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Automatic Thread Insertion Kit Sewing (ATIKs) Device for Vocational Fashion Design Student: Practical Sewing Application

Siti Salwa Abu Bakar[1], Wan Nurlisa Wan Ahmad[1,*], Nur Athirah Mohd Zubir[1], Tang Jing Rui[1], Wan Marlina Wan Ahmad[2]

[1] Department of Engineering Technology, Faculty of Technical and Vocational, Universiti Pendidikan Sultan Idris, Malaysia
[2] Department of Electrical Engineering, Politeknik Seberang Perai, Malaysia

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ABSTRACT

The incorporation of technology is a consistent aspect of education, which is widely advanced through teaching and learning (T&L) in the industrial revolution 4.0 (IR 4.0) education technology. In this study, an automatic thread insertion set for sewing (ATIKs) was developed. The ATIKs device improves students' understanding and facilitates the process of sewing in fashion design subjects for high school curriculum. The device was programmed using an Arduino microcontroller board and open source Arduino software (IDE). The CDIO model is used as the basis for product development, which includes the steps from conception to design, implementation, and operation. The development for this product consists of the main components standard needle size, automatic thread, Arduino UNO R3, stepper motor, coil, and Arduino coding to control the movement. In addition, this product is relatively portable with its dimensions of 7 x 7 x 10 cm. A qualitative research method was applied using a list of interview protocols validated by five professional experts in the field. Based on the open-ended questions, the experts indicated that this product facilitates the criteria of the T&L process, improves understanding of the use of the thread needle, and increases student confidence in the sewing process. In the future, this kit could be integrated into an automated control system. This research development can help develop teaching tools that further increase student safety and improve student skills and cleanliness in handling sewing tools during hands-on work.

1. Introduction

Teaching aids are an essential part of the teaching and support process [1]. The use of teaching aids can help provide students with information about the subject being taught in a clearer and more systematic way. The use of teaching aids allows the teacher to explain facts and concepts of the learning content more accurately than relying only on verbal explanations. A teacher must be able to prepare early on to manage the materials needed for instruction. Sewing skills sub-subject in fashion design is one of the most complex subjects to manage in practical work, especially when the practical

* *Corresponding author.*
E-mail address: nurlisa@ftv.upsi.edu.my

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teaching and teaching process are ineffective. Therefore, the teaching material for sewing skills is limited, and teachers prefer slide presentations, which makes the learning process lengthy. In terms of safety, many vocational students complete an internship in a workshop. Attention is paid to safety in handling hand tools, machines, and the environment to avoid accidents that result in damage to machines, equipment, and people. During the practical work, students are exposed to various hazards, especially when preparing materials for practical projects, handling various types of sharp instruments and high-powered machines, and through a deep learning process in the workshop [2].

PTV is education and training to develop specific knowledge and skills. PTVs or skills of students using technology in IR4.0 education can perform their tasks productively and effectively. Skills are knowledge acquired by students and applied through hands-on activities that stimulate thinking [3]. Although sewing kits were provided in the workshop and used throughout the workshop for the hands-on activities, this remains a problem for students due to the limited variation in teaching materials [4]. As a result, students lose interest in learning, leading to limited exploration of imagination, and the level of students' visualization skills is low [5]. Therefore, the teacher plays an important role in attracting and maintaining students' attention to fashion design. This study is about developing an automatic thread introduction set for fashion design students in vocational schools. The idea of developing an automatic thread introduction set arises when students are not interested in practical work and there is no simple product for students to use during practical activities in class. Teaching aids for the classroom and practicum are one of the most effective ways to create a conducive learning environment.

