Skills that Support Mechatronics Vocational High School Graduates

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ABSTRACT

Currently, we are in the era of the industrial revolution 4.0 where the skills of Vocational High Schools graduates (VHS) in the field of mechatronics are needed for manufacturing and other industries. This article discusses the skills requirements of Vocational High Schools Mechatronics Engineering students in the industry. The method used is descriptive qualitative with four stages. The first stage is data collection with a literature review of journals, the second stage is data reduction, the third stage is data display, which is presenting data, and the final stage is the conclusion. The results show that VHS students in Mechatronics Engineering need to have soft skills and hard skills. Soft skills include critical thinking, collaboration, communication, creativity, adaptability, and complex problem solving. The hard skills required include the ability to read and create technical drawings, the ability to make electrical wiring diagrams, computer programming, microcontroller programming, PLC, and HMI programming.

Keywords: *Skills, Engineering, Mechatronics, Vocational students.*

1. INTRODUCTION

The preparation of the most important skills occurs in vocational education, which is crucial for human growth. Along with the teaching provided by the vocational school itself, other elements, such as government policy, must support the crucial function that vocational education plays in society[1].

Every nation's national growth depends significantly on vocational education. The focus on developing employable skills and the curriculum's orientation towards the working world are two of vocational education's most significant functions. A person can enhance their quality of life by getting an education. It is a requirement of education to keep learning new things. Knowledge, attitudes, and skills are changes that occur in individuals to be successful when they learn.

The idea of Industry 4.0, often known as the fourth industrial revolution, is now a topic that academics, consultancies, and businesses are discussing and researching. Industry 4.0 is still a controversial idea, despite the growing interest in the subject. Regarding the ramifications and effects of this new manufacturing paradigm, there are still some nebulous thoughts. Additionally, the majority of businesses and manufacturers are unaware of the difficulties they may ncounter when attempting to integrate the Industry 4.0 framework[2][3].

Now we are already in the industrial era 4.0, where changes happen so fast. Changes that occur in the world of education and the world of work[4]. To grow and develop and advance, generally individuals must be able to have skills. In particular, mechatronics Vocational School graduates need to be equipped with skills in the form of soft skills and hard skills. soft skills and hard skills are the changes of each individual from the learning process. This paper discusses the skills needed by Vocational School graduates in the field of mechatronics.

2. METHODS

The method used is descriptive qualitative with four stages. The first stage is data collection with a literature review of journals, the second stage is data reduction, the third stage is data display, which is presenting data, and the final stage is the conclusion.

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Figure 1 Research methodology.

3. RESULT AND DISCUSSION

3.1. *What is Mechatronics Engineering?*

Mechatronics is defined in a variety of ways. Actually, there are as many definitions as there are experts in the field. One could contend that the semantics of the definition are unimportant. The majority of people would concur that mechatronics is an interdisciplinary field that integrates mechanics, electronics, and information technology to provide better products, services, and systems [5].

Most engineered products or processes have moving parts, which makes accurate manipulation and control of their dynamic structures necessary. This could involve the use of technological enablers such as sensors, actuators, software, communications, optics, electronics, structural mechanics, and control engineering. A key aspect of the mechatronics philosophy is the integration of microelectronics and information technology into mechanical systems in order to get the best results.

A mechatronic system consists of four fundamental parts. They consist of mechanical parts, sensors, controls, and actuators[2]. In each mechatronic system, the sensors are the crucial components. In a way, the system has eyes that allow for the detection of all types of variations and the implementation of the necessary countermeasures. The electronic circuit or controller is the mechatronic systems' central processing unit. Actuators are devices that transform one form of power—such as hydraulic or electrical power—into another form of motion, such as a linear or rotary motion[6].

With the aid of other fields' discoveries and their integration, mechatronics develops new sophisticated products. As a result, mechatronics are now a common feature of many modern, high-tech items. Integrity should be a key aspect of mechatronics education, as it should be. It should implement an innovative educational approach to equip the students to meet the changing industrial and societal needs, in addition to covering the knowledge and abilities of mechanical, computer, and electrical engineers[7].

Before beginning the design process for a mechatronic product, it is important to grasp the basic operating principles of mechatronic systems, regardless of the type of mechatronic system. An example of a mechanical system that is a power-producing or power-generating machine is the general scheme in Figure 2. The mechanical component, which transforms or communicates the mechanical process, is the basis of many mechatronic systems. Measurements of generalized flows (such as speed, mass flow, or electrical current/potentials (such as temperature, speed), must be made in order to determine the status of the mechanical process.The measured variables are the inputs for an inform digital electronics that transform them into manipulated variables for the actuators (like motors) or for monitored variables to show, along with the reference variables. One of the hallmarks of many mechatronic systems is the addition and integration of feedback information flow to a feed forward energy flow in the mechanical system (for example, motor drive, drainage pump). The advancement of electronics and IT technologies (such as SMS and voice control) has greatly improved human-machine interactions, making them more adaptable and user-friendly[8].

