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The 4th Industrial Revolution: Implications for School-based Agricultural Education

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Abstract

Global society has experienced a series of "revolutions" that have had significant impacts on the agriculture industry, including the teaching of agriculture in schools. Moving from foraging to farming, agriculture witnessed the growth of the agro-industrial complex and the move from rural to urban settings, followed by industrial movements from muscle power to mechanical power. Most recently, the advancements in technology and technical agriculture have been supported by the computer revolution and the advent of the internet. Now, the workforce must address the interface of technology systems without human interference including robotics, biotechnology, and the "internet of things". Agricultural education in the public schools in the U.S., including teacher education, is faced with how best to incorporate technological advancements with technical skill development in agriculture, including curriculum development and enhancement and teaching approaches.

Keywords: School-based agricultural education; Technology; Curriculum development; Teaching skills

Introduction

For more than two centuries, the world has experienced massive changes that have affected how we all live and work. With the first industrial revolution came the movement of peoples from foraging to farming, from agrarian to industrial, and from rural to urban during the 18th and 19th centuries. Population growth resulted in larger settlements and, in the U.S., a western movement to develop the vast areas of the new country. The development of ironworks, the steam engine, and textile manufacturing were central to the revolution and economic development. At a faster rate of development, the second revolution toward the end of the 19th century and the start of the 20th century evolved human muscle power to mechanical power. The production of steel, the discovery of oil and its uses, and the power of electricity involved mass production, assembly lines, and the division of labor in manufacturing. With the invention of the light bulb, internal combustion engine, the phonograph and telephone, labor became more central to development. Yet 17 percent of the world was still without electricity [1,2]. The advent of instruction in agriculture in the public schools coincided with the growth in and importance of agriculture.

Less than 50 years ago, the world was introduced to digital technology, automation, personal computers, and the internet, the third industrial revolution. Analogs were replaced with digital technology, personal computers, automation, semi-conductors and mainframe technology became the norm for much of the world. Information and communication technology quickly evolved, yet 50 percent of the world lacked internet access. Now we have entered the fourth industrial revolution, where such phenomena as robotics, 3D printing, autonomous vehicles and massive virtual communities have encroached upon our lives. Technology is embedded within societies and within the human body. Virtual and physical systems cooperate globally. Clearly the "Internet of Things" drives everyday lives [2,3]. The implications for humankind are vast. While interest abounds in figuring out new technologies, we have been reminded by Klaus Schwab that all these new technologies are, first and foremost, "tools made by people for people" [2].

Purpose

The purpose of this philosophical paper is to draw upon the recent literature to provide guidance to decision-makers in determining what vocational, technical and career education in agriculture should be like and do for the current populace and the near future.

Trends and Issues

Great benefits are being developed in response to the rapid changes in technological development. Consumers will gain the most, through new products and services and through increased efficiency and effectiveness. Better asset management will aid in regenerating the natural environment, and literally billions of

people will gain access to the internet. However, great challenges also arise. Concerns of fairness and rising inequality across regions and nations are coupled with the fear of life disruptions and job loss. Digital and biological phenomena will continue to drive the revolution, including sensors, remote monitoring, digital currency, genetics, synthetic biology, and engineering [2].

According to the World Economic Forum, based on a survey of 800 business executives, the following trends will affect the world through the year 2025 [4].

a. 10% of people will wear clothes connected to internet

b. 10% of reading glasses will be connected to internet

c. 30% of corporate audits will be performed by artificial intelligence

d. Taxes will be collected by a government blockchain (like Bitcoin)

e. 90% of the people will be using smart phones

f. 80% of people will have a digital presence on the internet

These trends will have varying impacts on human lives and the agro-industrial complex. How these innovations and changes affect human capacity development is a question to be addressed by education leaders around the world.

Potential Impacts

The World Economic Forum further described the potential impact on future employment [1,4].

i. The nature of work will change

ii. Adaptability will become more vital

iii. Speed/rate of change will continue to rise

iv. Labor substitution will occur, with both positive and negative potential effects

v. Not creating new jobs at previous rates

vi. New applications in existing jobs rather than new jobs

vii. Growth will occur in high-income, cognitive/creative jobs

viii. Diminished demands for middle-income, routine/repetitive jobs

ix. Low skill/low pay vs. High skill/high pay creates unrest

The question arises, then, regarding the impact of these changes on human capacity, skill development, and vocational, technical and career education, including agricultural education at all levels. The Future of Jobs Report [5] describes the needed growth in human skill development, indicating the growth in skill demand in 2020.

a. Cognitive abilities - 52%

b. Systems skills - 42%

c. Complex problem-solving - 40%

d. Content skills - 40%

e. Process skills - 39%

f. Social skills - 37%

g. Resource management skills - 36%

h. Technical skills - 33%

i. Physical abilities - 31%

It is interesting to note that the traditional "hands-on" thinking of skill development (physical ability, technical skills) remains an important focus of human skill development, yet they are out paced by more complex competence development. The temptation to disregard the importance of these attributes must be avoided; a successful and competent workforce must be prepared in all aspects of human skill development. How equipment and systems interact with each other technologically will be equally important to how each operates technically.