Developing products as teaching aids can help overcome the problems faced during class and internship, especially the problem of sewing skills and practical work in the subject add on [6]. The teaching materials are developed in a form and with functions that can help attract students to do practical work in the teaching subject of fashion design. The reason is that students are attracted to teaching materials when they are advanced, high quality and well developed. This method can be applied to all subjects, especially to teachers who teach fashion design, because this subject requires practical work to improve students' understanding. In technical subjects like fashion design, teaching must be done as practice and exercise in the workshop. Teaching materials help to attract students' attention and influence their way of thinking. They will get bored quickly and will not gain further experience if the teaching and learning process is only theoretical [7]. With the teaching aids, the student can understand the content of the lesson better through simple and accurate explanation than through oral description. Azman *et al.,* [8] found that the presence of the teaching case can arouse the attention and desire to learn. Through this use, students become active in hands-on activities as they apply a set of strategies and procedures in performing practical activities. In the study on the use of teaching tools in sewing, it was found that 100% of vocational students express their interest and can do the practical work early because it is too easy for them to handle the needle and sew. Therefore, the aim of this study is to develop an automatic thread introduction kit for vocational students in fashion design. The teaching tool will allow students to do hands-on work by picking up the tools and sewing with their hands in real time [9]. They can also serve as an early experience for students before they start hands-on work.

1.1 Literature Review

Practical learning is a process in which students improve their skills through various methods by using the skills they have been taught and the equipment they use. In addition, hands-on learning is an educational process that systematically and directly guides students to perform a skill. Practice allows participants to gain hands-on experience [10]. The basic idea of experiential learning encourages trainees to reflect or look back on the experiences they have had. Practice-based learning refers to internships [11]. Practice-based learning aims at experimental learning, example as learning based on concrete experiences and discussions with friends from which new ideas and concepts can be obtained. Learning is a process of building knowledge from concrete experiences, collaborative activities, reflection, and interpretation. Practice-based learning strategies can help students develop a practical mind. Therefore, practice-based learning can be used as an alternative form of learning that can encourage students to be active learners to reconstruct their conceptual understanding [12]. Hands-on work is important to (1) motivate science learning, (2) improve basic experimental skills, (3) apply scientific approaches, and (4) support mastery of course material. In addition, the practicum provides a context-rich learning experience, improves conceptual understanding, develops practical skills, and is the best way to learn the nature of science [13].

1.1.1 Learning according to Kolb

Kolb learning is a theory that describes how people learn. ABM is closely related to teaching methods, learning styles, and learning approaches to help students learn more effectively [14]. In this project, Kolb's learning theory and CDIO model were used to develop an automatic induction set for fashion design students in vocational schools. In research by Chan [15], according to Kolb, during the learning process, a person goes through four phases of the learning cycle, all of which are interrelated and contribute to the achievement of learning goals. According to Kolb's learning theory, the learning cycle begins with concrete experience (PK), reflective observation (PR), abstract conceptualization (KA), and active experimentation (AE) (PA). The learning cycle that students go through is presented below based on Kolb's theory:

i. To assess the functionality of the sewing tool, students must move from paper to fabric.
ii. Reflective Observation Observe how the instructor uses or handles the material.
iii. Conceptualizing the Abstract - Understand cutting, drawing, marking, and sewing techniques.
iv. Try to actively use your sewing tools on the fabric.

In addition, creating an experience that is easy for students to grasp, as described in Kolb's (1984) model, allows students to have a sense of the experience of the subjects being studied rather than theory or assignments that are simply about sewing fabric. In this study, Kolb's model used in four categories. A flowchart is used to provide structure. This method must be well executed to provide students with real experiences that relate to the topic of the curriculum. Reflective observation includes only teaching and abstract concept formation. It also includes listening to and observing audio and visual conversations in the classroom and in the real world. Finally, a tangible experience is a category of learning methods in which a product presentation is conducted during the last week of Innovation Week so that students can feel their own experience and show how much expertise they have gained in product development. This paradigm can be further discussed as shown below. Kolb's learning approach is a model of experiential learning that has generated interest in a variety of professions, especially those that require hands-on training. This model is described by Kolb (1984) as follows:

