Meta Analysis: The Effectiveness of Learning Media Based on Virtual Simulation in Technical Vocational Education

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ABSTRACT
This study's objective is to discuss the effectiveness of digital simulation-based learning media in vocational training engineering. This study uses a meta-evaluation technique with secondary statistical types. Data received from both the main and control groups from articles using digital simulation learning media. A total of 27 studies have been dissected and the data obtained have been calculated using the impact size (ES) formula. The calculation results show that digital simulation-based learning media has a high impact on learning outcomes in vocational training. Therefore, digital simulation-based learning media can be very effective and suitable to be used in the technical training process in vocational education.

Keywords: Learning Media Based on Virtual Simulation, Technical Vocational Education, Meta Analysis.

1. INTRODUCTION

Education is the right investment for a better life. With the existing potential education will be converted into competencies that will save from problems [1]. This potential change occurs with the learning process which is generally carried out in educational institutions in the form of schools or colleges [2]. One of them is a vocational education institution. Vocational education is education that prepares students to have the ability to work in the world of work and entrepreneurship, both from secondary education and higher education graduates [3]. Vocational education has many fields, one of which is engineering. Vocational schooling in engineering is ready with engineering engineering within the discipline of technology, which of direction objectives to supply graduates who are geared up to work in the field of work and entrepreneurship. For that we need an effective learning process in achieving this goal. In implementing effective learning, it is necessary to support effective learning media as well [5]. This is because effective learning media will determine whether or not learning information is conveyed properly to students which will later affect the learning outcomes of students [6]. Effective learning media will also be able to facilitate independent learning, so that student-centered learning will be carried out. Learning media that support independent teaching at least have low abstraction, high mobility and strong independence [7]. For the abstraction of studying media, it could be primarily based totally on the subsequent cone of Edgar Dale's experience.

![Figure 1. The Cone of Edgar Dale's Experience [5]](image)

In the cone of Edgar Dale's experience, student knowledge can be increasingly more precise if analyzing uses verbal language, simply so later it will cause versions in perceptions amongst university college students and educators. Knowledge will be more concrete if learning...
uses media that provides direct experience in learning, because it involves all human senses [5]. Meanwhile, the mobility of learning media can take advantage of computer or smartphone technology which can be used anywhere and anytime [8].

The independence of a media may be visible from the dependence of the mastering media on different media. As nicely as mastering media that actually need sensible gear and substances of their use [7]. So this makes independent learning outside the laboratory difficult to implement, even though vocational education has a larger portion of practical learning than theoretical learning [9]. For this reason, it is necessary to use learning media that can accommodate these needs so that failures during the practical process can be minimized.

The learning media that is most appropriate to accommodate these problems is virtual simulation-based learning media. Virtual simulation learning media is a learning media capable of displaying a physical model of an object or phenomenon from a macro to micro scale that cannot be presented in a real learning room or using physical props [10], [11]. The examples of the shape of studying media primarily based totally on digital simulation media are as follows.

**Figure 2. Simulation Virtual Learning Media [12]**

Simulation learning media is included in learning media that has low material abstraction because it provides direct experience, so it can improve students' conceptual understanding and minimize misconceptions. Virtual desktop-based learning media is also able to present practical tools and materials in 3D virtual objects in real time, so that the problem of the weakness of the independence of learning media can be overcome [7], [11]. In mobility, virtual simulation learning media can take advantage of smartphone or computer technology that is capable of running virtual simulation application software technology that can be used anytime and anywhere.

The benefits of digital simulation getting to know media are broadly utilized by the network of vocational schooling establishments within the getting to know process. The use of this simulation getting to know media further to presenting impartial getting to know facilities, is likewise capable of lessen the failure charge of practicum via way of means of presenting a discussion board for college kids to strive getting to know substances earlier than training with inside the laboratory. For this reason, this study will discuss the effectiveness of virtual simulation learning media in technical and engineering vocational education at various concentrations.

### 2. METHOD

The studies technique used on this studies is the meta-evaluation technique. In this meta-evaluation the statistics used are secondary statistics. Secondary statistics on this have a look at got here from the post-check rankings of the experimental and manipulate instructions in technical vocational training articles the usage of digital simulation studying media.

