The Basic of Hydraulic and Pneumatic Teaching Innovation Kit for Application in Fluid Power Technology Course

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ABSTRACT

This project utilizes a learning kit to visualize the function of Basic Hydraulic and Pneumatic in the classroom instead of using conventional teaching style; slides and videos. Hydraulic and pneumatic are introduced to the semester 5 students in subject Fluid Power Technology (MEC341). By the end of this course, students are expected to be able to apply, explain and demonstrate the operation of Fluid Power systems, hence they need to have a very strong grasp of Hydraulic and Pneumatic fundamentals in order to score this subject successfully. However, most students faced difficulties to imagine its working principle, thus failed to satisfy the cognitive evaluation. The idea of this project is obtained from a survey distributed in classes and most students agreed with the introduction of this learning kit in learning session. In this project, the demonstration of the basic components of Hydraulic and Pneumatic such as pump, piping and linear actuator (cylinder) are replaced by small scale component made from durable material. This teaching innovation kit allows students to better understand the topic, plus it is also believed to be more interesting to be demonstrated in class. Furthermore, this kit is easily understandable by others not only limited to engineering students.

Keywords
Hydraulic and Pneumatic; Working principle; Teaching innovation kit

Introduction

Nowadays scientists and engineers have established several of power technologies and used different methodologies for their analysis in order to enhance the most sophisticated power technology in the universe and one of them is Fluid Power Technology. Fluid Power technology is the technology that deals with the generation, control and transmission of power by using a pressurized fluid. Fluid Power is the general term expressed for both Hydraulic and Pneumatic. Hydraulic means that fluid used for power transmission is a liquid meanwhile Pneumatic means fluid used is a gas. Hydraulic drive has sufficiently high value of efficiency, increased rigidity and durability (Sokolov, Krol, 2017). For Hydraulic, due of using a liquid as a medium, it was very important to have a knowledge about Fluid Mechanics as well. Besides that, the better understanding of strong compression, the principle and basic concepts Hydraulic system such as pressure, flow, nature and the selection of Hydraulic fluid must be highlighted (Jian L., et al., 2017). Meanwhile, Pneumatic component is the attempt to provide energy savings which the traditional Pneumatic drive systems are commonly controlled by a single pressure with a three-position, five-way reversing valve. Many researchers have achieved the aim of saving compressed air by improvising the Pneumatic valve and cylinder (Du H., et al., 2018). Moreover, Pneumatics is more inexpensive large output force/weight ratio, rapid response, strong adaptability to various circumstances, and provide very adaptive linear motion load (Saravanakumar D., et al., 2017). However, both Hydraulic and Pneumatic technology are widely used in industrial engineering applications because of its remarkable and compelling technical characteristics such as construction machinery, metallurgical machinery, ships, aerospace, weapons and equipment, agriculture and forestry machinery, simulation platform, packaging machinery and etc (Xu L., et al., 2016).

Literature Review

Fluid Power Technology is basically the studies of Hydraulic and Pneumatic concept and their uses, although it is considered as an interesting and simple subject but the students have difficulty to understand its application in industrial engineering especially when it comes to how exactly fluid flow works. Recently, students are more attracted and enthusiastic to modern teaching and learning rather than traditional method. Many researchers have come out with their studies, most of them restructure the course content and improve teaching and learning