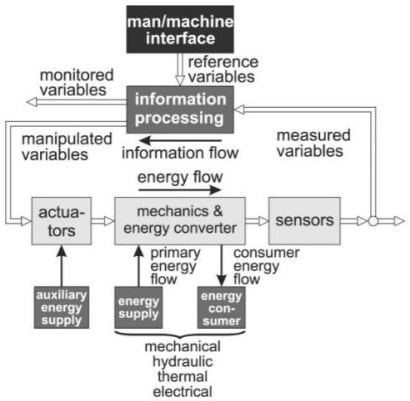

Figure 2 Mechatronic systems are created as a result of mechanical process and information processing[9].

3.2. *Soft skills in mechatronics engineering*

A person's personality traits, routines, attitudes, and manners that make them a good employee and easy to get along with are referred to as soft skills[10]. Soft skills include critical thinking, collaboration, communication, and creativity[11]. Soft skills are abilities possessed by individuals naturally which include intelligence, both emotional and social, communicating or interacting with other individuals, and the like. Figure 3 shows the soft skills that graduates of the mechatronic engineering Vocational School need to have.

Figure 3 Soft skill minimum requirement graduate of mechatronics engineering.

A sort of educational program called vocational education prepares students for both formal and informal jobs. Vocational education is distinctive in that it emphasizes the connection between knowledge, competence, and skills as well as the mentality required for students to enter the workforce. At the current stage of societal development, the evolution of education entails a change in emphasis from passive knowledge absorption to independent learning. [12]. The development of self-concept is one of several factors that can enhance learning freedom. A person's vision or perception of oneself, which takes into account all of their physical, psychological, social, emotional, moral, and cognitive characteristics, is known as their self-concept.[13].

Modern educational methods and frameworks must include critical thinking. [14]. If students want to flourish and be independent in the future, they must cultivate the ability to think critically [15]. Education will have a problem if people cannot think critically[16]. The 4Cs-critical thinking, collaboration, communication, and creativity are often used to describe 21st-century skills. To successfully navigate the fourth industrial revolution, one needs to be able to think imaginatively. During the fourth industrial revolution, science and technology advanced quickly and significantly, which was a distinctive characteristic[17].

To prepare vocational school graduates, students need to be trained in communication skills with the following activities: (1) teacher should persuade their students that the course is not challenging, (2) more textbooks on the topic should be written by the Communication Skills lecturers, (3) students should work harder to enhance their communication skills, (4) Teachers should urge their students to seek advice when they are having problems, (5) Teachers should give the themes like ambiguity, sentence pattern, and dangling modifier, another look, as suggested by the students. They could be a little challenging for students, (6) To promote active involvement in class, class sizes should be lowered, (7) The researcher's final recommendation is that the curriculum developers for the course form a committee to look at how many years the course should be studied [18].

The skills necessary for achieving objectives involving social talents, interpersonal abilities, and personal attributes are communication skills. Numerous purposes of communication can occasionally be used to influence or even change behavior. In particular, communication is regarded to be the sharing of emotions and ideas for a variety of goals that seek to connect with others, such as: energizing, motivating, issuing instructions, entertaining, directing, controlling, informing, and educating [19]. The capacity to listen to and accurately comprehend information are qualities that define communication skills. Information can be conveyed in a straightforward, unambiguous manner.

The advancement, evolution, and survival of humanity have all benefited from cooperation. According to research, teams produce greater outcomes for organizations than individuals do. One of the most successful work structures is teamwork. As teamwork satisfies requirements like social connection and affiliation, it also has positive effects on the individual on a personal level. Despite the extensive data supporting the benefits that cooperation offers to firms, many management staff still do little to foster teamwork[20].

Teamwork is the ability to be able to communicate, listen, and execute work in a coordinated manner. The importance of teamwork includes: (1) preventing mistakes, (2) achieving predetermined goals, (3) improving individual performance, (4) practicing conflict and risk management. the benefits of teamwork include: (1) working more effectively, (2) getting more ideas, (3) creativity is increasingly honed, (4) problem solving is more optimal.

The ability to be creative is crucial to learning. Creativity improves the student's attitude toward learning and makes studying more enjoyable. The learner uses imagination to transform the passive information into a product, so activating it. People can more easily manage their daily life challenges and become more productive in adulthood because of the creativity they learn at a young age [21]. Research, discovery, development, study, and exploration of new ideas and breakthroughs in the realm of science and technology require the ability to think creatively. This requires power, energy, and strength. In today's globalized society, innovation is considered a crucial personal trait. Research on this phenomenon has been conducted in many fields of study, including administration, education, economics, psychology, and sociology, among others, and is considered to be of multidisciplinary importance [22]. Someone who can think critically, independently, creatively, and

innovatively can get employment with ease and experience future success.

The requirements of the employment market are not specified in training programs or curricula. Employers also found that graduates needed to improve their collaboration, attitude, honesty, and work discipline. Instructors place restrictions on theoretical lessons, which causes graduates to lack expertise in their fields, which has an impact on the employment market. Another challenge is that teachers lack experience in the industry and have minimal skills. Train students in solving problems that exist in the world of work.[23].