Thoughtful, observation-oriented students are more likely to think about the meaning of a fact or idea. Students who use this method of learning will notice and reflect on the meaning of words and situations they have learned.

i. Students who use abstract conceptual approaches can develop hypotheses and concepts based on their findings. Theories are used to research and think in a real-world setting.
ii. Students who participate in active experiments are directly involved in the topics they are exploring. Students work in groups, cooperate, and learn new things about the topics they are exploring.
iii. Students who approach learning through comprehensive experiences participate in activities that provide them with new experiences. They can learn a lot by watching and then doing it themselves to get a sense of the experience they are mastering.
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1.1.2 Human learning theory

The "Cone of Experience" or cone of experience is a theory of human learning that explains how various media influences affect human learning from difficult to easy. Students can benefit from verbal and symbolic media that help them interpret abstract material. The use of modern technology in the classroom can help maximize learning [16]. The impact of various media in teaching and learning can take student understanding from difficult to accessible Dale's Theory [17]. The use of tangible, non-electronic media such as speech, photographs, diagrams, models newspapers, magnetic boards, flannel boards, scan cards, or other materials to engage the senses in the teaching and learning process. Because they engage only a few senses, electronic aids such as educational films, slides, filmstrips, videotapes, radios, audiotapes, recordings, and the Internet are less effective. They differ from learning through direct experiences such as plays, field trips, projects, exhibits, available materials, and other activities that can engage multiple senses simultaneously. Many teachers do not take the initiative to use presentation concepts as teaching tools in their classrooms. Each member of the class has different psychological and intellectual abilities. Consequently, planned instruction must be relevant, organized (the level of students), and supported (with instructional tools) to promote the full development of individual potential.

Consequently, technical teachers need to be smart and creative in their teaching and use more ABM. ABM is helpful in teaching and learning because it can arouse students' interest in learning. Professors often use demonstration methods to teach in workshops, and demonstrations are often repeated because students cannot learn every crucial step [8]. The specified teaching and learning time increase when demonstration methods are repeated. The use of ABM in teacher education is inevitable because these tools can help students refine their senses to learn successfully [18]. Students should be able to expand their conceptual knowledge and actively engage in planned learning activities. Meanwhile, technological innovations in the classroom are predicted to lead to positive changes in students' academic performance [18]. It is claimed that the more senses are used, the more effective learning is, because different sensory inputs elicit different responses [19]. Each sense helps to compensate for the deficiency by enhancing the perception of the other senses. Consequently, a classroom that employs a variety of ABMs can engage a variety of senses and achieve a variety of consequences through direct experiential learning. A kit is a collection of goods or equipment for a specific purpose. In contrast, learning is described as knowledge or skills acquired through experience or the act of learning or teaching [20]. Consequently, a learning package is defined as a collection of learning materials. A learning package may include films, handouts, slides, compact disks, PowerPoint slides, scrapbooks, models, and diagrams, among others [21]. Reddy and Andrade [22] conducted a study to determine the effectiveness of learning sets in increasing student achievement, the product evaluator must confirm the usefulness of the learning sets. Learning sets that are adapted to students' cognitive levels can help them self-learn according to their individual learning needs. One of the tactics used by technology teachers in secondary schools is the use of models or kits as teaching aids in the teaching and learning process.

2. Methodology

This section corresponds to the flow of a product development process followed by a CDIO model, specifically the development of this ATIKs. The information gathered in the first phase is processed into physical sketches. After brainstorming, testing, and screening, the product design emerges from the final sketch agreed upon. Figure 1 show a drawing construction sewing machine for the product and Table 1 is a full description for the ATIKs component and function.