approaches. Based on Meti and Giriyapur (2014), trainers concept are used to train the students by expending the outcome based on learning approaches adopted in the Basic Hydraulic and Pneumatic control course. The instructor planned the course content and other activities at the beginning of the semester, the principles, concepts and design analysis will be delivered during the theory session. The structured approach obtained the positive response from student's feedback analysis and it motivates the instructor to improve this kind of learning approaches for other courses. Outcome based education learning approach supports and encourages students of different levels and skills in accordance with the 21st century skills. According to Pobedza and Guzowski (2015), innovative approach is more popular in postgraduate education of Fluid Power Technology. The article proposed the development of model of studies and its innovative components. The proposed model presented together with characteristic of education in Hydraulic and Pneumatic systems. From the survey conducted, it was found out that the completed studies met students personal and professional expectations. Its highly rated in terms of obtaining the knowledge and skills, organizations of study, course schedule, the quality of teaching material and laboratory equipment. Based on audience opinion, remote work allowed the greater flexibility in performing tasks, and better new knowledge and skills. The completed model help postgraduate students to raise their level of qualifications and reliably improve their professional competence and competitiveness in a labour market. A structured approach to teaching Fluid Power systems using spread sheets has been proposed by Ball, et al., (2007). The uses of spread sheets such as Microsoft Excel to supplement Engineering Technology has been applied in many areas successfully. In this project, students developed independent Excel worksheets in a logical progression corresponding to topics delivered in the class. The students can check homework problems and perform laboratory calculations by using those created worksheets. The conclusion stated that the student's feedback and performance has been positive. Their ability to understand theoretical concepts more are improved and can be seen by comparing their results from the past and recent semesters. Results show that they do a better performance on homework assignments, laboratory and tests. According to Xu, et al., (2016), a diversified teaching mode is to improve the traditional single teaching mode. By proposing the completed training system which includes the function of Hydraulic components, the cognition of functional symbols, the functional analysis of Hydraulic system, the layout of Hydraulic system in PLC and the production practice, it is believed that it can supplement the traditional teaching mode that only pays attention to the theoretical knowledge which is not constructive to the component of students' knowledge. From investigation, expressed that the new teaching mode can give a lot of advantages and it is more conductive to the overall student's development compared to traditional mode. The clearly advantages of new teaching mode are to make more complete training systems which contribute to the establishment of a complete knowledge system. Then from the combination of theory and practice understanding can be easier and student's learning interest improves. Furthermore, based on Xu, et al., (2017), the new training mode advocates the self-study of students after class, while strengthening the guide role of teaching. The teaching scheme improvement of Hydraulic and Pneumatic Transmission is based on the professional certification training mode. This scheme aims at focusing the aspect of links such as teaching skills, class teaching content and engineering practice, practice teaching, syllabus revision and students self-study guidance. It is believed that by restructuring the teaching plan which improves teaching skills, connection between class teaching content and engineering practice, revision and upgrading teaching syllabus, increasing student's self-study time after class will meet the requirements of the new training program. Research on teaching reform and practice in Hydraulic transmission practice shows a good teaching effect (Jian, et al., 2017). Teaching reform proposals and suggestions in three aspects of Hydraulic transmission course in the teaching content, teaching and assessment methods leads to a good result in teaching practice. These three aspects reform teaching content by dividing into three parts namely basic theory, Hydraulic components, Hydraulic basic circuit and typical system. Next reform teaching methods by using multimedia courseware improves teaching effect, experimental teaching methods and cultivating student's engineering ability, which enrich teaching methods to improve student's learning effects and last optimized examination methods. Wei, et al., (2017) suggest the application research of Hydraulic and Pneumatic transmission teaching based on TRIZ Theory and FESTO simulation software. TRIZ Theory is mainly the invention problem theory which contains the technology system evolution laws of its theoretical system, 40 innovation principles, technical contradiction matrix, and separation methods of contradiction. It is broadly used in machinery, electronics, management and education. Meanwhile, FESTO is simulation software that usually used to design the Hydraulic and Pneumatic systems. This software provides several Hydraulic and Pneumatic components to generate a circuit. Based on research, course teaching model of combination of the TRIZ theory and FESTO simulation has a great guiding significance on the whole machinery knowledge and it is recommended to reform other courses. However, in this project, the demonstration of Innovative learning kit will be conducted in the classroom to expose the students about the Basic of Hydraulic and Pneumatic component system. The demonstration activities was implemented twice in the semester and delivered the principles, concepts and

design analysis to the group of students during the theory sessions. Thus, the novelty of this project does not only focuse on reforming the course content such as stabilize the teaching and learning skills, and changing the course structure and syllabus in order to extemporize the Fluid Power Technology subject, but also implementing the prototype model of Hydraulic and Pneumatic basic learning innovative kit for students practice in the class.

