

# Web-Based Interactive Learning Media Integrated with Soft Skills for Network System Administration in Vocational High Schools

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## Abstract

Vocational high schools are expected to prepare students with technical competence and employability-oriented soft skills. However, learning in Network System Administration often remains dominated by teacher explanation, static materials, and assessments that focus mainly on technical knowledge and final scores. This study developed and evaluated a web-based interactive learning medium integrated with soft skills for vocational high school students. Using a Research and Development approach, the study synthesized the 4D, ADDIE, and Borg and Gall models into seven stages: needs analysis, design, development, testing and revision, implementation, evaluation and final revision, and dissemination and adoption. Data were collected through observation, interviews, expert validation sheets, student-response questionnaires, and pretest-posttest learning outcome tests. The product consisted of learning objectives, interactive materials, video resources, quizzes, automated feedback, project tasks, evaluation results, and soft-skill activities covering character, citizenship, collaboration, communication, creativity, and critical thinking. Expert validation indicated that the product was highly feasible, with mean scores of 93.50% from material experts and 90.73% from media experts. Practicality testing showed progressive improvement from 69.00% in one-to-one trials to 74.00% in small-group trials and 84.00% in field trials. The effectiveness test showed that the experimental class achieved a higher mean gain than the control class, 29.47 compared with 3.00. The posttest comparison was statistically significant,  $t(58) = 2.44$ ,  $p = .018$ , with a medium effect size, Cohen's  $d = .63$ . These findings suggest that web-based interactive media can enhance technical understanding while supporting soft-skill-oriented vocational learning in more meaningful and engaging classroom contexts.

**Keywords:** Interactive learning media; Network system administration; Soft skills; Vocational pedagogy; Vocational school; Web-based learning

## INTRODUCTION

Vocational education occupies a strategic position in preparing young people for work, further education, and lifelong skill development. In the context of technological transformation, vocational high schools need to produce graduates who are not only able to perform technical tasks but also able to communicate, collaborate, solve problems, manage time, and adapt to changing work situations. This demand has become more urgent because the labour market increasingly values a combination of technical, digital, and human-centred skills. Polakova et al. (2023), for example, showed that technologically driven fields continue to require soft skills such as analytical thinking, problem-solving, communication, creativity, and flexibility. Similarly, the World Economic Forum (2025) identified analytical thinking, creative thinking, technological literacy, resilience, flexibility, and leadership-related social skills as critical skill areas for the near future. These developments indicate that vocational learning should not treat soft skills as supplementary attributes but as core learning outcomes embedded in technical instruction.

In Indonesia, this issue is particularly important for vocational high schools because the transition from school to work remains challenging. National labour statistics show that open

unemployment among vocational graduates has remained a public concern, reinforcing the need for stronger alignment between school learning and workplace expectations (Badan Pusat Statistik, 2026). The problem is not merely a shortage of technical content. Many vocational graduates already receive intensive technical instruction, yet their employability may still be constrained by limited workplace communication, weak collaboration, low self-management, and insufficient problem-solving experience. Therefore, the central challenge is to design learning environments that can simultaneously strengthen technical understanding and cultivate soft skills through authentic, interactive, and reflective learning activities.

This challenge is especially visible in Network System Administration because the course is not limited to memorizing server concepts or configuration commands. Students are expected to interpret network architecture, configure web services, diagnose connection and service errors, document technical procedures, communicate troubleshooting decisions, and work responsibly in teams. These tasks require collaboration when students divide roles in configuration practice, communication when they explain procedures and report errors, critical thinking when they identify causes of server failure, and work ethics when they follow security rules and complete tasks accurately. Consequently, the subject provides a strong pedagogical setting for integrating employability-oriented soft skills into technical learning, rather than teaching soft skills as separate motivational content.

Educational technology provides one pathway for addressing these pedagogical needs. Web-based learning media can combine text, diagrams, video, simulation, quizzes, immediate feedback, and learning analytics in a flexible platform that students can access both inside and outside the classroom. Such media may also support student autonomy because learners can revisit materials, complete practice tasks, and receive feedback at their own pace. Chiu (2021) argued that digital support can improve student engagement in blended learning when the design supports students' psychological needs and active learning. In science and technology education, web-based interactive learning media have also been associated with improved critical thinking and learning outcomes (Saputra et al., 2025). For vocational contexts, Ferdiansyah and Irfan (2021) developed website-based interactive media and found that the product was valid, practical, and effective for improving the learning process in vocational schools.

