ISSN No:-2456-2165

The Age of Mechatronics: A Phenomenological Study of Students' Utilization of Educational Robots in Class

Alkriz Zahir M. Reyes, Carl Denise A. Dawal, Carl Jerick A. Anacio, Heru Joshrene D. Pelobello, Jaztyn A. Loya, Keno J. Delos Reyes, Mariane P. Palima, Sean Zaki Emil Jethro L. Sapon, Vincent Ivan Fred D. Legacion

12 STEM ENGINEERING 04
Research Paper in Practical Research 1
Senior High School Department
Adamson University, Ermita, Manila, Philippines

Daniel Day V. Aguillon, LPT, MAEd
Adviser

Abstract:- Our society is ever-evolving and continuously progressing especially in the aspect of technology. As such, robots are becoming a part of our society and can be used in various fields, particularly in education. For further understanding of the area, the study entitled "The Age of Mechatronics: A Phenomenological Study of Students' Utilization of Educational Robots in Class" had determined that the use of robots is beneficial to the specialized course, and established that it is convenient for the students in comprehending and applying knowledge relating to their course. In conformity, this study is a qualitative type of research, specifically a phenomenological study, which utilized four (4) 5th-year college students of Mechatronics Engineering as participants. Data was collected through a focus group interview that was held inside the premises of Adamson University, a catholic educational institution in the City of Manila. Verbatim transcription was employed for the data to be credible, and related literature and studies were used to support the data. Moreover, having robots in class is a productive way for the students to learn, experience, and be able to have an effective learning discovery. Teachers need to be reassured that the sole purpose of this study is not to replace them with robots, but rather provide them with a teaching tool/aid that can complement the students' learning experience.

Keywords:- *Mechatronics/ Robots/ Utilization/ Focus Group Interview/ Phenomenological/ Verbatim Transcription.*

I. INTRODUCTION

The researchers had chosen the topic "The Age of Mechatronics: A Phenomenological Study of Students' Utilization of Educational Robots in Class", not only because it is in line with their strand, but also because the 21st-century teaching techniques are more reliant with the use of technologies. Research has to be made to identify mechatronics students' utilization of robots in class.

Before the 1970s, most household products solely depend on mechanical engineering design. Large manufacturing plants were powered by workers controlling mechanically driven devices. Until the discovery of microprocessors in the 1980s, mechatronics grew more popular by the 1990s, which paved the way for the field to integrate aspects of computer science and programming, and creating almost endless possibilities to the usefulness of mechatronics engineering. Hence, the said course, along with vocational training courses, is rapidly developing and being widespread across the world (The Evolution of Mechatronics Engineering, n.d.).

In addition to that, a study conducted by Barendregt & Serholt (2014) mentioned that "Although this questionnaire yielded some interesting results on students' views on the use of robots in education in relation to ethical questions such as privacy and accountability, it should also be analyzed in relation to the focus group discussions that took place during the workshops to gain a greater understanding of students' concerns.". The researchers had employed the same technique for the study as Barendregt and Serholt, which specifically pointed out that focus group discussions can gain a greater understanding of the students' concerns.

Withal, the researchers determined the experiences of mechatronics students in line with the utilization of robots class. Specifically:

1. What are the relevant past experiences of mechatronics students in using robots in class?
2. What are the influences of the use of robots in class on Mechatronics students?
3. How is associating with robots improve the academic track of the mechatronics students?

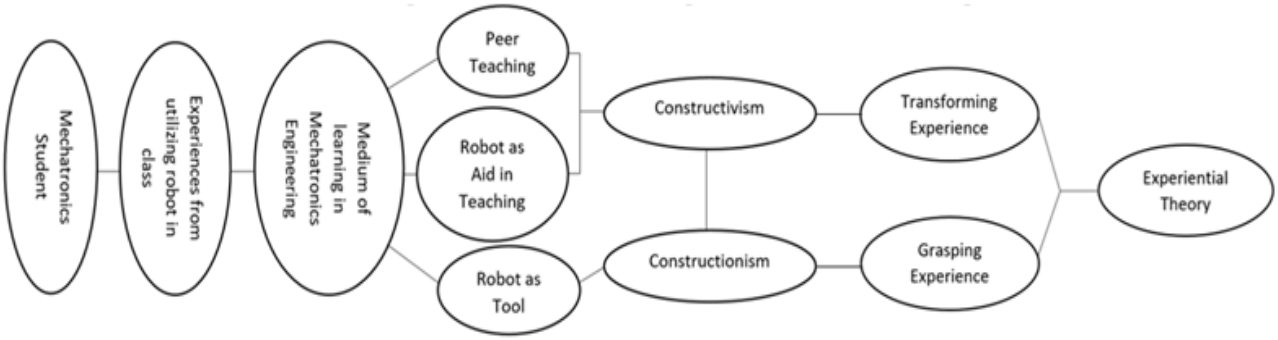

Fig 1:- Theoretical Framework

In-depth consideration of the study, the researchers would want to know the experiences of selected students in mechatronics on changing the traditional way of teaching by using educational robots or an artificial intelligence programmed mechanical application that may be used in teaching their course.