The research articles used come from national and international journals from 2016 to 2020. The number of research articles used is 27 articles from research on various concentrations of technical vocational education that are scattered in various Vocational High Schools in the world. Then the data that has been obtained is calculated using the effect size formula. The impact length system is as follows.

\[
ES = \frac{M_e - M_c}{SD}
\]

Information:
- **ES** = Value effect size
- **M_e** = Mean price of the experimental class
- **M_c** = Mean price of control class
- **SD** = Value of pooled fashionable deviation

Furthermore, to obtain the pooled standard deviation value, it can be calculated using the SD pooled formula. The SD pooled formula follows.

\[
SD_{pooled} = \sqrt{\frac{(N_e - 1)SD_e^2 + (N_c - 1)SD_c^2}{N_e + N_c - 2}}
\]

Information:
- **SD pooled** = Value pooled standard deviation
- **N_e** = The range of college students within the experimental class
- **N_c** = The wide variety of college students within the manage class
- **SD_e** = The standard deviation value for experimental class
- **SD_c** = The standard deviation value for control class
After the pooled SD fee is obtained, then the imply fee of the experimental magnificence values is decreased with the aid of using the common manipulate fee, then divided with the aid of using the same old deviation. The calculation results will get a value, which is then interpreted by the effect size category table, which later on based on the results of this interpretation the effect category of a treatment is obtained. In this case the treatment is the application of virtual simulation-based learning media in technical vocational education.

Table 1. Effect Size Criteria

| Effect Size | Information       |
|-------------|-------------------|
| 0.00 – 0.20 | Has a weak effect |
| 0.21 – 0.50 | Has a low effect  |

Table 2. Meta Analysis Data

| Author                    | Year | Title                                                                 | Simulator Application | Majors                                      | Post Test |
|---------------------------|------|-----------------------------------------------------------------------|-----------------------|---------------------------------------------|-----------|
| Rifatuz Zainiah, Tri Rijanto | 2016 | Pengembangan Media Pembelajaran Berbasis Animasi Dan Simulasi Untuk Meningkatkan Hasil Belajar Siswa Pada Mapel Instalasi Penerangan Listrik di SMKN 1 Sidoarjo, [14] | Macromedia Flash | Electrical Power Installation Engineering | 81.5      |
| Mira Juwita Eva Distyasa | 2016 | Pengembangan Media Pembelajaran Berbasis Simulasi Pada Mata Pelajaran Perakitan Komputer Untuk Siswa Kelas X di SMK N 3 Surabaya, [15] | Flash CS6 | Computer and Network Engineering | 80.0      |
| Reza Setiawan, Rahmat Hidayat | 2016 | Penerapan Multimedia Interaktif (MMI) Model Simulasi Pada Mata Pelajaran Perakitan Komputer Untuk Siswa Kelas X di SMK N 3 Surabaya, [15] | Multimedia Interaktif (MMI) | Mechanica l Engineering | 88.0      |
| Chita Riska Handini, Euis Ismayati | 2016 | Pengembangan Media Pembelajaran Interaktif Courselab Dengan Menggunakan Model Pembelajaran Kooperatif Tipe Snowball Throwing Pada Mata Pelajaran Teknik Elektronika Dasar di SMK Negeri 7 Surabaya, [17] | Courselab | Audio Video Engineering | 70.0      |
| Yoyo Zakaria              | 2016 | Peningkatan Hasil Belajar Siswa Pada Mata Pelajaran Perakitan Pedengan Menggunakan Simulasi Perakitan PC (Aplikasi Cisco Essential Dekstop Versi 4.0) di SMK Muhamadiyah 2 Kuningan, [18] | Cisco Essential Dekstop | Computer and Network Engineering | 70.1      |
| Adrian Y P Wijaya, Setya Chendra Wibawa | 2017 | Pengembangan Media Pembelajaran Jaringan Komputer Berbasis Android Untuk Meningkatkan Hasil Belajar Siswa di SMK Antartika Surabaya, [19] | Android | Computer and Network Engineering | 82.0      |
| Taufiq Pandu Ampriliambudi, Bambang Sujatmiko | 2017 | Modul Pembelajaran Virtual LAN Pada Cisco Packet Tracer Untuk Meningkatkan Kompetensi Psikomotorik Siswa di SMK | Cisco Packet Tracer | Computer and Network | 76.8      |

