Development of Arduino Assisted Microcontroller Instructional Devices in Vocational High Schools

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Abstract. This development research aims to find out: (1) feasibility, (2) functioning, and (3) the effectiveness of the arduino-assisted microcontroller assisted devices with the arduino simulator Xevro version 1.5 as a learning media for the material programming of microcontroller programming skills in Mechatronics Engineering at the Vocational High School. The subjects of this study were the XI grade students of the Mechatronics Engineering expertise program at vocational high schools N 1 Bawang Banjarnegara and Leonardo Klaten Vocational High School. The results of this study are an Arduino-assisted microcontroller simulation for microcontroller programming material. The results of the feasibility assessment of the Arduino-assisted microcontroller simulation according to the validator are 83.33 so that it is categorized as "Very Worthy" and according to students is 70.98 of a scale of 100 so that it is categorized as "Eligible". The results of the assessment of the function of Arduino-assisted microcontroller simulations according to the validator are 82.92 so that it is categorized as "Very Worthy" and according to students is 71.55 of a scale of 100 so it is categorized as "Eligible". This Arduino-assisted microcontroller simulation has an effective impact, because the significance value when tested using the t test is $t_{count} = 11.075 > t_{table} = 1.983$ and Asymp. Sig (2-tailed) <0.05. The level of effectiveness can be seen from the magnitude of the gain value.

1. Introduction
Improving the quality of vocational education can be done by sharpening the cognitive abilities and skills of students in line with the growing work competency needs. Work competency is a basic characteristic possessed by someone who indicates how to think and act for various situations and for a long period of time [1].

Vocational education [2] is a form of education that is equivalent to high school but historically, vocational education has focused on work preparation and can be defined as courses and educational programs offered at less than baccalaureate level.

Vocational education has a variety of objectives. [3] states that the purpose of vocational education is to focus on (a) informing someone about job selection; (b) individual initial preparation for work life;
(c) developing one's competencies to face the world of work; and (d) educational experience as an effort to adapt someone to the world of work. The selection of majors is based on students' choices, students' skills in utilizing the choices they already have, and students' skills whether their chosen competencies are in line with opportunities in the future [4].

The success of vocational education can be assessed from four aspects, namely the number of students, infrastructure and teaching staff, curriculum, and graduate results [5]. Vocational education begins to provide training for skilled workers and teachers try to find ways to engage students in classrooms and laboratories so students can be skilled when working in the industry [6].

Great vocational teachers are dedicated, great facilitators, learning leaders, great communicators, motivators, positive thinkers, creative problem solvers capable of utilizing ICT, respecting students, caring for students, being able to identify the needs of students, listeners and pedagogically very competent in developing various teaching and learning methods [7].

Learning media is everything that is used to channel messages and can stimulate thoughts, feelings, attention, and willingness to learn so that it can encourage the occurrence of a deliberate, purposeful and controlled learning process [8]. The criteria for media selection according to [9, 10] are as follows: the accuracy of the teaching objectives; support for the content of study material; ease of obtaining media; teacher skills in using it; available time to use it; and in accordance with the level of thinking of students. Simulation is an imitation of the operation of real-world processes or systems over time [11]. Anderson [12], real objects or model objects that are very similar to real objects, will provide a very important stimulus for students in learning tasks that involve psychomotor skills. Simulator is included in the context of M-learning with a new concept and contains content that is easy to use, and does not involve the location where the learner does it [13-14]. Simulation of industrial multi-process control as a medium or means of practice has good performance in the use of learning in class [15]. Digital simulations include teaching how to use information, communication and technology that is very much needed in the world of work. Skills include digital information management through processing software in the form of data, numbers and presentations [16].

Based on the description previously explained, the formulation of the problem in this study is how the feasibility, functioning and effectiveness of the arduino-assisted microcontroller assisted with Xevro simulator version 1.5 which is equipped with material modules on the competence of Mechatronics expertise in vocational high schools.