Furthermore, the purpose of this study is to offer an alternative, with a firsthand experience to students in the field of engineering that will enable them to have more opportunities to develop and enhance technology and enables them to embody what is expected of them to do in the future with regard to the society's advancement in technology. This could furthermore help students to understand and explore the importance of innovation and advancement of technology.

➢ *Robots In The 21st Century*

Robots are very diverse in terms of their use. Hence, the definition itself varies to different people. Robots according to Chang et al. (2010) are the physical embodiment of computations and provide unique experiences for the learner. But as per the statement of Rouse (2016), a robot is a machine that is developed to complete numerous tasks systematically with constant speed and precision. In connection to this, a robot is a mechanical machine, with different levels of autonomy that can be controlled by programming to carry out multiple tasks (Dr. Williams, 2019). Some robots can freely move around, others can operate things, some are obliged to do a certain task, while others are versatile. (Institute of Electrical and Electronics Engineers, n.d). Robots can be categorized following their operational environment. It can be sorted into two: fixed robots and mobile robots. Fixed robots are designed to do distinct repetitive tasks and can be usually identified as an industrial robot. While on the other hand, mobile robots are known to be able to move around, perform tasks, and easily adapt to an unknown environment and unpredictable circumstances, such as cars and robotic vacuum cleaners (Ben-Ari & Mondada, 2017).

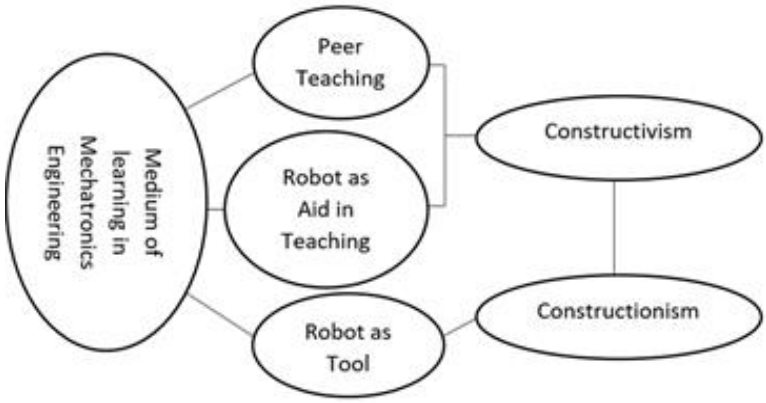

Fig 2:- Constructivism & Constructionism

➢ *Application of Robots*

The diversity of robots' functions results in its widespread use among other fields. It can be used in the industry, remote operations, and help in providing services. According to Robot Industries Association (RIA), as cited in Hall, 2015, the industrial robot was defined as "a reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks." In short, industrial robots are best-known to work in an environment of production tasks (Ben-Ari & Mondada, 2017). On the other hand, robots can be controlled from afar, which includes the underwater, hazardous environment, bomb disposal, law enforcement, and outer space, with the use of remote applications (Dr. Williams, 2019). Lastly, service robots, as mentioned by Ben-Ari & Mondada (2017), are designed to be of convenience to humans with their daily tasks. These apply to do chores with the use of robotic vacuum cleaners, self-driving cars in transportation, and robotic surgery in medicine.

Robots according to Mubin et al. (2013) provides an embodiment, the ability to add social interaction to the learning context, and advancement on purely software-based learning. Also, educational robots are a subset of educational technology, where they are used to facilitate and improve the scholastic performance of students.

➢ *Constructionism and Constructivism*

According to Vygotsky in 1978, the notion of social constructivism that he proposed, generally applies to most peer or tutor-based methodologies of robotics education. In line with this, Doswell and Mosley in 2006, stated that this theory gave rise to the principle of scaffolding, i.e., breaking up complex tasks into smaller tasks, a common occurrence in robotics education.

The main principles of constructivism are rich user-centered interaction, use of authentic problem situations, collaborative learning and learning experience of and with the knowledge construction process (Mikropoulos & Bellou, 2013).

The essential contribution of ICT mainly involves tasks for the active participation of students and teachers, action and counteraction through interactive activities, as well as processes that support the creation of mental models (Mikropoulos & Bellou, 2006). These are under the constructivist theoretical model developed by Piaget proposing that learning is an active process of knowledge construction based on experiences gained from the real world, as well as with the social dimension to knowledge construction proposed by Vigotsky (Mikropoulos & Bellou, 2013).

The work of Papert on the programming language Logo to introduce turtle geometry has been well-grounded in robotics literature under the theory of constructionism (Basic Books, Inc., 1980).

➢ *Use of Robots in Class*

In 2013, according to Mubin et al., the primary use of robots is to provide language, science or technology education and it can take on the role of a tutor, tool or peer in the learning activity. The results from their overview show the interest of the administration in educational institutes who wish to comprehend the wider implications of robots in education, not just the interest of the researchers according to Mubin et al. (2013). Such kits are fully programmable and students can also build robots and upload scripts to them. If the kits allow more mechanical freedom and flexibility with the robot design, we step into the category of robots such as used LEGO Mindstorms (LEGO, n.d.).