Table 1. Comparison of literature review and current study

Author, Year	Title	Objectives	Method Used	Conclusion
Meti V.K.V., Giriyapur A.C., 2014	A Structured Approach to Teaching and Learning Hydraulics & Pneumatics	- To provide a new concept in the design of a coursework for teaching and learning Hydraulics and Pneumatics	- Applied the outcome based learning education learning approaches - Distributed questions set for the course, to validate the feedback from students	- The positive response obtained from students feedback analysis - The analysis motivates the instructors/faculties to improve or adopt these kinds of learning approaches.
Pobedza, J., Guzowski A, 2015	Innovative Approach to Postgraduate Education in the Field of Fluid Power Technology	- To developed and innovative model of postgraduate education in the area of fluid drive and control technology	-	- The completed of this model helps postgraduate students to raise their level of qualification and reliably improve their professional competence and competitiveness in a labour market.
Ball A. K., Anderson R., Ferguson C.W., 2007	A Structured Approach to Teaching Fluid Power Systems Using Spread sheets	- To reinforce theory through interactive formula based learning software products - To write equations and structure worksheets through a logical interactive approach of Fluid Power Systems	- Using independent Excel worksheet in a logical progression corresponding to topics covered in class	- The conclusion stated that the student's feedback and performance has been positive. Their ability to understand theoretical concepts improve which can be seen by comparing their results from past and recent semesters. Results show that they obtain a better performance on homework assignment, laboratory and tests.
Xu L., Ma H., Li J. 2016	The diversified Teaching Mode Reform Hydraulic and Pneumatic Transmission.	- To improve the traditional single teaching mode by proposing a diversified teaching mode - To establish a complete knowledge system and to improve student's ability to solve	- Replaced the traditional teaching mode to diversified teaching mode - Distributed questions set for the course, to validate the feedback from students	- The new teaching mode makes training system more complete which contributes to the establishment of a complete knowledge system, then from the combination of theory and practice can make easier understanding and improve student's learning interests.

		engineering practice.		
Wei Z., Zhao S., Zhao H., 2017	Application Research of Hydraulic and Pneumatic Transmission Teaching based on TRIZ Theory and FESTO Simulation Software	- To reform the plan aiming at the professional certificate mode - To propose new teaching programs that not only are suitable or new to requirements of professional certification training mode but also prepare the higher level of professional personnel training	- Applied new teaching program, improvement measured of teaching plan	- For conclusion, it is believed that restructuring the teaching plan improves teaching skills, connection between class teaching content and engineering practice, revision and upgrading teaching syllabus, increasing student's self-study time after class will meet the requirements of the new training program.
Jian L., Cai L., Ma H., 2017	Research on Teaching Reform and practice in Hydraulic Transmission	- To specify reform schemes of Hydraulic transmission course	- Reform Hydraulic transmission course from following three aspects which are teaching contents, teaching methods and assessment method.	- Teaching practices resulted that the reform measures obtained good teaching effects.
Wei Z., Zhao S., Zhao H., 2017	Application Research of Hydraulic and Pneumatic Transmission Teaching based on TRIZ Theory and FESTO Simulation Software	- To apply the combination of TRIZ theory and FESTO simulation for daily teaching - To aim the integration of teaching theory, practice, and innovation - To focus on cultivating student's ability on innovation	- Used combination of TRIZ theory and FESTO simulation as teaching mode in class to solve assessment and so on	- Based on research, by developing course teaching model of combination of the TRIZ theory and FESTO simulation, gave a great guiding significance on the whole machinery knowledge and it is recommend to other course reforms.
Current Study A.M.M. Ismail, N.A.S. Manssor, H. A.K. 2018	The Basic of Hydraulic and Pneumatic Teaching Innovation Kit for Application in Fluid Power Technology Course	- To visualize and demonstrate the function of Basic Hydraulic and Pneumatic in the classroom instead of using conventional teaching styles, slides and videos - To improve the teaching and learning approach to enhance student's better understanding of Hydraulic and	- Reforming the course content such as stabilizing the teaching and learning skills, changing the course structure and syllabus in order to extemporize the Fluid Power Technology subject. - Implementation of the prototype model demonstration of Hydraulic and Pneumatic basic Learning Innovative Kit	-

Pneumatic applications - Distributed a survey for the course, to validate the feedback from students. A preliminary survey disseminated to previous students (semester session 1 2017/2018) and current survey distributed to students (semester session 2 2017/2018).	for students practice in the class