Despite these contributions, three more specific gaps remain visible. Empirically, many studies of digital learning media in vocational education still emphasize cognitive achievement, whereas soft skills are frequently treated as indirect benefits rather than observed learning processes. Methodologically, previous R&D studies often report validation and posttest results but provide limited explanation of how development stages, instrument validation, baseline differences, and product revisions shape the interpretation of effectiveness. From a product-design perspective, few web-based vocational media explicitly translate soft-skill constructs into learning activities, observable behaviors, assessment indicators, and evidence sources. These gaps are important in Network System Administration because students need not only conceptual knowledge of server configuration and network services but also disciplined troubleshooting, teamwork, ethical technology use, and clear technical reporting.

The present study responds to these gaps by developing a web-based Interactive Learning Media (ILM) product for Network System Administration in vocational high schools. The contribution is fourfold: it offers a concrete web-based product, presents a justified R&D procedure that integrates 4D, ADDIE, and Borg and Gall stages, proposes an operational matrix for embedding soft skills into technical learning activities, and reports feasibility, practicality, and learning-outcome evidence. The novelty of the study is therefore not simply the combination of development models, but the way these models are used to guide iterative product design, user validation, classroom implementation, and soft-skill operationalization in a specific vocational technology subject. The study was guided by four research questions: (1) How was the web-based interactive learning media integrated with soft skills developed for vocational

high school learning? (2) How feasible was the product based on material and media expert validation? (3) How practical was the product according to student responses in one-to-one, small-group, and field trials? (4) How was students' learning improvement associated with the use of the product in Network System Administration?

## METHODS

This study used a Research and Development (R&D) design to produce and evaluate a web-based interactive learning medium for vocational high school students. The development procedure synthesized three instructional development traditions: 4D (Thiagarajan et al., 1974), ADDIE (Branch, 2009), and Borg and Gall's educational R&D cycle (Gall et al., 2003). The synthesis was selected to combine the strength of 4D in defining, designing, developing, and disseminating instructional products; the strength of ADDIE in iterative analysis, design, development, implementation, and evaluation; and the strength of Borg and Gall in product testing and revision. Rather than treating the synthesis itself as the novelty, the procedure was used as a practical framework for needs diagnosis, prototype design, expert validation, small-scale revision, classroom implementation, and final product refinement. The resulting procedure consisted of seven stages: needs analysis, design, development, testing and revision, implementation, evaluation and final revision, and dissemination and adoption.

**Table 1.** Mapping of development models into the seven-stage R&D procedure

| <b>Seven-stage procedure</b>  | <b>4D contribution</b>          | <b>ADDIE contribution</b> | <b>Borg and Gall contribution</b>      | <b>Rationale for synthesis</b>   |
|-------------------------------|---------------------------------|---------------------------|--|--|
| Needs analysis                | Define learner and task needs   | Analysis                  | Research and information collecting    | Identify classroom problems, user needs, and soft-skill gaps                 |
| Design                        | Design objectives and prototype | Design                    | Planning                               | Produce objectives, storyboard, flowchart, and soft-skill integration plan   |
| Development                   | Develop product draft           | Development               | Develop preliminary product            | Build web content, quizzes, videos, feedback, and project tasks              |
| Testing and revision          | Development validation          | Formative evaluation      | Preliminary field testing and revision | Obtain expert judgement and early user feedback                              |
| Implementation                | Limited dissemination           | Implementation            | Main field testing                     | Examine classroom use in the experimental group                              |
| Evaluation and final revision | Revision before dissemination   | Evaluation                | Operational revision                   | Analyse feasibility, practicality, learning outcomes, and product weaknesses |
| Dissemination and adoption    | Disseminate                     | Implementation follow-up  | Dissemination and implementation       | Prepare the product for teacher and student use                              |