Expressed by Tuomi (2018), Artificial Intelligence (AI) will not only make existing education more efficient but that will also change the context where learning occurs and where it becomes socially relevant. The study conducted by the researchers is related to the study Tuomi did, using an AI program facility will improve and become more efficient. Through the use of this kind of learning, society will be more connected to the technology of the world today. Especially if the mechatronics students will be thought about using this kind of teachings, they can adapt and grasp the essence of their career. Technology is already advance and everyone must cope up and maximize the benefits.

According to Tuomi (2018), his report describes the current state of the art in artificial intelligence (AI) and its potential impact on learning, teaching, and education. It provides conceptual foundations for well-informed policy-oriented work, research, and forward-looking activities that address the opportunities and challenges created by recent developments in AI.

According to Chang et.al (2010) “Using robots to support teaching and learning, from secondary school, to undergraduate courses, and to graduate education, has become a popular research topic in recent years (Klassner, 2002; Klassner & Anderson, 2003; Ryu, Kwak, & Kim, 2008).” As robot technology advances, many researchers have tried to use robots to support education. Numerous studies show that students can develop problem-solving abilities and learn computer programming, mathematics, and science through the use of robots. The development of educational robots is still in the initial stages.

Similarly, Ahmad Khanlari (2014), as cited in Highfield, 2010, p. 22, stated that educational robots provide a chance to incorporate “engaging problem-solving tasks” into the curriculum of mathematics. It can also be perceived as an alternative way of learning that enhances the students’ comprehension of mathematical concepts (Khanlari, 2014, as cited in Brosterman, 1997).

➢ *Robots Used in Classroom Instruction*

Robots can portray different roles with varying levels of involvement when it comes to the learning process but the choice depends on: the content, the instructor, type of student, and the nature of the learning activity. Firstly, robots can partake in a passive role that would especially be beneficial to robotics where it serves as a learning tool/teaching aid wherein it includes building, creating and programming robots (Mubin et al., 2013).

In 2013, according to Mubin et al., we can define three main categories of the role of a robot during the learning activity: tool, peer, or tutor.

Currently, the roles of educational robots can be described in terms of three categories: learning materials, learning companions, and teaching assistants Chang et al. (2010).

Peer teaching, according to Whitman (1998) happens when students, by design, teach other students. Peer teaching includes one or more students teaching other students and builds on the belief that “to teach is to learn twice.” It is the system of instruction in which learners help each other and learn by teaching (Goodlad & Hirst, n.d.)

Robots, according to Mubin & Ahmad (2016) are increasingly being used to teach students in the classroom for several subjects across science, math, and language. The design goals of most robots, according to Mubin & Ahmad (2016) are to function as an aid in the classroom and to improve the added value they can bring as a stimulating and engaging educational tool.

A robot is a multifunctional manipulator that can be programmed, designed to maneuver objects, parts, tools or specialized devices and to perform a variety of tasks through programmed motions (Kapila n.d.). This is where adaptable tools such as the LEGO Mindstorms are useful as they cater for learners from diverse technical backgrounds by providing various programming options (Chang et al., 2010).

- *21st Century Mechanical Engineering*

Through the advancement of science and technology, numerous ideas, innovations, and inventions were uncovered. Consequently, the area of mechatronics emerged from evolution. The term mechatronics came from Tetsuro Mori, senior engineer of Yaskawa Electric Company (Asheesh, n.d.). It is derived from the word mecha from mechanics and tronics from the word electronics (engineering.nyu.edu, n.d.).

As per the statement of the International Federation of Automatic Control, "Mechatronics is the synergistic combination of precision mechanical engineering, electronic control, and systems thinking in the design of products and manufacturing processes. It relates to the design of systems, devices, and products aimed at achieving an optimal balance between basic mechanical structure and its overall control." To further supplement, Rouse (2017) stated that mechatronics is a branch of engineering that focuses on designing, manufacturing and maintaining products that have both mechanical and electronic components.

Beyond that, a mechatronic engineer designs smart machines and systems wherein they are aware of their environment, and can process information to make decisions (UNSW Engineering, n.d.). They also follow a design philosophy founded by a multidisciplinary technology for producing an array of engineering devices with smart components, intelligent systems, robots and flexible manufacturing facilities (Geddam, 2013). Through the use of mechatronics, it provides a solution that is an efficient and reliable system, mechatronic system mostly has microcomputers to ensure smooth functioning and higher dependability (Iqbal, 2017).

- *Robots in Mechatronics Engineering*

According to Ahmed & Alsaleh (2011), the use of robots in engineering is an effective learning tool for students to learn engineering design and programming. Such as letting them experience a hands-on, project-based learning which could enable them to be familiar with the different components and parts of a machine. This also motivates them to improve their independent thinking, research, and problem-solving skills.

A robotics project was given to first-year engineering students in Qatar. As such, they needed to develop functions and programs; use arithmetic, relational and logical operators and variables in a program; and create a program containing conditional statements and loops. "Students were comfortable with the use of hands-on, project-based learning." (Ahmed, & Alsaleh, 2011).

According to Gonçalves (n.d.), the objective of using LEGO Mindstorms robotics kit is to develop teaching methodologies with the use of LEGO kits to encourage the students and also to endorse a higher interdisciplinarity, by proposing projects that unify different disciplines.