3. RESULTS AND DISCUSSION

After conducting a review on 27 research articles using virtual simulation learning media in technical vocational education, post-test results were obtained. Post-test data came from each control class and experimental class in the Research and Development (R&D) study. The data obtained came from research spanning 2016 to 2020 with various fields of vocational engineering expertise. The data set is presented in table 2.
| Author                        | Year | Title                                                                 | Simulator Application                      | Majors                         | Post Test |
|------------------------------|------|----------------------------------------------------------------------|--------------------------------------------|--------------------------------|-----------|
|                              |      |                                                                      |                                            |                                | Eks       | Con       |
| YPM 1 Taman, [20]            |      |                                                                      |                                            |                                |           |           |
| Mukhamad Syaifullah, Meini Sondang Sumbawati | 2017 | Pengembangan E-Modul Berbantuan Simulator Sebagai Media Pembelajaran Pemrograman Web Kelas X Rekayasa Perangkat Lunak SMKN 1 Surabaya, [21] | CMS Wordpress LearnPress              | Software Engineering            | 73.3      | 80.3      |
| Kevin Patria Kusuma, Rina Harimurti | 2017 | Penerapan Modul Penggunaan Fitur Activity Wizard Pada Cisco Packet Tracer Sebagai Media Evaluasi Pembelajaran Pada Mata Pelajaran Rancang Bangun Jaringan, [22] | Cisco Packet Tracer                     | Computer and Network Engineering | 81.8      | 77.3      |
| Sapto Haryoko, Hendra Jaya | 2018 | The Implementation of LAVIR Networking Model at Vocational School (Efforts To Foster Students’ Learning Responses Through Visual Literacy), [23] | GNS 3 and Oracle Virtual Box              | Computer and Network Engineering | 88.0      | 79.0      |
| Purnawan, D Rohendi, Wardaya, N Darsono | 2018 | The Effectiveness of Simulator as Pneumatic Control System Learning Media, [24] | Fluid SIM-P                               | Electrical Power Installation Engineering | 66.4      | 66.0      |
| Nurdianah, H Hanafi, Nina Ikhwati Wahidah | 2018 | The Implementation Of Virtual Machine Simulation Methods On Learning The Operation System Installation In State Vocational High School 5 Makassar, [25] | VirtualBox                               | Computer and Network Engineering | 87.1      | 65.3      |
| T U Nugroho and T Sukardi | 2018 | Developing project based learning module of CNC milling mechanical technique on mechanical engineering department vocational high schools in Surakarta,[26] | Computer Aided Manufacturing (CAM)        | Mechanical Engineering          | 84.0      | 81.1      |
| Ardyoyo Nofriansyah, Totok Heru Tri Maryadi | 2018 | Efektivitas Penggunaan Software Simulasi Fluidsim Terhadap Prestasi Belajar Siswa Pada Kompetensi Menerapkan Macam-Macam Sistem Kontrol di SMK N 3 Yogyakarta, [27] | Fluidsim                                | Mechanical Technology            | 85.0      | 74.0      |
| M. Akmal Hidayat, Muh. Yahya, R T Mangesa | 2018 | Efektivitas Penggunaan Media Pembelajaran Berbasis Cisco IT Essential Untuk Meningkatkan Hasil Belajar Perakitan Komputer di SMK, [28] | Cisco IT Essential                      | Computer and Network Engineering | 77.4      | 66.5      |
| Fengki Wijatmiko, Firman Yasa Utama | 2018 | Pengaruh Penggunaan Simulasi Mach 3 Turn Terhadap Hasil Belajar Siswa Pada Mata Pelajaran CNC (Computer Numerically Controlled) Kels XII Teknik Pemesinan di SMK Negeri 2 Surabaya, [29] | Mach 3 Turn                            | Mechanical Engineering          | 82.8      | 70.0      |
| Arya Putra                  | 2018 | Penerapan Modul Berbasis Web                                         | Cisco IT                                  | Computer                      | 79.8      | 76.0      |
| Author                                      | Year | Title                                                                 | Simulator Application | Majors                                                                 | Post Test |
|---------------------------------------------|------|----------------------------------------------------------------------|-----------------------|------------------------------------------------------------------------|-----------|
| Kusumawardana, Meini Sondang Sumbawati      |      | Berbantuan Cisco IT Essentials Virtual Dekstop Pada Mata Pelajaran Komputer Dan Jaringan Dasar di SMK Negeri 3 Buduran Sidoarjo, [30] | Essentials            | Computer and Network Engineering                                        |           |
| Muhammad Habibullah, Ekokohariadi          | 2019 | Pemanfaatan GNS3 Untuk Meningkatkan Hasil Belajar Pada Mata Pelajaran Merancang Bangun Dan Menganalisa Wide Area Network di SMK Negeri 1 Sidayu Gresik, [31] | GNS3                 | Computer and Network Engineering                                        | 76.4      |
| Marsiska Ariesta Putri, Iwan Setiawan W     | 2019 | Penerapan Model Simulasi Oracle Virtualbox Pada Kompetensi Sistem Operasi di SMK Hidayah Semarang, [32] | Oracle Virtualbox     | Computer and Network Engineering                                        | 71.8      |
| Fitri Eka Setia, Putra Jaya                 | 2019 | Pengaruh Penggunaan Media Simulasi Jaringan Cisco Packet Tracer Terhadap Hasil Belajar Siswa, [33] | Cisco Packet Tracer   | Computer and Network Engineering                                        | 93.5      |
| Aang Sahrial Islam, Ekokohariadi            | 2019 | Pemanfaatan Aplikasi Cisco Packet Tracer Untuk Meningkatkan Kemampuan Pada Mata Pelajaran Administrasi Infrastruktur Jaringan Berbantuan Modul di SMKN 1 Sidayu Gresik, [34] | Cisco Packet Tracer   | Computer and Network Engineering                                        | 81.8      |
| Agustinus L Suban, Imelda D Reja, Helena Y Monika | 2019 | Optimalisasi Pemahaman Materi Rangkaian Logika Menggunakan Metode Direct Instruction dan Perangkat Bantu Simulasi Circuit Wizard, [35] | Circuit Wizard        | Software Engineering                                                   | 77.2      |
| Habib Satria, Andri Basir                   | 2020 | Implementasi Media Interaktif Berbasis Macro Mediaflash pada Mata Pelajaran Sistem Pengendali Elektromagnetik, [36] | Macro Mediaflash      | Electrical Power Installation Engineering                               | 85.0      |
| S C Wibawa, D S Megsari, M Mashudi, M Sahlan, A Kristanto, V K Dewi | 2019 | Camera DSLR Animation Media As Learning Toolbase, [37] | Adobe Flash           | Audio Video Engineering                                                 | 81.8      |
| Ruzi Diatul Amri, Almasri                   | 2020 | Komparasi Penggunaan Media Simulasi Proteus dan Media Simulasi Multisim Pada Mata Pelajaran Dasar Listrik dan Elektronika Siswa Kelas X Teknik Mekatronika SMKN 1 Sumatera Barat, [38] | Proteus               | Electrical Power Installation Engineering                               | 86.5      |
| I Kustiawan, T Hariyadi, M Aldhi, and D R Nurjannah | 2020 | Improving Learning Outcomes on the Subject of Planning and Antenna Installation of Transceiver Systems at Vocational High School, [39] | CST Microwave Studio  | Computer and Network Engineering                                        | 79.4      |
| M Rifai, S Masitoh, Bachtiar S. Bachri, W H. Setyawan, N, H Puspitasari | 2020 | Using Electronic Design Automation and Guided Inquiry Learning Model in Higher Engineering Education, [40] | Electronic Design Automation (EDA) | Electrical Power Installation Engineering                               | 80.6      |