As a result, businesses embracing Industry 4.0 begin to value skilled labor differently. The following best describes the trends: Companies without Industry 4.0 is Trend A. No modifications to direct manufacturing, but effects on indirect production (such as workspaces for Industry 4.0 deployment in the future). Companies with little "Industry 4.0" depth represent Trend B. stagnation or a modest increase in the number of highly trained workers, such as technicians, master craftsmen, and skilled laborers, as well as a discernible rise in productivity. Companies with significant "Industry 4.0" depth represent Trend C. Increase the number of well-qualified skilled employees, master craftsmen, and technicians by 20–30%. Significant decline in the number of semi-skilled, and unskilled workers with low qualifications[24][25].

Adaptation is necessary to face life's challenges. The ability to adapt is essential for career success. Numerous elements, both internal and external to individuals, have an impact on adaptability. Human characteristics, such as age, race, and gender, may have an impact on adaptation because they may create expectations based on social norms and lead to variations in workplace preferences and treatment [26].

The six factors that employees must change for Industry 4.0 to be implemented successfully. Interpersonal adaptability in Industry 4.0, crisis management, and unforeseen circumstances are among the six dimensions. Industry 4.0 emphasizes flexibility, including adaptation to innovative problem-solving, adaptability with ongoing learning, education, and training, adaptability with stress management, and adaptability in teams[27]. Adaptability is an ability that is closely related to a person's psychological condition when dealing with changing roles in the world of work. They can adapt to their new roles well and carry out their duties well. By having adaptability, graduates of the Mechatronics Vocational School can be successful in life and the world of work.

Complex Problem Solving is a relatively new concept that is often assessed using microworlds that are computer-based. It is thought to be a promising candidate to supplement or perhaps take the place of conventional intelligence tests in the analysis of educational performance[28]. We argue complex issue-solving is a technique for deciphering a real-world problem that is extremely complex. To solve difficulties and remove obstacles to goal achievement, a strategy is needed

Complex problem solving is a type of problem-solving where the problem (the structure of the (a) external problem representation and/or (b) mental representation of the problem) or the process of its solution must be formalized as a set of many highly interrelated elements, i.e., a complex system[29]. The ability to solve complex problems is regarded as one of the key components of effective learning. Our daily activities include solving problems, such as choosing what to wear in the morning, learning how to use new technology, figuring out how to take public transportation to a restaurant, planning our schedule to maximize productivity at work, and figuring out how to interact with others[30].

3.2. *Hard skills in mechatronics engineering*

Hard skills are those that can directly and visibly generate a result. Tests that are technical or practical might be used to evaluate hard skills. From quotient thinking intelligence, which has indications for calculation, analysis, design, wide insights and knowledge, model-making, and critical thinking, we may discover components of hard skills. Mastery of science, technology, and technical abilities is tied to knowledge[2]. Hard skills which are also often called technical abilities are needed by workers to carry out a series of basic tasks to achieve work goals [31].

Hard skills are measurable technical abilities to perform particular tasks. Examples include the skills of reading, writing, math, and using computer programs. The skill in question is a specific ability about something. Hard skills are often measured through exams, tests, or certifications that can ensure a person has sufficient ability in a particular field. For graduates of Vocational schools in mechatronics, the minimum hard skills that need to be possessed are shown in Figure 4.

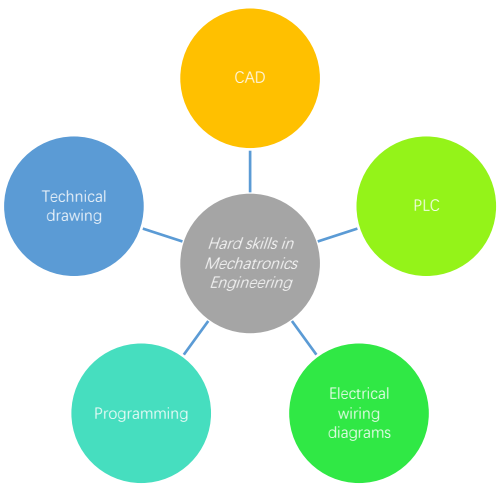

Figure 4 Hard skill minimum requirement graduate of mechatronics engineering.

Hard skills include creating technical drawings and CAD [32][33], the ability to make electrical wiring diagrams, computer programming, microcontroller programming, PLC [34][35], and HMI programming [36][37]. This technical ability is needed in the field when a company is going to make a product. starting from product design to product manufacturing stage related to automation for mass production. For this reason, graduates of the Vocational School of Mechatronics at least have the ability to read drawings, design a product with CAD, create programs and assemble mechanical and electrical components for machine automation.

CONCLUSION

To be able to work well, mechatronics engineering vocational school graduates need to have skills that can support their performance and achievements. Soft skills will have a bigger effect than hard skills. Individuals who have soft skills tend to be more able to control themselves and bring themselves to better self-change including hard skills. This article provides an overview of the six plus five skills of mechatronics vocational high school graduates, namely six soft skills and five minimum hard skills that need to be possessed to face the challenges of the industrial era 4.0.

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