According to Gonçalves (n.d.) "The undergraduate teaching of mechatronics engineering at Federal University of Uberlândia includes formal laboratory work for robotics teaching and final year projects."

Also, Jaksic & Spencer (2007) stated that "The LEGO Mindstorms NXT Urban Challenge experiment is a part of the pedagogical system implemented in the Introduction to Mechatronics course and the Mechatronics curriculum."

- *Product of Mechatronics Engineering Students*

As aforementioned, mechatronics is a branch of engineering that focuses on designing, manufacturing and maintaining products that have both mechanical and electronic components.

In correlation, Jones stated in an article that "We're excited to get Cassie out into researchers' hands because researchers tend to be the most abusive, so we will learn all the failure points and build better robots in the future," (LATEST TWO-LEGGED WALKING ROBOT ARRIVES AT MICHIGAN, 2017).

According to The Adamson News (2019) "Five dual degree students showcased Adamsonian excellence in an international mechatronics competition hosted by the Ministry of Education of Taiwan last May 23-25. With their thesis titled EXOID: Design of Upper-limb Exoskeleton Suit for the Rehabilitation of Human Arm Functionality."

II. MATERIALS AND METHODOLOGY

The research entitled, "The Age of Mechatronics: A Phenomenological Study of Students' utilization of Educational Robots in class ", is a qualitative type of research, specifically a phenomenological study in association of an exploratory research design, utilized responses from four (4) 5th year college students who are taking up Bachelor of Science in Mechanical Engineering Major in Mechatronics Engineering. Raw data was collected inside the premises of Adamson University through the use of focus group interview and audiovisual materials, specifically voice recording devices. Interview

questions were validated by the content adviser, a licensed educator with a master's degree in teaching, with the help of Jacquelyn White and Marilyn K. Simon's rubrics entitled "Interview Validation Rubric for Expert Panel – VREP". The researchers used a non-probability sampling technique, specifically a purposive sampling, for the sole purpose of knowing the Mechatronics students' relevant experiences of utilizing robots in class. After collecting responses, the data was organized through the use of tables and eventually was analyzed using thematic analysis. For the data to be credible, verbatim transcription was employed. Moreover, the collected data will be further supported by the accumulated related literature and studies.

III. RESULTS AND DISCUSSION

➢ *Advantages and Disadvantages of Students' Utilization of Robots in Class*

Technology is playing an essential role in helping humans work more effectively. The growing popularity of utilizing robots across a wide range of sectors looks set to continue over the next few years, as education looks to take advantage of the numerous benefits it offers.

Naturally, not everyone has been convinced of the advantages utilizing robots can deliver. There is still some cautiousness about adapting an existing production line, with some reasonable objections posed by those yet to try the technology (Barden, 2017). To address both sides of the discussion, the researchers had put together a few brief advantages and disadvantages in accordance to four (4) 5th year Mechatronics students' experiences of utilizing robots in class.

ADVANTAGES	• Hands-on experience • Cost-effectiveness • Quality assurance • Programming and assembling actual robots • Continuous learning • Application of theoretical studies • Learn about robot interface • See infinite possibilities • Adjustments can be seen • Ability to learn faster • See and learn the universal language programming • Know the different parts of a robot • Additional knowledge
DISADVANTAGES	• Cost of robots' parts • Availability of robots • Programming a robot

Table 1

➢ *Relevant Experiences of Mechatronics Students in Utilizing Robots*

There are countless possibilities when it comes to the use, function, and learning experience provided by robots. Consequently, the data provided by the participants resulted in (3) three main experiences in utilizing robots (i.e. hands-on learning, lack of understanding and costly resources). Firstly, robotics provides hands-on learning through which they can learn various engineering applications. An experiential learning approach was proposed by Kolb which organizes learning-by-doing processes so that the learner can acquire both practical skills and theoretical knowledge (Lesh & Kelly, 2000)– a theory that complements one of the participant's response which is "It's easier to learn robotics if you have a robot with you". Moreover, Kolb also believes "learning is the process whereby knowledge is created through the transformation of experience" and it takes a more holistic approach and emphasizes how experiences, including cognition, environmental factors, and emotion, influence the learning process (Cherry, 2019). In addition, Leifer showed that embedding the experiential learning process, in designing a mechatronic system, can combine the technical and instructional goals of the robotics course. On the other hand, most of the data from the participants pertains to the effects of lack of understanding in robotics or programming; hence, robots can certainly handle their prescribed tasks, but they typically cannot handle unexpected situations (Barden, 2017). Besides, robots operate based on information fed to them through a chip. If one thing goes wrong, the entire company bears the loss (Barden, 2017). Likewise, it explains further the data from the participants, specifically the statement "Just a little miscalculation, you can destroy everything". Apart from this, it is observable that the world is changing in a fast way, and technological improvements have increased in all sectors (Eguchi, 2014). According to Soffar in 2019, many schools or universities are not able to provide the costly resources of mechatronic equipment due to lack of funds and costly electricity bills. Concerning, Raman & Haughery in 2016, found the total time and cost of their mechatronic experience deployment to be 240 hours at $17,000. Based on a sample size of 48 students, a total capital cost of $5,000 ($104 per student) was reported wherein in peso, it

is Php 4,867.20 per student. Thus, the result of the data gathered talks about costly resources of robots in the making as one of the student's hardships in utilizing robots to their course.