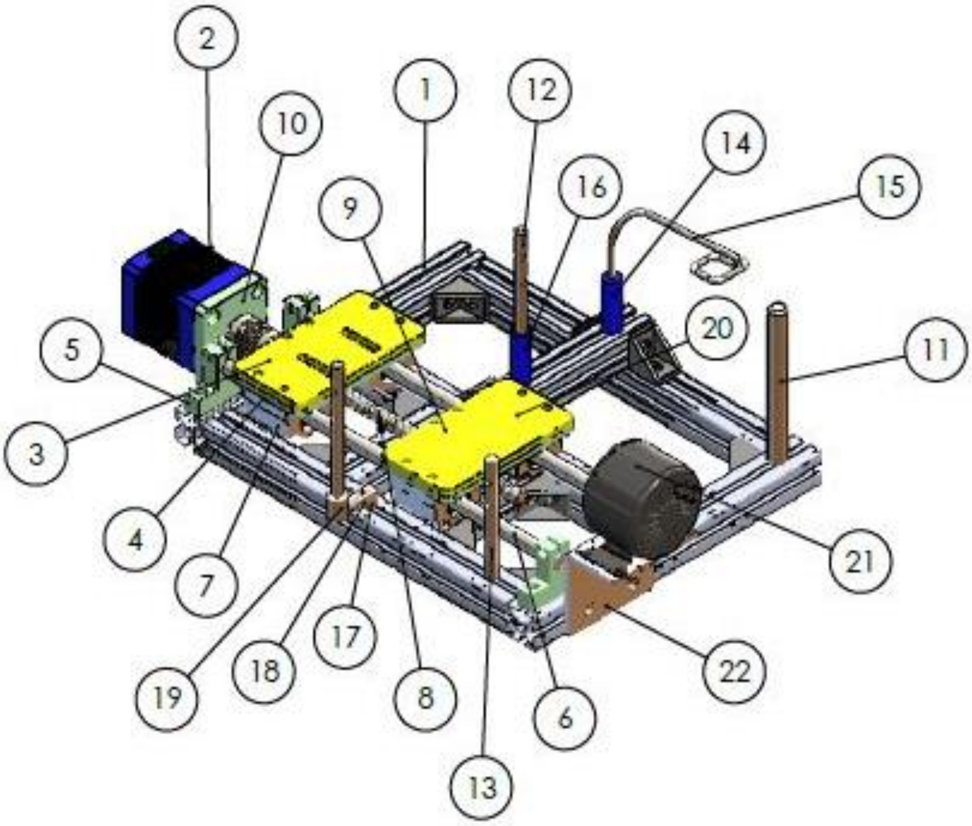

Fig. 1. ATIKs Component and Structural Design Product

Table 1
Parts and Function of ATIKs

No.	Part	Function
1.	Yarn Poles and Threads	Holds the thread tightly
2.	Pillar 1,2,3 and 4	It supports thread passing through it. This pole has a hole as a thread holder for smooth movement.
3.	Aluminium Profile	Aluminium was chosen because the project looks modern and is easy to install.
4.	Stepper motor	To move the led screw forward and backwards automatically using Arduino coding.
5.	Bearings	To control the movement of the led screw and not break the led screw. It can also control movement smoothly.
6.	Shaft T	To hold the smooth rod on the project.
7.	Thread Entry Tool	This tool is designed in the right size to ensure that the needle and thread that passes through it will be accurate.
8.	Thread Puller	This tool uses the existing one but is improved with the idea so that the thread can be inserted easily and clings firmly.
9.	Smooth Rod	This smooth rod is used to support the movement of the shaft accurately.
10.	Led Nuts and Screws	To launch the movement with the existing ring on the rod.
11.	Boats and Boat Holders	To fill the thread and support the thread from moving freely.
12.	DC motors	To move the boat using batteries.
13.	9V battery	To start a dc motor.
14.	Switch	It can be turned on/off and control the movement of the motor.
15.	Arduino UNO R3	For coding activation and connected to model.

2.1 Implement for Operating ATIKs

In this software section, Autodesk AutoCAD and Cura Ultimate (Figure 2), Solidwork and Fritzing (Figure 3) lastly Arduino IDE (Figure 4) are used as tools that facilitate the development of ATIKs according to the stages.