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In order to make it easier to analyze the post-test data, the post-test collection is presented in graphical form. The graph of the post-test collection is as follows.

Figure 3. Meta Analysis Data Tabulation

After the post-take a look at fee records for the experimental and manage lessons had been collected, the experimental magnificence common rating turned into 80.3, the manage magnificence imply rating turned into 71.17 and the same old deviation pooled turned into 7.84, so that once being calculated with the impact length formula, the very last fee turned into 1.16. The rating turned into 1.16 if interpreted with the impact length standards table, the digital simulation-primarily based totally studying media has a excessive impact on studying outcomes.

The high effect of virtual simulation-based learning media on learning outcomes in technical vocational education is due to the fact that this media is able to facilitate students to learn independently with previous simulations before carrying out practicum in the laboratory. The ability of this learning media cannot be separated from good abstraction, mobility and independence.

Virtual simulation-based learning media can be the best option in the flipped classroom and blended learning method because this method carries out learning in part at home and in part at school [41], [42]. Especially the current condition of the Covid-19 pandemic, virtual simulation-based learning media is a very appropriate choice to use in learning without having to spend a lot of money on learning [43].

4. CONCLUSION

Virtual simulation-primarily based totally getting to know media has a excessive impact at the getting to know effects of technical vocational schooling. This is primarily based totally at the outcomes of studies information calculations that get an impact length of 1.16. This makes digital simulation-primarily based totally getting to know media the best and powerful getting to know medium to be used in vocational schooling in engineering and engineering. Especially for getting to know that makes use of the flipped study room technique, combined getting to know technique and getting to know in pandemic situations which require getting to know to be finished at home.

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