➢ *Influence of Utilizing Robots to Mechatronics Students*

The data provided by the participants resulted in (3) three benefits as they utilize robots (i.e. experience and exposure, versatility, and no adverse effects). First, the experience and exposure that it can give to a student as they learn mechatronics. The use of robots in engineering is an effective learning tool for students to learn engineering design and programming. Such as letting them experience a hands-on, project-based learning which could enable them to be familiar with the different components and parts of a machine. This also motivates them to improve their independent thinking, research and problem-solving skills (Ahmed & Alsaleh, 2011). Second, the versatility of the knowledge that they have acquired with regard to utilizing robots. This can be substantiated to the statement of RobotWorx (n.d.) that the versatility of a programmer to assemble a robot depends on what will be its use. Once it is made, it can be used as a tool to multitask and to perform such action. Lastly, utilizing robots does not have an adverse effect on students. Robots serves as a learning tool/teaching aid wherein it includes building, creating and programming robots (Mubin et al., 2013).

➢ *Association of Robots to the Academic Track of Mechatronic Students*

It is observable that robotics is slowly being widespread, particularly in the field of education. For further understanding, the accumulated data by the researchers was deducted to three (3) main effects of utilizing robots in mechatronics (i.e. integration of traditional way of teaching and use of robots in class, experience and knowledge, and safety procedures). Mechatronics, according to Rouse (2017), is a branch of engineering that emphases on designing, manufacturing and maintaining products that have both mechanical and electronic components. The best way to teach mechatronics to students is through the use of actual robots and the traditional way of teaching, specifically with the use of books. In addition to that, robots according to Mubin et al. (2013) provides an embodiment, the ability to add social interaction to the learning context, and advancement on purely software-based learning, which is directly connected to what Tuomi expressed in (2018), "Especially if the mechatronics students will be thought about using this kind of teachings, they can adapt and grasp the essence of their career." Apart from this, experiences of actually having to use a robot in class and the knowledge gained on programming, language and parts in a short period were also deducted from the interviewees' accumulated data. It can be substantiated by the statement of Ahmed & Alsaleh (2011) that the utilization of robots to engineering is an effective learning tool for students to learn engineering design and programming. Doing such things enables the students to experience hands-on, project-based learning that could allow them to be familiar with the different components and parts of a machine. Lastly, all of the participants pointed out that without the knowledge in safety engineering, utilizing robots would be a disaster. The interviewees stated that to practice safety engineering, a background on electronics and how the components cooperate is needed. It would be a drawback for the students if they are not familiar with the preceding statement. In justification, Verma, Karanki & Ajit (2015) stated that "Reliability and Safety Engineering presents an overview of the basic concepts, together with simple and practical illustrations." Accordingly, as long as the students follow the procedure, they are properly maximizing the knowledge, application, and experience offered in mechatronics.

➢ *Coding Scheme*

To support the problem "What are the medium of learning in Mechatronics Engineering?", the researchers had described 3 categories in a form of a coding scheme that can help us to know what medium of learning can be used in Mechatronics Engineering. The table below shows the categories and their definitions that are helpful for the interpretation of data.

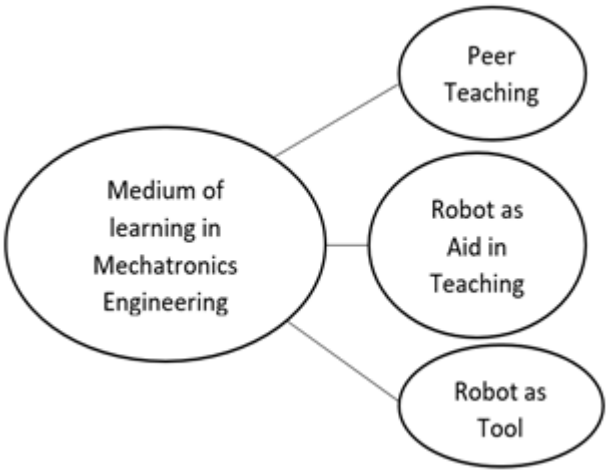

Fig 3:- Medium of Learning in Mechatronics Engineering

MEDIUM OF LEARNING IN MECHATRONICS ENGINEERING	
CATEGORIES	**DESCRIPTION**
PEER TEACHING	Peer teaching, according to Whitman (1998) happens when students, by design, teach other students. Peer teaching includes one or more students teaching other students and builds on the belief that "to teach is to learn twice."
ROBOTS AS AID IN TEACHING	The design goals of most robots, according to Mubin & Ahmad (2016) are to function as an aid in the classroom and to improve the added value they can bring as a stimulating and engaging educational tool.
ROBOTS AS TOOL	A robot is a multifunctional manipulator that can be programmed, designed to maneuver objects, parts, tools or specialized devices and to perform variety of task through programmed motions (Kapila n.d.).