Implications for the Workforce

Therefore, an important aspect of the fourth industrial revolution is the need for human development through vocational, technical and career education and training. Employment globally will be affected by the nature of the work itself, adaptability efforts, the increasing rate of change, and labor substitution. Curriculur development, credentialing, social skills development, and public-private collaboration locally and globally are critical to preparing the current and next generations of the workforce with adequate 21st century skills. While technical skills (although greatly transformed) are still the basis of work, skills such as cognitive ability, systems thinking, problem-solving, and processing will become increasingly important and desired in the labor market.

Several implications are derived from an examination of the potential impact of the current revolution. The following issues arise for vocational, technical and career education professionals to consider as they determine the content and context for programs of the future. First are the potential impacts on human development in general [6].

1. Life aspirations - work, study, family; go anywhere; a transient workforce supplants the traditional 30-year career in one industry in the same local environment

2. Identity - no longer place, ethnic group, culture, language; people no longer closely associated with a finite set of demographics

3. Family - traditional unit more trans-national network; "moving away" will continue to be more common

4. Labor - mobility (good and bad); industry can take advantage of population mobility to seek and secure needed talent, yet be subject to "losing" well-trained workers in a competitive market

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5. Inequality - leads to social unrest; those who have the needed competence will prosper; those who do not will become more disenfranchised with their station in life

6. Community - defined by personal interest, not space, work, or family; what people do will become increasingly more influential than where they work or where they live

More specifically, this 4th industrial revolution has significant impact on education and training specifically [1,2,7-9]. Vocational, technical, and career education and training programs face an array of challenges in terms of human capacity development and skills training at all levels of education and in all levels of agricultural education [10-13].

a. The push for "college-ready" (everyone needs a college degree) puts students in low-class universities who then earn below average salaries and feel the "system" has let them down.

b. An expanded need for career guidance and career development emerges top aid students and adults in identifying what they want to do and how to achieve their work goals.

c. Graduates may adopt the job first/degree later approach to personal and career development.

d. Gender inequality may grow, with technology eliminating jobs typically held by young women. Therefore, women must be prepared for and allowed in the high-tech community.

e. When/how will higher education catch up to the changes in student development and faculty preparation?

f. Access to education will become truly global, with education and training available regardless of location. Students will be able to learn from the best, not just the available.

g. Perhaps the need is not new programs/courses but in infusing new competences into existing curricula. The need for agricultural producers will certainly continue (and grow) but with skills in addition to historic production competencies.

h. Personal development and social skills development will become more important to industry.

i. Moving vocational education and training to a higher academic level should lead to development of problem-solving and systems thinking abilities.

j. Interface with business/industry to ascertain their projected needs becomes increasingly more central to vocational education and training program re-development.

Implications for Agricultural Education

Brought together, human resource development and vocational, technical and career education must work together, in harmony, to ensure that human development and the needs of the broad agro-industrial complex are aligned. Lee [2] purports the need for the following changes.

I. "Future ready" curricula

II. Early exposure to the workplace

III. Certification and credentialing of skill attainment

IV. Private sector involvement to improve the social status of vocational education and training

V. Need for constant updating: education and training throughout life

VI. Social skills development

VII. Closer ties to business/industry; needs of future and current employees

VIII. Broader sharing of resources - used anywhere by anyone

IX. Classroom/lab teaching augmented with virtual materials

X. Teacher preparation and continued professional development to align with new curricula

XI. Interactive, engaging, content-rich instruction

XII. Shift from employment to entrepreneurship

Schools at all levels will need to develop and re-develop future-ready curricula, with students gaining exposure to the workplace at earlier ages. Private sector support and involvement will be needed to help improve the stature of vocational education and training. Industry partnerships will be essential in determining the content and context of credentials and program certifications. With fewer face-to-face interactions, future workers will need a different and perhaps more important set of social skills. Classroom and laboratory instruction will be augmented through the virtual world. Vocational education and training will advance beyond "hands-on" to be hands-on and mind-on. And all these changes require interactive, engaging, content-rich instruction provided by teachers who are adequately prepared for these new environments and are provided on-going professional development opportunities to stay with and ahead of the game.

Summary

School-based agricultural education must undergo extensive re-development to help ensure that program completers have the opportunity to develop and enhance the broad array of human, technical, and technological skills and competencies. Agricultural teacher education must provide leadership for teachers, schools and communities to address the future needs of the agriculture workforce. Professional development efforts should focus on all aspects of skill and competence development, well beyond the typical technical agriculture skills. Schools, communities and universities need stronger partnerships with the agricultural industry to gain support for and acceptance of this new era in agriculture.

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