Problem Statement

Based on Table 2, most topics were presented through slide presentations. Those interesting chapters may appear dry when conducted through slides only; therefore, most lecturers use some videos available in the internet as teaching resources. Although the utilization of the videos may seem beneficial for some students, it was observed that it is not useful for some groups of students. Although no research and survey is conducted to support this argument, it is believed that those students with kinaesthetic learning styles failed to take advantages from the videos information as compared to students with visual and auditory dominants. The course is designed to introduce the students of hydraulic and pneumatics components for a week. While almost 80 % of the syllabus contains theory that need to be read and memorized, lecturers tend to finish a topic at a short time even though 2 hours has been allocated. Students are likely to lose focus and interest when lecturers prolong their lectures with repetitive explanation and extended information which is not available on notes. It was also observed that some students may learn and apply the lesson to solve problems in the assessment such as examination, but often they do not appreciate or understand the concepts because they are unsuccessful to relay and apply their lesson in real life once they undergo to the industrial training in industries. This paper reports findings from a pilot implementation of a Basic Hydraulic and Pneumatic learning kit conducted in class for subject Fluid Power Technology for 56 semester 5 students on session 2 2017/2018. The objectives of the implementation of this learning kit is to encourage students towards a more effective course understanding, benefiting visual, auditory, kinaesthetic style students all together. Besides, it was also believed that this kit serves to support the lecturers in class to maximize their teaching session within allocated time. Lastly, application of a hardware that mimicked a real hydraulic and pneumatic system is purposely done to approach students in industrial environment.

Table 2. The general structure of course outline conducted in all classes for the last four semesters for this subject.

Week	Topics	Teaching Method	Time Allocation	Exact Time Allocated in Class
1	*Introduction to Fluid Power Technology*	Lectures (Power Point slides and Videos)	2 hours	1 hour
2	*Principle of Hydraulic*	Lectures (Power Point slides)	2 hours	2 hours
3	*Hydraulic Pumps*	Lectures (Power Point slides and Videos)	2 hours	2 hours
4-5	*Hydraulic Actuators*	Lectures (Power Point slides and Videos)	4 hours	2 hours
6	*Hydraulic Valves* ***Test 1***	Lectures (Power Point slides and Videos)	2 hours	1 hours

	Laboratory Session: Basic Hydraulic			
7-8	*Hydraulic Components and Accessories*	Lectures (Power Point slides and Videos)	4 hours	3 hours
	Laboratory Session: Advance Hydraulic			
9-10	*Industrial Hydraulic Circuits and Applications*	Lectures (Power Point slides and Videos)	4 hours	4 hours
	Mini Project: Basic Pneumatic and Advance Pneumatic			
11	*Principle of Pneumatic*	Lectures (Power Point slides and Videos)	2 hours	1 hour
12	*Pneumatic Components*	Lectures (Power Point slides and Videos)	2 hours	1 hour
	Pneumatic Circuit and Application	Lectures (Power Point slides and Videos)	4 hours	4hours
13-14	***Test 2***			
	Presentation of Mini Project			

Methods

A preliminary survey

At the end of the semester session 1 2017/2018, the lecturer had distributed a survey to 90 students who had finished taking the course. The survey was designed to gain insight of the students' satisfaction on how this course was conducted in class. The survey consists of a set of 12 questions comprising likert-type scale and a short paragraph questions and it was accessed via a Google doc's spread sheet. The lecturer distributed the link of the survey to the students and every students needed to key in their student number in order to make sure that the survey was valid and answered by the intended students only.

Implementation of Basic Hydraulic and Pneumatic Learning Kit in Class

At the beginning of the semester session 2 2017/2018, the lecturer had planned the content, learning kit exercises that are related to syllabus and industrial application based on the outcome based education that had been planned for this course. The lecturer explained the new learning approach adopted in the course and explained the theory contents using slides and videos as per current practice. By the fifth week of study session, the Basic Hydraulic learning kit was introduced and demonstrated while by the tenth week of study session, the Basic Pneumatic learning kit was exhibited in class to show the flow and the functions of both components in an interactive way. The lecturer permitted the students to explore the kit to gain hands on experience dealing with hydraulic and pneumatic system. Table 3 shows the proposed general structure of the new course outline approach. The demonstration activities were implemented at the beginning of the semester and delivered the principles, concepts and design analysis to the group of students during the theory sessions. A total of 10 students in each Fluid Power class were randomly selected to explain the principle and concepts and the rest were responsible for handling the installation of Hydraulic and Pneumatic during the laboratory session.