Table 2

Mechatronics engineers, according to The Evolution of Mechatronics Engineering (n.d.) have brought amazing features into the products they work on. Cars, backup cameras, sensors, and anti-lock brakes are a great examples of what engineering skills can design and implement. The field is really exploding with a great number of students having countless thoughts on innovation and advancement. Learning in Mechatronics can be categorized into 3 main parts (i.e. Peer Teaching, Robots as Aid in Teaching, and Robots as tool). Peer teaching defined by Goodlad & Hirst (n.d.) is the system of instruction in which learners help each other and learn by teaching. According to a participant, "Robots can be learned through your peers because we cannot deny that professors or teachers are sometimes hard to understand". This is in accordance with the constructivist theoretical model developed by Piaget proposing that learning is an active process of knowledge construction based on experiences gained from the real world, as well as with the social dimension to knowledge construction proposed by Vigotsky (Mikropoulos & Bellou, 2013), which will be discussed furthermore. The casual way of teaching in Mechatronics is with a professor in class, teaching the students and demonstrating the robot. In line with this regard, robots, according to Mubin & Ahmad (2016) are increasingly being used to teach students in the classroom for a number of subjects across science, math and language. Lastly, learning in Mechatronics would not be completed without the actual use of robots. Robots are toolkits that can be physically manipulated allowing students to learn a variety of disciplines across engineering. It is basically invented to make work easier because it is a machine. Machines, as defined by the Merriam-Webster Dictionary "a mechanically, electrically, or electronically operated device for performing a task", task such as being a tool in learning.

➢ *Educational Robotics and Constructionism*

Constructionism in education can be defined as focusing on one's own discovery of learning which encourages the individual to associate with physical objects that can enhance their knowledge. This approach of learning can be observed in science, math, and technology classes, which is believed to be effective in honing the students' creativity and collaboration skills (David, 2016) and can also increase the student's motivation due to a hands-on approach in learning (Chang et al., n.d.). To correlate, one of the mediums of learning robotics is by recognizing it as a tool, in which it underlies the learning approach of constructionism because of its firsthand experience collaboration with objects and it contradicts the traditional style of teaching, which is instructionism. In association with constructionism to educational robots, tool kits and other necessary resources for the making of robots are needed (David, 2016). With that, as per the statement of Chang et al. (n.d.), students are in complete control of the design and the assembly of the robots.

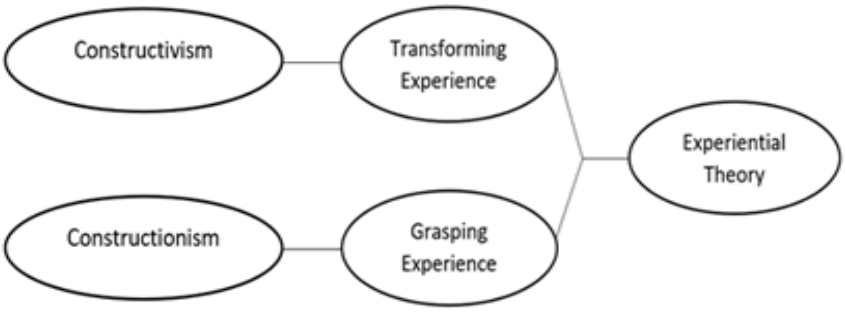

Fig 4:- Constructivism and Constructionism to Experiential Learning Theory

➢ *Educational Robotics and Constructivism*

Constructivism, according to David (2015), states that "learning is an active, contextualized process of constructing knowledge rather than acquiring it. Knowledge is constructed based on personal experiences and hypotheses of the environment." In short, it is a knowledge already learned by an individual of their own understanding and experiences, in which it hones their cognitive learning. As aforementioned, social constructivism refers to the peer or tutor based as one of the

methodologies in robotics education. Similarly, it is related to the medium of learning in mechatronics such as peer teaching and robots as an aid in teaching. Utilizing educational robots will be recognized as a constructivism approach if peer-to-peer teaching is present, and robots are used as an aid in teaching.

➢ *Educational Robotics and Experiential Learning Theory*

In the consolidation of everything that has been mentioned, Experiential Learning Theory (ELT) by Kolb, Boyatzis & Mainemelis (1999) states that experience has a role in the learning progress of an individual. And as such, knowledge is the synergy of grasping and transforming experiences. And under these experiences is the concrete experiences wherein it is regarded as the observations and reflections. To complement, it is followed by the abstract concept in which a newly formed implication was done based on the concrete experience. With the formed implication, it then can be actively tested and encounter new experiences. Grasping experience refers to the accumulation of new experiences or through experiencing concrete reality. Similarly, constructionism, as aforementioned, is the individuals' learning discovery through the use of physical objects to hone one's knowledge. And in a way, utilizing robots as a tool is a great example of grasping experience in a constructionist approach. On the other hand, others tend to take hold of new data through symbolic representation or abstract conceptualization where others prefer critical thinking rather than using sensation as a guide. In addition, in transforming experience others tend to observe people involved in the experience and think deeply, while others prefer to immediately start doing things. In lieu with that, transforming experiences acquires data through observation and critical thinking which is complementary to constructivism's theory on how knowledge is developed through the learner's experiences and basic knowledge wherein both theories are under the domain of experiential learning theory that speaks about how knowledge is created. Moreover, through peer teaching together with constructivism theory, the learner's knowledge is developed together with other students through helping each other in acquiring new information. Robots play a vital role in molding knowledge the same as peer teaching, where learnt knowledge is developed and enhanced through the process of transforming experience.

