tragic to see them wasted.

A Role for Elementary Industrial Arts

It has been shown that learning and successfully practing a trade demands a firm grasp of basic cognitive skills. Not only are the skills characteristic of most workers in the trade, they are also expected by a large number of employers. Every indication is that American workers will be called upon more and more frequently to adapt to technological changes in their jobs, perhaps to the point of having to seek and master entirely different employment. Mental ability is one of the few skills one can possess which transfers readily from job to job.

Disadvantaged students characteristically lack the cognative skills displayed by the average student. For a number of reasons, they exhibit a restricted used of language which interfers with their reading development. The inability to read well often destroys their chance for success in other subjects. (Biehler, 1971) Some characteristics of disadvantaged students show a particular compatibility with certain traditional Industrial Arts philosophies. The first is poor self-concept.

The self-concept of a disadvantaged student diminishes in relation to his lack of success in school compared to more able students. Industrial Arts is directed in part, towards developing an "appreciation for craftsmanship... and a respect for the dignity of all useful work." (The Industrial Arts Curriculum, 1977)

If a student were given an opportunity for success in industrial arts lab activities, some of this dignity and respect would fall to him.

A second characteristic of the disadvantaged student makes this boost in self-concept possible.

Disadvantaged students tend to favor physical, practical task, over those of an abstract or theoretical nature. Industrial arts at any level can capitalize on this trait in several ways. One is to provide hands-on experiences which result in the development of psychomotor skills. This would hopefully yield the reward of satisfaction, motivation to succeed,and improve self-concept, all of which might transfer to other curricular areas.

Another is that Industrial Arts, as much as any other subject, provides a practical proving ground for cognative tasks. Industrial Arts activities can be structured to enhance the learning of all cognitive abilities.

One relationship of Industrial Arts to these other abilities comes through the unique vocabulary of technology. A third characteristic of disadvantaged students is their restricted use of language activities. Activities in Industrial Arts can be structured so as to relate technical words to real objects and operations. The association of words with things is one popular route to vocabulary development (Harris, 1975).

Another way to enhance reading and language ability is through practice listening to and following instructions in the proper sequence. Role play activities can offer excellent opportunities to develop this skill. Role play has another interesting effect on disadvantaged students.

Modeling and role playing have been shown to increase motivation in disadvantaged students by providing them with a visible connection to the real world. It offers a connection between what they are learning and how it can pay off for them as adults. If the models come from the same socio-economic background and race, the effect is marked. (Henderson, 1967)

While intrinsic motivation to learn is certainly a more desirable trait, extrinsic motivation through role play and modeling can be of great help with these students. Industrial Arts lends itself well to the career orientation excerises.

Maximum efficiency of an elementary Industrial Arts program designed around the disadvantaged student would depend upon close cooperation between the Industrial Arts teacher, the various vocational instructors, and the teachers of coordinated subject areas. Through careful selection of individual objectives and careful coordination of teaching effort, Industrial Arts could play a vital role in enhancing the basic education of all students. (Miller, 1970)

By discussing Industrial Arts in relationship to particular characteristics of the disadvantaged, I am by no means advocating vocational tracking in the old misconceived sense. I am instead pointing out a large population of students who could benefit from a program structured around their learning modality. The real purpose is to enhance the acquisition of basic skills critical to the adult success of every student, whether they intend to become sanitation workers or physicians.

Industrial Arts can offer all students a chance to see the practical aspects of math and science applied to real situations, thus reinforcing classroom learning.

It can offer extrinsic motivation by showing a connection between ability and the world of work. It can expose the student to a broad "technical" vocabulary, the mastery of which will aid in both professional as well as vocational education. Industrial Arts, last of all, can lead to appreciation for the skill, craftsmanship, and dignity of work and to the individual and self that this brings about. None of this would be wasted on any student.

For decades, American students have been subjected to a collegiate preparation curriculum inspite of full knowledge that only a small minority would need a prOfessional education. The time for reversing this trend is past due. No one can dispute the value of a broad liberal arts education, but everyone should be aware that it offers no sustenance to the unemployed or poorly skilled workers.

The <u>first</u> priority of education should be assuring that every student acquires the skills necessary for them to enjoy the benefits of productive employment and to fulfill the responsibilities of their citizenship.

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