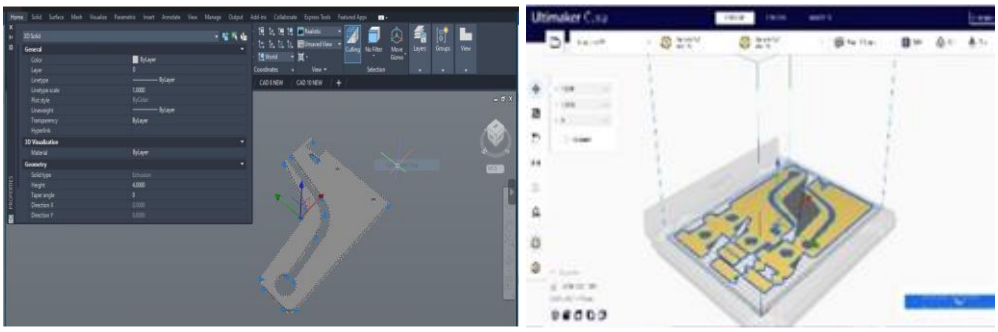

Fig. 2. Autodesk AutoCAD and Cura Ultimaker

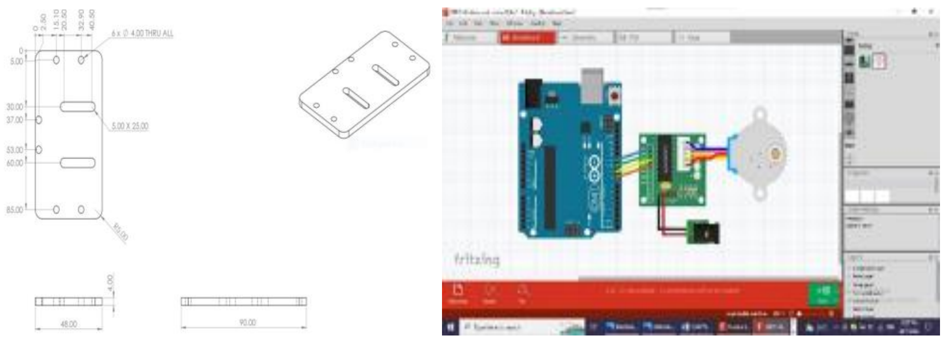

Fig. 3. Solidwork and Fritzing

Fig. 4. Arduino IDE

2.2 Product Development and Materials
2.2.1 List of components

Table 2 and Table 3 provides a list of components used to make a needle threader kit and the ATIKs function. As can be seen from the table, the components for developing an automatic needle threader kit consist of two parts: Software and Hardware. The software is the main component used to build the kit. It uses a special model that is only used for these kits, such as the plate for the threader and the screw, which we customize using 3D printing. Hardware components are parts that can be modified. These components include accessories, service orders, frames, and instrument panels. Due to the availability of components and spare parts in the market, the production of this needle threader kit can be done by small industries or households [23].

Table 2
List of components

Component	Quantity	Size
Arduino Nano	1 Set	18mm × 45mm
A4899	1 Set	8V-35V
Dc Motor	1 Set	3V-12V
Stepper Motor	2	42 × 48mm
SK 8	4	8mm
SK Shaft	4	8mm
Aluminium Profile	7	100 cm
Hardened Linear Shaft	2	8mm
T8 Lead	2	8mm/200mm
Nut	2	8mm
Acrylic	1	297mmX420mm

Table 3
Function of ATIKs

Equipment Name	Function
Hammer	Used to form malleable soft iron. This iron has been reshaped using a hammer.
Measure Tape	Used to measure length accurately.
Player	To hold delicate components and to tighten screws.
Allen Key	Used to press screws and it is easier to use.
Screwdriver Set	Used to change the voltage on the motor driver A4988.
Mikita Jig Saw	Used to cut acrylic.
Cutter Machine	To cut aluminum profile, smooth rod, and screw lead.