All things considered, it can be said that an experiential learning approach in mechatronics is a productive way for the students to learn, experience, and be able to have an effective learning discovery. Withal, the individual can acquire both practical skills and theoretical knowledge, wherein practical skills indicate to one of the mediums of learning mechatronics, by utilizing robots as a tool, with a constructionist approach that will yield to grasping experiences. And correspondingly, theoretical knowledge refers to peer teaching and robots as an aid in teaching with a constructivist approach that will render transforming experiences. As an implication, mechatronics, with respect to experiential learning, is a combination of technical and instructional objectives that is substantial in robotics.

The study encountered three (3) limitations (i.e. time, participants, and related literature). Although the given time to finish the research was enough, the researchers experienced hardships in following their research timeline. Even though decent data has been gathered from the respondents, the researchers believed that a great number of participants will result in numerous data waiting to be interpreted. In relation with the participants, there are only few related literatures in line with the study. A large number of researches was neglected such as certain works and reports from educational institutions because they are not readily and widely available. A large number of researches was neglected such as certain works and reports from educational institutions because they are not readily and widely available.

IV. CONCLUSION

Taking everything into account, it can be said that the use of robots is all the more beneficial to the mechatronics students than being a disadvantage. Although the students' experiences hands-on learning, exposure to robotics, and the versatility of the application of robots, they also encounter difficulty with the resources needed and in programming. Aside from that, associating the students with robots is the integration of theoretical learning and practical learning.

Thus, the development of educational robots is still in the initial stages and robot technologies bring new developments to education. Even with the rapid evolution of technology and the reliance of the society to it, the researchers do not intend to give the idea that robots can replace human teachers. Instead, it highlights the additional value that robots can bring to the classroom in the form of a stimulating, engaging and instructive teaching aid.

REFERENCES

[1]. Ahmed, B., Alsaleh, K. (2011). Robotics: Its effectiveness as a tool to teach engineering design and computer programming. 1018 - 1021. 10.1109/EDUCON.2011.5773272.
[2]. Al-qadi, H. M., Al-oun, I. S., & Al-barri, Q. N. (2013). The Effect of Using the Strategy of Peer Teaching on Developing the Active Learning Skills of the Basic Sixth Grade Students in Arabic Language in Jordan. Journal of Education and Practice, 4(19), 71–77.
[3]. Ben-Ari, M., Mondada, F., (2017). Elements of Robotics. *Robots and Their Application*. Retrieved November 1, 2019, from https://link.springer.com/chapter/10.1007/978-3-319-62533-1_1
[4]. Chang et al. (2010). Exploring the Possibility of Using Humanoid Robots as Instructional Tools for Teaching a Second Language in Primary School. *Educational Technology & Society*. 13. 13-24.