The learning kit was constructed on two acrylic glasses to demonstrate the basic concept of hydraulic (30 x 60 cm) and pneumatic (60 x 90 cm) separately. The hydraulic module the kit consisted of two sets of pump, reservoir, directional controlled valve and syringe. Figure 1 illustrates the hydraulic components to represent the extend and retract of the syringe. Pump 1 pumped the liquid from the red reservoir 1, and through the tube the liquid was transferred to the syringe 1, thus extended it. At the same time pump 2 pumped the green liquid from reservoir 2, to retract syringe 2.

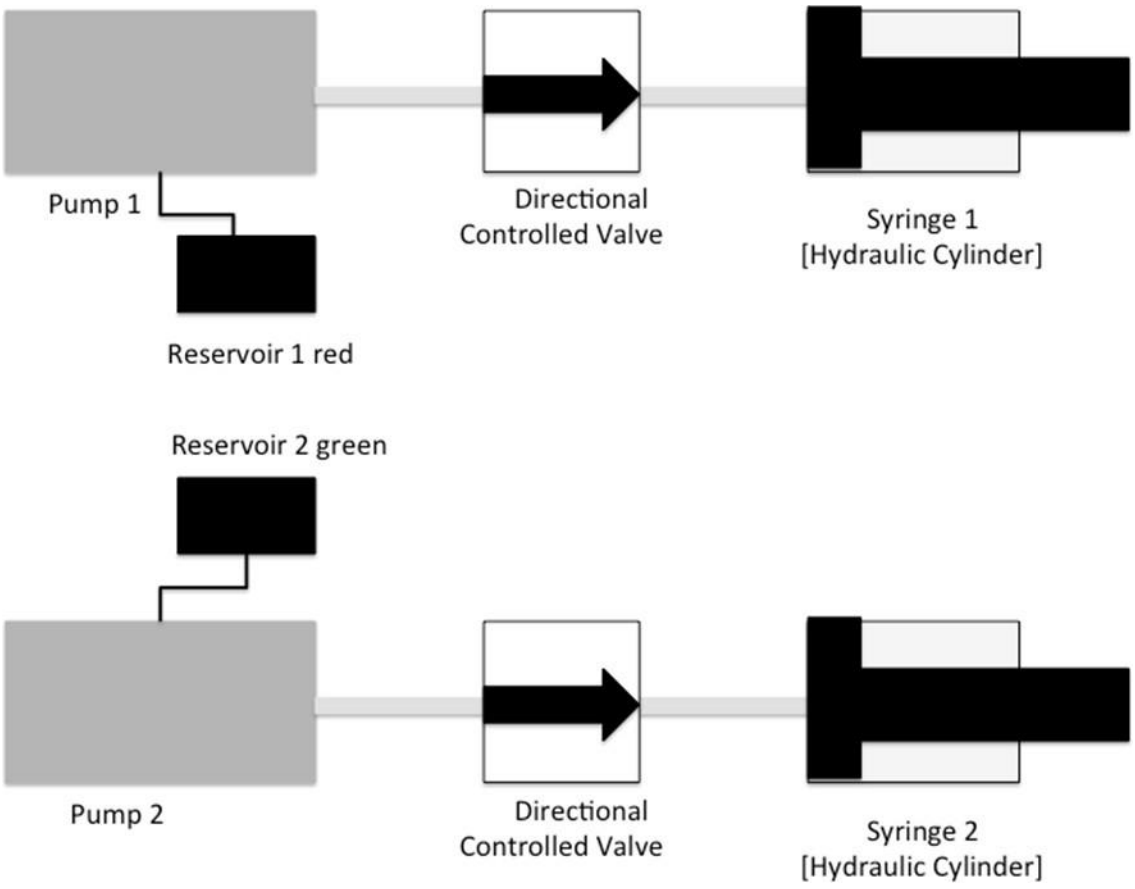

Figure 1. The illustration of basic hydraulic learning kit

Meanwhile, the pneumatic system was manually operated and consisted of a directional controlled valve connected to an air pump and a linear actuator as shown in Figure 2. The components linked each other to form a circuit using several tubes. Aside from the mechanical components, the kit also displayed the basic pneumatic system using two syringes connected to each other by a tube and a valve. The pneumatic application was demonstrated by pressing the pump or syringe 1, and compressed air was transferred through tube to extend or retract the linear actuator or syringe 2. The extend/retract condition was controlled by the valve between the components.