2.3 Product Validity and Usability Testing

Once the complete project is developed, the product is tested with electronic functionality that automatically includes movements. Product validity of the practical sewing kit was conducted in a previous study. A questionnaire consisting of 4 statements was used to collect technical and aesthetic data of the kit. In addition, the performance test is conducted through an interview from experts where you provide input and see the results of the movement of the ATIKs via video. Table 4 shows the background of the experts for validation process. In addition, the whole product is tested on users through an Arduino IDE. Since online distance learning was still in progress at the time of this study, the ABM tests were conducted by three ERT teachers watching a video tutorial on the movement of ATIKs.

Table 4
Background of the experts for validation process

Expert	Instituition	Background	Experience
Teacher	Sekolah Menengah Kebangsaan Bakri	Design Technology	8 years
Teacher	Kolej Vokasional Tun Hussein Onn	Fashion Design	11 years
Teacher	Kolej Vokasional Setapak	Fashion Design	15 years

3. Results
3.1 The Technical Analysis and Result

Effective practical learning will help students gain understanding in practical work. Therefore, this section explains the importance of appropriate teaching tools that elicit an interesting response in learning. This ATIKs has been performance tested (Arduino IDE), and usability feedback (Table 5) will be used to determine feasibility and usability in hands-on learning.

3.2 Validity's Feedback

Table 5
Usability feedback to determine feasibility and usability in hands-on learning

No.	Question Items	R1	R2	R3
Determination of Question Codes for Aspects of ABM Requirements in Visualization Skills				
1.	Overall Usability	/		/
2.	Safety		/	/
3.	Simplify the Process	/	/	/
4.	Comfort	/	/	/
5.	Benefit to users	/	/	/
6.	Potential Product Usability	/	/	/
7.	Assisting during Learning Process	/	/	
8.	The needs for Tailors and Public	/	/	
Determination of Question Codes for ABM Development Aspects				
9.	Appropriate in Design	/	/	/
10.	A Neat Product Installation	/	/	/
11.	Knowledge Acquisition	/	/	
12.	Creating Real Applications	/	/	/
13.	Facilitate Movement	/	/	/
14.	Appropriate in Size	/		/
15.	Quality of Materials	/	/	/
16.	Durability of Materials	/	/	/
17.	Products Flexibility	/	/	/

18.	Usefulness	/	/	/
Determination of Question Codes for Aspects of ABM Testing				
19.	Operation System (Handling)	/	/	/
20.	Functionality	/	/	
21.	Systematic Movement	/	/	/
22.	Marketable	/	/	/
23.	Attracting User Interest	/	/	/
Determination of Question Codes for Product Usability/Functionality Aspects				
24.	Model Diversity	/	/	/
25.	Finishing Improvement	/	/	/
26.	Material Selection	/	/	/
27.	Portable in Size	/	/	/
28.	Cost	/	/	/
29.	Ergonomic Factor	/	/	/
30.	Solve Major Problem (Thread Assembly)	/	/	/
31.	Weight Reduce	/	/	/
32.	Avoid Injury (Safety)	/		/
33.	Attract users (Students)	/	/	
34.	Multifunction	/	/	/
35.	Long-term Product		/	/
36.	Modern tools/products	/	/	/

4. Conclusions

This paper presents a method for developing laboratory devices for low-cost and portable automated functions. In addition, the use of ATIKs as teaching tools in hands-on classes will help students to be more attentive and concentrate better than in classes using only a blackboard and transparencies. In addition, the built-in design of the developed ATIKs is exciting and can make students continue to learn and arouse their interest in learning topics related to theoretical learning, and they should imagine the sewing machines. On the other hand, in the context of the suitability of the product for the learning topic, the simple ATIKs are good because the product is easy to carry and suitable for use in classrooms or workshops. The reason is that the product contains many kinds of important learning content that can improve students' understanding of how to use the sewing machine. The ATIKs can simulate the process of sewing machine during practical teaching, which is related to daily phenomena in various households and industries. Therefore, when students practice with the ATIKs, they can strengthen their fashion design skills and competencies, which is in line with in his study, "teaching tools are used to enhance learning, promote higher order thinking and problem-solving ability.