[5]. Doswell, J.T., Mosley, P.H. (n.d.). An innovative approach to teaching robotics, Proc. Advanced Learning Technologies, 2006, 1121–1122.
[6]. Dr. Williams, B. (2019). An Introduction to Robotics. Retrieved November 1, 2019, from https://www.ohio.edu/mechanical-faculty/williams/html/PDF/IntroRob.pdf
[7]. Gonçalves, R. S. (n.d.). Application of LEGO Mindstorms Kits for Teaching Mechatronics Engineering. *5*(10).
[8]. Goodlad, S. & Hirst, B. (n.d.). Peer Tutoring. Retrieved from A Guide to Learning by Teaching: https://eric.ed.gov/?id=ED311006
[9]. Hall, E., (2015). Robotics 1 Introduction. *Robotics: A User-Friendly Introduction*. Retrieved November 1, 2019, from file:///C:/Users/User/Downloads/RoboticsLecture1.pdf
[10]. Han, J., Kim, D. (n.d.)R-Learning services for elementary school students with a teaching assistant robot, Proc. HRI, 2009, 255–256.
[11]. Hashimoto, T., Kobayashi, H., Polishuk, A., Verner, I. (n.d.). Elementary science lesson delivered by robot, Proc. HRI, 2013, 133–134
[12]. Highfield, K., Mulligan, J., Hedberg, J. (n.d.). Early mathematics learning through exploration with programable toys, Proc. Joint Conference Psychology and Mathematics, 2008, 17–21
[13]. Howell, R. (2003) The Importance of the Project Method in Technology Education, Journal of Industrial Teacher Education, 40(3) http://scholar.lib.vt.edu/ejournals/JITE/v40n3/howell.html
[14]. Institute of Electrical and Electronics Engineers (n.d.). What is a Robot?. Retrieved November 1, 2019, from https://robots.ieee.org/learn/
[15]. Jaksic, N., & Spencer, D. (2007). An introduction to mechatronics experiment: LEGO mindstorms next urban challenge. *ASEE Annual Conference and Exposition, Conference Proceedings*.
[16]. Khanlari, A. (2014). TEACHERS' PERCEPTIONS OF USING ROBOTICS IN PRIMARY/ELEMENTARY SCHOOLS IN NEWFOUNDLAND AND LABRADOR. Retrieved November 1, 2019, from https://pdfs.semanticscholar.org/01f0/0ff19676581a58ec0045d327dcc567f03c41.pdf?fbclid=IwAR2BEcAXXs58QBJnVQXvLuPw8aXU6oaq1mmKkmRRdlmm3Hki2H4hMmsWYaY
[17]. Kolb, David A. 1984. Experiential Learning: Experience as the Source of Learning and Development. Prentice-Hall, Inc., Englewood Cliffs, N.J.
[18]. LEGO (n.d.). Lego Mindstorms Nxt. Retrieved October 31, 2019, from http://mindstorms.lego.com/en-us/Default.aspx.
[19]. Lesh, R., and Kelly, A. (2000) Multitiered Teaching Experiments. In: A. Kelly and R. Lesh (Eds.), Handbook of Research Design in Mathematics and Science Education, Lawrence Erlbaum, 197-230.
[20]. Merriam-Webster Dictionary. (n.d.). Retrieved from: https://www.merriam-webster.com/dictionary/machine
[21]. Michigan Engineering (2017). LATEST TWO-LEGGED WALKING ROBOT ARRIVES AT MICHIGAN. *Mechanical Engineering.* Retrieved October 31, 2019, from https://me.engin.umich.edu/news-events/news/latest-two-legged-walking-robot-arrives-michigan
[22]. Mubin, O. & Ahmad, M. I. (2016, November 7). Robots likely to be used in classrooms as learning tools, not teachers. Retrieved from https://theconversation.com/robots-likely-to-be-used-in-classrooms-as-learning-tools-not-teachers-66681
[23]. Okita, S.Y., Ng-Thow-Hing, V., Sarvadevabhatla, R. (n.d.). Learning together: asimo developing an interactive learning partnership with children, Proc. ROMAN, 2009, 1125–1130
[24]. Papert, S. (n.d.). Mindstorms: children, computers, and powerful ideas (Basic Books, Inc., 1980).
[25]. RobotWorx (n.d.). Versatility is Key for Assembly Robots. Retrieved November 7, 2019, from https://www.robots.com/articles/versatility-is-key-for-assembly-robots?fbclid=IwAR0yX9BE9oVFiCdwGvtBvi5T2pUEEZ7uQ2F5M37lQQi81Jo8EHTlaF5IIOw
[26]. Rouse, M. (2016). What is a Robot?. Retrieved November 1, 2019, from https://searchenterpriseai.techtarget.com/definition/robot
[27]. Rouse, M. (2017). Mechatronics. Retrieved August 19, 2019, from https://whatis.techtarget.com/definition/mechatronics?fbclid=IwAR3rKre-itR2jiSSeknlW5KMLu_EHfJ-mWVsj12cf2-SsjjkhJ009TKnsfQ
[28]. Serholt, S., Barendregt, W. (2014). Students' Attitudes towards the Possible Future of Social Robots in Education. Retrieved August 19, 2019, from https://www.researchgate.net/profile/Sofia_Serholt/publication/262932496_Students'_Attitudes_towards_the_Possible_Future_of_Social_Robots_in_Education/links/542bbab80cf277d58e8a2c26.pdf
[29]. Spana, G., Rane, A., & Kaouk, J. H. (2011). Is robotics the future of laparoendoscopic single-site surgery (LESS)? BJU International, 108(6 B), 1018–1023. https://doi.org/10.1111/j.1464-410X.2011.10513.x
[30]. The Adamson News. (2019). Mechatronics studes bag 3rd in Int'l Robotic Tilt. Retrieved October 31, 2019, from https://www.adamson.edu.ph/v1/?page=view-news&newsid=1707
[31]. The Evolution of Mechatronics Engineering. (n.d.). Retrieved from CAPITOL TECHNOLOGY UNIVERSITY: https://www.captechu.edu/blog/evolution-of-mechatronics-engineering
[32]. Tuomi, I. (2018). The Impact of Artificial Intelligence on Learning, *Teaching, and Education: Policies for the Future.* 10.2760/12297.

[33]. UNSW Sydney (n.d.). Mechatronic Engineering. *School of Mechanical and Manufacturing Engineering.* Retrieved August 19, 2019, from https://www.engineering.unsw.edu.au/mechanical-engineering/study-with-us/types-of-mechanical-and-manufacturing-engineering/mechatronic-engineering?fbclid=IwAR00GW-3ZkT2eawKjrdtoXrQQwFj5tlHlZbdKUPky_cCPa5kgZ4O5rsmu2k
[34]. Verma, A., Ajit, S., Karanki, D. (2015). Reliability and Safety Engineering: Second Edition. Retrieved November 7, 2019, from https://www.researchgate.net/publication/292354699_Reliability_and_Safety_Engineering_Second_Edition
[35]. Verma, Ajay & Ajit, Srividya & Karanki, Durga Rao. (2015). Reliability and Safety Engineering: Second Edition. 10.1007/978-1-4471-6269-8.
[36]. Verner, I. & Korchnoy, E. (2006). Experiential Learning through Designing Robots and Motion Behaviors: A Tiered Approach. Retrieved November 7, 2019, from https://www.ijee.ie/articles/Vol22-4/07_ijee1800.pdf
[37]. Vygotsky, L., (n.d.). Mind in society (Harvard University Press, 1978).