

ABSTRAK

Haida Dafitri, NIM 8226124002, Pengembangan Model HAIDA Virtual Lab Learning Pada Pembelajaran Jaringan Komputer di SMK

Penelitian ini bertujuan untuk mengembangkan, memvalidasi, menguji kepraktisan serta menguji keefektifan *Model HAIDA Virtual Lab Learning* sebagai inovasi pembelajaran digital reflektif pada mata pelajaran Jaringan Komputer di Sekolah Menengah Kejuruan (SMK). Model ini dikembangkan untuk mengatasi keterbatasan sarana laboratorium fisik sekaligus menyesuaikan kebutuhan pendidikan vokasi di era digital dan industri 4.0. Metode penelitian yang digunakan adalah *Research and Development (R&D)* yang mengadaptasi model Plomp (2013) melalui lima fase: (1) analisis kebutuhan, (2) perancangan model awal, (3) validasi ahli, (4) uji kepraktisan, dan (5) uji keefektifan serta penyusunan model final. Model HAIDA dirancang berlandaskan teori konstruktivistik, humanistik, dan *Technological Pedagogical Content Knowledge (TPACK)* dengan lima tahapan pembelajaran utama: *Highlight, Analyze, Integrate, Do, dan Assess*. Setiap tahapan mengintegrasikan aspek kognitif, afektif, dan psikomotor melalui aktivitas berbasis *Virtual Lab* dan *Learning Management System (LMS)*. Hasil validasi ahli menunjukkan tingkat kelayakan sebesar 92,3% (kategori sangat layak), sedangkan hasil uji kepraktisan memperoleh nilai 90,8% (kategori sangat praktis). Efektivitas model diuji menggunakan desain *quasi-experimental non-equivalent control group design* dengan dua kelas (eksperimen dan kontrol). Hasil menunjukkan peningkatan signifikan hasil belajar siswa, dengan nilai *N-Gain* sebesar 0,57 (kategori sedang) pada kelas eksperimen dan 0,31 (kategori rendah) pada kelas kontrol. Uji *independent t-test* menunjukkan $t_{hitung} = 7,812 > t_{tabel} = 2,02$ ($p < 0,05$) dan nilai *effect size (Cohen's d)* sebesar 1,64 yang termasuk kategori efek besar. Temuan ini menegaskan bahwa model HAIDA Virtual Lab Learning efektif meningkatkan hasil belajar kognitif dan keterampilan reflektif siswa pada pembelajaran jaringan komputer di SMK. Secara teoretis, penelitian ini memperkaya pengembangan *Reflective Digital Pedagogy* dalam konteks pendidikan vokasi digital, dengan menegaskan pentingnya integrasi antara *virtual simulation, adaptive learning*, dan pembelajaran reflektif. Secara praktis, model HAIDA Virtual Lab Learning memberikan alternatif solusi pembelajaran digital yang kontekstual, kolaboratif, dan reflektif, serta dapat direkomendasikan sebagai rujukan bagi pengembangan sistem pembelajaran vokasi berbasis *virtual lab* di SMK.

Kata kunci: HAIDA Virtual Lab Learning, pembelajaran digital reflektif, pendidikan vokasi, jaringan komputer, efektivitas pembelajaran.

ABSTRACT

Haida Dafitri, Student ID 8226124002, Development of the HAIDA Virtual Lab Learning Model in Computer Network Learning at Vocational High Schools (SMK)

This study aims to develop, validate, examine the practicality, and test the effectiveness of the HAIDA Virtual Lab Learning Model as an innovation in reflective digital learning for the *Computer Network* subject at Vocational High Schools (SMK). The model was developed to overcome the limitations of physical laboratory facilities while addressing the needs of vocational education in the era of digital transformation and Industry 4.0. The research employed a Research and Development (R&D) approach adapting Plomp's (2013) model through five phases: (1) needs analysis, (2) initial design, (3) expert validation, (4) practicality testing, and (5) effectiveness testing and final model formulation.

The HAIDA model was designed based on constructivist, humanistic, and Technological Pedagogical Content Knowledge (TPACK) theories, consisting of five key learning phases: Highlight, Analyze, Integrate, Do, and Assess. Each phase integrates cognitive, affective, and psychomotor aspects through activities supported by a Virtual Lab and Learning Management System (LMS). Expert validation results indicated a feasibility level of 92.3% (very feasible category), while practicality testing achieved 90.8% (very practical category). The model's effectiveness was tested using a quasi-experimental non-equivalent control group design involving two classes (experimental and control). The findings revealed a significant improvement in students' learning outcomes, with an N-Gain score of

0.57 (moderate category) in the experimental class and 0.31 (low category) in the control class. The independent t-test results showed $t_{count} = 7.812 > t_{table} = 2.02$ ($p < 0.05$) and an effect size (Cohen's d) of 1.64, indicating a large effect. These results confirm that the HAIDA Virtual Lab Learning Model is effective in enhancing students' cognitive learning outcomes and reflective skills in computer network learning at SMK. Theoretically, this research enriches the development of Reflective Digital Pedagogy within the context of digital vocational education by emphasizing the integration of *virtual simulation*, *adaptive learning*, and *reflective practice*. Practically, the HAIDA Virtual Lab Learning Model provides a contextual, collaborative, and reflective digital learning solution and can be recommended as a reference for developing virtual lab-based learning systems in vocational education.

Keywords: HAIDA Virtual Lab Learning, reflective digital learning, vocational education, computer networks, learning effectiveness.