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References

[1] Yuan, Philip F., Hua Chai, Chao Yan, and Neil Leach. *Proceedings of the 2021 DigitalFUTURES: The 3rd International Conference on Computational Design and Robotic Fabrication (CDRF 2021)*. Springer Nature, 2022. https://doi.org/10.1007/978-981-16-5983-6

[2] Eladly, Amira Mohamed, Mohamed Gaber Abou-Ali, Aida Mohamed Sheta, and Sherwet Hussein EL-Ghlomy. "A flexible ergonomic redesign of the sewing machine workstation." *Research Journal of Textile and Apparel* 24, no. 3 (2020): 245-265. https://doi.org/10.1108/RJTA-10-2019-0050

[3] Kiong, Tee Tze, Alvy Wendyline Florentius, Mariam Abu, Dalilah Mohd Rubi, Suriani Mohamed, Yee Mei Heong, and Mimi Mohaffyza Mohamad. "Tahap penguasaan teori dan amali dalam kalangan pelajar ekonomi rumah tangga: Kajian persepsi di universiti awam (Malaysia Theoretical and practical command of Malaysia's home economics students: A perception study from a public university)." *Malaysian Journal of Society and Space* 12, no. 3 (2016): 79-87.

[4] Saim, Aishah, Saharuddin Talib, and Ibrahim Burhan. "The Effectiveness of the Electro-Pneumatic Trainer Embedded with PIC and Visual Basic Platform for Educational Purposes." *Asian Journal of Vocational Education And Humanities* 2, no. 2 (2021): 1-7. https://doi.org/10.53797/ajvah.v2i2.1.2021

[5] Fauzi, Muhammad, Amir Hasan, and Vera Oktari. "Determinan Auditor Switching Pada Perusahaan Finance Yang Terdaftar Di BEI." *Jurnal Kajian Akuntansi dan Bisnis Terkini, Fakultas Ekonomi Dan Bisnis, Universitas Riau, Pekanbaru* 1, no. 1 (2020): 89-105. https://doi.org/10.31258/jc.1.1.89-105

[6] Ismail, Zawawi, Ab Halim Tamuri, N. M. R. N. Yusoff, and Mohd Ala-Uddin Othman. "Teknik pengajaran kemahiran bertutur bahasa arab di SMKA di Malaysia." *GEMA Online® Journal of Language Studies* 11, no. 2 (2011): 67-82.

[7] Nashir, Irdayanti Mat, Ainall Yaqeen Darina Zainal, and Aishah Sulaiman. "Pembangunan Modul Multimedia Interaktif bagi Pembelajaran Sains Rumah Tangga Sekolah Menengah Harian di Malaysia." *Asian Pendidikan* 2, no. 1 (2022): 8-17.

[8] Azman, Mohamed Nor Azhari, Nur Amierah Azli, Ramlee Mustapha, Balamuralithara Balakrishnan, and Nor Kalsum Mohd Isa. "Penggunaan alat bantu mengajar ke atas guru pelatih bagi topik kerja kayu, paip dan logam." *Sains Humanika* 3, no. 1 (2014): 77-85.

[9] Mehta, Nirav J., Ketan Jani, and Ijaz A. Khan. "Clinical usefulness and prognostic value of elevated cardiac troponin I levels in acute pulmonary embolism." *American Heart Journal* 145, no. 5 (2003): 821-825. https://doi.org/10.1016/S0002-8703(02)94704-6

[10] Susilo, Tri. "Aplikasi Gugus Kendali Mutu (Quality Control Circle) Dengan Menggunakan Deming Prize Untuk Mengendalikan Dan Meningkatkan Mutu Produk Di Koperasi Intako." *Tekmapro: Journal of Industrial Engineering and Management* 2, no. 1 (2012).