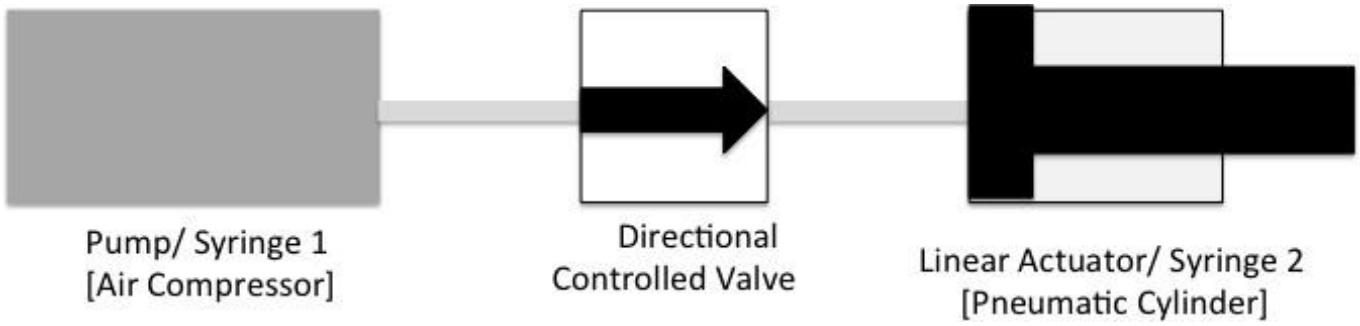

Figure 2. The illustration of basic pneumatic learning kit

Current survey

A survey was also distributed to the students who were taking this course within week 3 of study session. The purpose of the survey is to gain perception of student's satisfaction of the usage of learning Kit approach in class.

Table 3. The proposed general structure of the new course outline approach

Week	Topics	Teaching Method	Time Allocation	Exact Time Allocated in Class
1	*Introduction to Fluid Power Technology*	Lectures (Power Point slides and Videos)	2 hours	1 hour
2	*Principle of Hydraulic*	Lectures (Power Point slides)	2 hours	2 hours
3	*Hydraulic Pumps*	Lectures (Power Point slides and Videos)	2 hours	2 hours
3	***A survey the implementation of using an Innovative Learning Kit were distributed***			
4-5	*Hydraulic Actuators*	Lectures (Power Point slides and Videos)	4 hours	2 hours
5	***Demonstration of Basic Hydraulic Learning Kit***			***1 hours***
6	*Hydraulic Valves*	Lectures (Power Point slides and Videos)	2 hours	1 hours
	Test 1			
	Laboratory Session: Basic Hydraulic			
7-8	*Hydraulic Components and Accessories*	Lectures (Power Point slides and Videos)	4 hours	3 hours
	Laboratory Session: Advance Hydraulic			
9-10	*Industrial Hydraulic Circuits and Applications*	Lectures (Power Point slides and Videos)	4 hours	4 hours
10	***Demonstration of Basic Pneumatic Learning Kit***			***1 hours***
	Mini Project: Basic Pneumatic and Advance Pneumatic			
11	*Principle of Pneumatic*	Lectures (Power Point slides and Videos)	2 hours	1 hour
12	Pneumatic Components	Lectures (Power Point slides and Videos)	2 hours	1 hour
13-14	Pneumatic Circuit and Application	Lectures (Power Point slides and Videos)	4 hours	4hours
	Test 2			
	Presentation of Mini Project			

Result and Discussions

From the survey that had been conducted to the previous students (session 1 2017/2018), most of the students scored B and only 21.7 % scored A, even though this does not require final examination and was considered as an easy subject to score. One of the questions posed which teaching method was preferable to be conducted in class and 93.8 % students agreed that lectures combined with videos and demonstration is the best method. Besides, it was also

observed that 87.5 % of the students agreed that video and demonstration would benefit them in learning this course and 67.8 % of the responds believed that they do not enjoy a passive learning process where students have a minor participation in class. One of the purposes of conducting survey is to obtain students opinion on the implementation of this innovative learning kit in class session, and 81.3 % of the students strongly agree that this teaching aid is valuable to be implemented in the class. Meanwhile, regarding to the feedback from survey for the current students (session 2 2017/2018), one of the questions posed which teaching method is preferable to be conducted in class and 88.1 % students agreed that lectures combined with videos and demonstration is the most superlative method. The totals of 85.7% students agreed that video and demonstration helps their learning mode. Further, it was observed that 90.5% students strongly agreed that it was better if a basic learning kit for hydraulic and pneumatic was introduced to class as a teaching aid for subject Fluid Power Technology. In addition, 38.1% of the students are aware of the fourth industrial revolution (IR 4.0).