2. Research Method

Learning material module Arduino assisted microcontroller was developed using the ADDIE model developed by Lee and Owens (2004). The ADDIE development model is a learning media product development model which consists of four stages, namely (1) needs analysis and assessment (needs assessment and analysis), (2) design (design), (3) development and implementation, and (4) evaluation (evaluation). Programming media simulations (simulators) in this study was developed using the waterfall method developed by Pressmann (2012). Waterfall method consists of: (1) system / information engineering and modeling; (2) software requirements analysis; (3) design; (4) coding; (5) testing; and (6) maintenance.

Needs analysis is the stage of gathering information to find out the gap between reality and ideality. Needs analysis consists of two stages, namely needs assessment and front-end analysis Arduino-assisted microcontroller products consist of two types of media, namely media objects (simulation) and print media (Arduino assisted Microcontroller material modules).

Testing is done in 2 vocational schools with mechatronics expertise competency with 3 stages, namely (a) black box testing to test portability and functionality, (b) material and media validation testing by experts, (c) testing is limited to 2 classes of competency student classes mechatronics expertise at vocational high schools N 1 Bawang and vocational high schools Leonardo.
3. Results and Discussion
This study analyzes the feasibility of an Arduino-assisted microcontractor system instructional device as a result of the development of instructional devices. The function of Arduino simulation is done by black box testing. The trial consists of two dimensions, namely portability and functionality. The results of the black box test can be seen in Table 1 below.

| Respondent | Portability | Functionality | Category |
|------------|-------------|---------------|----------|
| 1          | 100         | 100           | Eligible |
| 2          | 100         | 100           | Eligible |
| 3          | 100         | 100           | Eligible |
| Average    | 100         | 100           | Eligible |

Table 1 presents the feasibility of an Arduino-assisted microcontractor system instructional device to be used in Vocational Schools. The feasibility of this Arduino-assisted microcontractor system instructional device was developed from the point of view of the substance aspects of the material and the design of learning.

The aspects developed based on functionality are assessed from aspects of functionality, portability, usability and layout. Rating scales from 1 to 4 are applied in the questionnaire statement, the scores obtained from the next questionnaire are changed to a scale of 1 to 100 for determining the assessment category. Table 2 shows the results of the assessment of the function of the Arduino-assisted microcontroller system.

| No. | Respondent | F Val | Catg. | P Val | Catg. | U Val | Catg. | LA Val | Catg. | Average Total Val | Category |
|-----|------------|-------|-------|-------|-------|-------|-------|--------|-------|------------------|----------|
| 1   | Expert 1   | 75    | L     | 75    | L     | 75    | L     | 78.57   | L     | 83.9             | SL       |
| 2   | Expert 2   | 79.17 | SL    | 83.3  | SL    | 83.3  | SL    | 82.14   | SL    | 82               | SL       |
| 3   | Expert 3   | 87.5  | SL    | 91.7  | SL    | 79.17 | SL    | 89.28   | L     | 87               | SL       |
| 4   | Expert 4   | 83.33 | L     | 91.7  | SL    | 79.17 | SL    | 89.28   | SL    | 86               | SL       |
| 5   | Expert 5   | 91.67 | L     | 83.3  | SL    | 87.5  | SL    | 89.28   | L     | 88               | SL       |
| 6   | Expert 6   | 83.33 | L     | 75    | L     | 75    | L     | 85.71   | SL    | 80               | SL       |
| 7   | Expert 7   | 87.5  | L     | 91.7  | SL    | 83.3  | SL    | 85.71   | L     | 87               | SL       |
| 8   | Expert 8   | 79.17 | SL    | 79.2  | SL    | 75    | L     | 78.57   | L     | 78               | SL       |
| Average |          | 83.33 | SL    | 83.9  | SL    | 79.69 | SL    | 84.82   | SL    | 83               | SL       |

L: Eligible, SL: Very Eligible

Student learning outcomes from cognitive aspects between before and after operating the Arduino simulation are used as a reference in terms of the effectiveness of Arduino-assisted microcontroller instructional devices with simulations developed.
Furthermore, the assessment of the microcontroller instructional system media to the user in this case is the VOCATIONAL HIGH SCHOOLS students. The results of the student response assessment consisted of two aspects of assessment, namely the feasibility and functioning aspects of the instructional system of the microcontroller assisted by Arduino simulation.