[11] Uemuraa, Kaito, Takumi Sasakia, and Yuhki Kitazonoa. "Improvement of the Movement Speed of Tying Fishing Line Automatically." In *Proceedings of the 8th IIAE International Conference on Industrial Application Engineering*, pp. 56-60. 2020. https://doi.org/10.12792/iciae2020.013

[12] Fiet, James O. "The pedagogical side of entrepreneurship theory." *Journal of Business Venturing* 16, no. 2 (2001): 101-117. https://doi.org/10.1016/S0883-9026(99)00042-7

[13] Koskinen, Anniina, Pirita Seitamaa-Hakkarainen, and Kai Hakkarainen. "Interaction and embodiment in craft teaching." *Techne Series: Research in Sloyd Education and Craft Science A* (2015).

[14] Schwichow, Martin, Corinne Zimmerman, Steve Croker, and Hendrik Härtig. "What students learn from hands-on activities." *Journal of Research in Science Teaching* 53, no. 7 (2016): 980-1002. https://doi.org/10.1002/tea.21320

[15] Chan, Cecilia Ka Yuk. "Exploring an experiential learning project through Kolb's Learning Theory using a qualitative research method." *European Journal of Engineering Education* 37, no. 4 (2012): 405-415. https://doi.org/10.1080/03043797.2012.706596

[16] Subramony, Deepak Prem, Michael Molenda, Anthony K. Betrus, and Will Thalheimer. "The mythical retention chart and the corruption of Dale's cone of experience." *Educational Technology* (2014): 6-16.

[17] Yunus, Jailani Md, Maizam Alias, Marina Ibrahim Mukhtar, Lee Ming Foong, Tee Tze Kiong, Siti Nur Kamariah Rubani, Faizal Amin Nur Yunus, Hashima Hamid, Junita Sulaiman, and Sri Sumarwati. "Validity of vocational pedagogy constructs using the rasch measurement model." *Journal of Technical Education and Training* 9, no. 2 (2017).

[18] Aji, Sudi Dul, Muhammad Nur Hudha, Choirul Huda, Asep Bayu Dani Nandiyanto, and Ade Gafar Abdullah. "The improvement of learning effectiveness in the lesson study by using e-rubric." *Journal of Engineering Science and Technology* 13, no. 5 (2018): 1181-1189.

[19] Gorschek, Tony, Per Garre, Stig Larsson, and Claes Wohlin. "A model for technology transfer in practice." *IEEE Software* 23, no. 6 (2006): 88-95. https://doi.org/10.1109/MS.2006.147

[20] Chao, Chih-Yang, Yuan-Tai Chen, and Kuei-Yu Chuang. "Exploring students' learning attitude and achievement in flipped learning supported computer aided design curriculum: A study in high school engineering education." *Computer Applications in Engineering Education* 23, no. 4 (2015): 514-526. https://doi.org/10.1002/cae.21622

[21] Coil, David, Mary Pat Wenderoth, Matthew Cunningham, and Clarissa Dirks. "Teaching the process of science: faculty perceptions and an effective methodology." *CBE-Life Sciences Education* 9, no. 4 (2010): 524-535. https://doi.org/10.1187/cbe.10-01-0005

[22] Reddy, Y. Malini, and Heidi Andrade. "A review of rubric use in higher education." *Assessment & Evaluation in Higher Education* 35, no. 4 (2010): 435-448. https://doi.org/10.1080/02602930902862859

[23] Abdullah, Raja Nazim, Junaidah Abdul Muait, and Ganefri Ganefri. "Students' perception towards modern technology as teaching Aids." *Asian Journal of Assessment in Teaching and Learning* 9, no. 2 (2019): 37-42. https://doi.org/10.37134/ajatel.vol9.no2.5.2019