Conclusion

As a lecturer teaching millennial generations, it is significant to consider students' learning style dominancy and fit to our teaching approach to benefit all of them. There are numerous types of students' learning style such as visual, auditory and kinaesthetic. The visual learning style is usual expressed as spatial learning style is a way of learning in which information allied with images, remember what they read rather than what they hear. An auditory learner depends on hearing, speaking and repeating skills to sort through the information that is sent to them as a main way of learning. Meanwhile kinaesthetic learning takes place by the students carrying out physical activities, rather than listening to a lecture or watching demonstrations. Therefore, this learning kit is in agreement will benefiting all groups of students because this kit is effortlessly understandable by others but not only limited to engineering students. A survey was conducted in order to improve the teaching style and method instead of using traditional method as it helps to know how the students want to be taught. Overall, positive response obtained from the student's feedback collected from the implementation of this learning kit. Besides, it is believed that his teaching innovation kit allows students to understand the topic better. It is also assumed to be more interesting to be demonstrated in class.

Limitations and Future Studies

The future assessment will include the planned of designing an advanced Hydraulic and Pneumatic learning kit that is suitable for laboratory task and engineering applications. So that, students will be able to expand their skills and knowledge differently by using their creativity instead of follow teaching convention to finding the right answers to solve the problems as obligatory in the fourth industrial revolution (IR 4.0). On going project will continue to provide the effectiveness of using teaching and learning method.

References

Abdullah, D. B., Abdullah, M. Y., Mohamad S. M. A., (2017). A Review on the Concept of Fourth Industrial Revolution and the Government's Initiatives to promote it among youths in Malaysia. *Special Articles, Journal o Social Sciences an d Humanities*.

Ball, A. K., Anderson, R., Ferguson, C. W. (2007). A Structured Approach to Teaching Fluid Power Systems Using Spreadsheets. *ASEE Southest Section Conference.*

Du, H., Xiong, W., Jiang, Z. A., Li, Q., Wang, L.(2018). Energy Efficiency Control of Pneumatic Actuator Systems through Nonlinear Dynamic Optimization. *Journal of Cleaner Production.*

Felder, R. M., (1988). Learning and Teaching Styles in Engineering Education. *Engineering Education*. 78(7). 674-681.

Jian, L., Cai, L., Ma, H. (2017). Research on Teaching Reform and practice in Hydraulic Transmission. *7th International Conference on Education, Management , Computer and Society, EMCS 2017. Advance in Computer Science Research*. Volume 61.

Meti, V. K. V., Giriyapur, A. C. (2014). A Structured Approach to Teaching and Learning Hydraulics & Pneumatics. *Engineering Education Transformation.* Volume 28.

Pobedza, J., Guzowski, A. (2015). Innovative Approach to Postgraduate Education in the Field of Fluid Power Technology. Technical Transactions Mechanics.

Saravanakumar, D., Mohan, B., Muthuramalingam, T. (2017). A review of recent research trends in servo pneumatic positioning systems. *Journal of Precision Engineering 49.*481-492.

Sokolov, V., Krol, O. (2017). Installations Criterion of Deceleration Device in Volumetric Hydraulic Drive. *International Conference on Industrial Engineering, ICIE 2017. Procedia Engineering 206.* 936-943.

Wei, Z., Zhao, S., Zhao, H. (2017). Application Research of Hydraulic and Pneumatic Transmission Teaching based on TRIZ Theory and FESTO Simulation Software. *7th International Conference on Management, Education and Information, MEICI 2017. Advance in Intelligent Systems Research.* Volume 156.

Xu, L., Ma, H., Li, J. (2016). The diversified Teaching Mode Reform of Hydraulic and Pneumatic Transmission. *International Seminar on Education, Innovation and Economic Management, SEIEM 2016. Advances in Social Science, Education and Humanities Research.* Volume 75.

Xu, L., Ma, H., Li, Ji. (2017). The Teaching Scheme Improvement of "Hydraulic and Pneuematic Transmission" Based on the Professional Certification Training Mode. *2nd Internatioanl Conference on Education, E-Learning and Management Technology. EEMT 2017.*