4. Conclusion
First, the results of testing instructional devices Arduino-assisted microcontrollers found that Arduino simulations have feasibility and functionality in the "Eligible" category. Second, instructional devices Arduino-assisted microcontrollers can be used in learning because the display is acceptable (interesting), the operation is considered easy, and has a stable performance in practicum, complete material, easy to understand, coherent from simple to complex, this shows Arduino simulation is very useful in facilitating the learning process (for teachers and students), because it can motivate and improve student learning outcomes. Third, the effectiveness of Arduino simulations of microcontroller subjects between the posttest mean values of the pretest mean was declared effective, because the value of $t_{hitung} = 11.075 > t_{table} = 1.983$ and Asymp. Sig (2-tailed) <0.05. This shows that the use of Arduino-assisted Microcontroller simulation has significant effectiveness on increasing the value of student learning outcomes.

5. References
[1] Spencer, Lyle & Signe M. Spencer. 1993. Competence at Work, Models For Superior Performance. Canada : John Wiley & Sons, Inc.
[2] Zirkle, Chris. (1998). Perception of Vocational Educators And Human Resource/ Training and Development Profesionals Regarding Skills Dimension of School to Work transsitin Programs. Journal of Vocational and Technical Education, Vol 15, 1, 4.
[3] Billet. S. (2011). Vocational Education: Purpose, Traditions and Prospect. New York: Spinger.
[4] Gough, S. (2009). TVET as Sustainable Investment. Technical and Vocational Education and Training: Issues, Concerns and Prospects. Journal Vocational, Vol.8, 107-116. doi: 10.1007/978-1-4020-8194-1
[5] Guo, Z. & Lamb, S. (2010). International Comparisons of China’s Technical and Vocational Education and Training System. New York: Springer
[6] Zirkle, C. & Martin, L. (2012). The Future of Vocational Education and Training in a Changing World. New York: Springer
[7] Lucas, B. (2014). Vocational Pedagogy: What It Is, Why It Matters and How to Put It into Practice. Report of UNESCO-UNEVOC Virtual Conference, 12-26 Mei 2014. Retrieved from www.unevoc.unesco.org.
[8] Miarsro, Yusufhadi. (2009). Menyemai Benih Teknologi Pendidikan. Jakarta: Kencana Prenada media Group.
[9] Sudjana, N. (2016). Penilaian Hasil Proses Belajar Mengajar. Bandung: Remaja Rosdakarya.
[10] Khairudin M., Triatmaja A.K., Istanto W.J., Azman M.N.A., (2018). Mobile Virtual Reality to Develop a Virtual Laboratorium for the Subject of Digital Enggineering. International Journal of Interactive Mobile Technologies. Vol 13, No 04 (2019)
[11] Banks, J., Nelson, B. L. (2004). Discrete-Event System Simulation. New York: Prentice Hall
[12] Anderson, L.W dan Krathwohl, D.R. 2010. Kerangka Landasan untuk Pembelajaran, Pengajaran dan Asesmen (Revisi Taksonomi Pendidikan Bloom). Yogyakarta: Pustaka Pelajar.
[13] Hulme, A.K dan Traxler, John. (2005). Mobile Learning, A Handbook for Educators and Trainers. USA: Routledge.
[14] Triatmaja, A. K. & Khairudin, M. (2018). Study on Skill Improvement of Digital Electronics Using Virtual Laboratorium With Mobile Virtual Reality. Journal of Physics: Conference Series. Vol. 1140, DOI: 10.1088/1742-6596/1140/1/012021

[15] Sukir. (2010). Simulasi pengendalian multiproses industri dengan Programmable logic controller sebagai sarana dan bahan ajar praktik instalasi listrik. Jurnal Pendidikan Teknologi dan Kejuruan. Vol 19, No.1, Mei 2010, pp. 81-104.

[16] R.W Komang & M.M Abubakar, (2018). The Usage Effectivity Of Project Based Interactive E-Module In Improving Students’ Achievement. Jurnal Pendidikan Teknologi dan Kejuruan, Vol. 24, No. 2, October 2018, 198-202