The study was conducted in three vocational high schools in Makassar, Indonesia: SMK Nasional Makassar, SMK Negeri 2 Makassar, and SMK Negeri 10 Makassar. These schools were selected purposively because they offered the Computer and Network Engineering programme and taught Network System Administration in Grade XI. Teachers and classes were selected based on programme relevance, school permission, schedule availability, and students' prior exposure to basic computer-network concepts. The development and practicality phases

involved students with different levels of academic ability and digital literacy. The one-to-one trial involved 3 students, the small-group trial involved 15 students, and the expanded field-practicality trial involved 64 students; these trial participants were used to refine product readability, navigation, interactivity, and soft-skill tasks. The effectiveness test involved two intact Grade XI classes from the same participating programme because random assignment was not permitted by school scheduling: 30 students in an experimental class used the web-based interactive learning media, whereas 30 students in a control class learned the same topic using teacher explanation, printed/digital static materials, and ordinary exercises without the developed ILM. The practicality and effectiveness samples were analyzed separately, and students who participated in the initial one-to-one and small-group trials were not included in the final effectiveness comparison.

Data were collected using observation, interviews, expert-validation sheets, student-response questionnaires, and learning outcome tests. Needs analysis included classroom observations, interviews with three Computer and Network Engineering teachers, and a student needs questionnaire. The observation focused on teaching methods, media use, student interaction, troubleshooting practice, and the visibility of soft-skill activities. The material-validation sheet covered five dimensions: material suitability, clarity, industry relevance, soft-skill integration, and instructional implementation. The media-validation sheet was adapted from the ISO/IEC 25010 software product quality model, which includes functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability (International Organization for Standardization, 2011). The adaptation process involved translating these software-quality dimensions into educational-media indicators, reviewing them with experts, and revising unclear items before validation. The student-response questionnaire measured seven practicality aspects: engagement and motivation, user friendliness, soft-skill development, learning satisfaction, interactivity, relevance, and accessibility. All validation and practicality items were scored using a Likert-type scale, and interpretation categories were determined from the percentage of obtained score against maximum score.

The product consisted of a web-based learning package with several main components: login/dashboard, learning objectives, interactive learning materials, videos, interactive exercises, final evaluation, evaluation results, and a soft-skills page. The soft-skills page was designed to support project work, collaborative activities, discussion, and reflection. The technical material focused on Network System Administration, especially web server concepts and related configuration tasks. Learning activities required students to read technical explanations, observe diagrams, watch learning videos, answer quizzes, complete project tasks, report troubleshooting steps, and reflect on character, communication, collaboration, creativity, citizenship, and critical thinking. To avoid treating soft skills as labels only, each soft-skill dimension was linked to a learning activity, observable behavior, assessment indicator, and evidence source as shown in Table 2.

**Table 2.** Operationalization of soft skills in the developed web-based ILM

| <b>Soft skill</b> | <b>Learning activity</b>                     | <b>Observable behavior</b>                    | <b>Assessment indicator</b>                 | <b>Evidence source</b>                |
|-------------------|--|---|---|---------------------------------------|
| Character         | Individual configuration task and reflection | Shows discipline, honesty, and responsibility | Completes procedures and submits reflection | Dashboard log; task sheet; reflection |
| Citizenship       | Scenario on ethical technology use           | Uses digital resources responsibly            | Chooses safe and ethical actions            | Quiz response; reflective prompt      |
| Collaboration     | Pair/group troubleshooting project           | Shares roles and helps peers                  | Contributes to group problem solving        | Project report; observation           |

|                   |  |  |                                      |                                  |
|-------------------|--|--|--------------------------------------|----------------------------------|
| Communication     | Technical reporting and discussion       | Explains procedures, errors, and solutions | Produces clear technical explanation | Discussion notes; report         |
| Creativity        | Alternative solution or improvement task | Proposes feasible troubleshooting strategy | Suggests relevant improvement        | Project artefact; teacher review |
| Critical thinking | Diagnosis of server/service failure      | Identifies causes and justifies decisions  | Uses evidence to defend a solution   | Interactive exercise; worksheet  |

Quantitative data were analyzed using descriptive statistics, percentages, and inferential tests. Expert-validation and practicality scores were converted using the formula: percentage = (obtained score / maximum score) x 100. The interpretation criteria were 81.00-100.00% = highly feasible/highly practical, 61.00-80.99% = feasible/practical, 41.00-60.99% = moderately feasible/moderately practical, 21.00-40.99% = less feasible/less practical, and 0.00-20.99% = not feasible/not practical. Learning outcome data were analyzed using pretest and posttest scores. Normality and homogeneity were examined before independent-sample t-testing, with an alpha level of .05. Because the pretest means of the two intact classes were not equivalent, effectiveness was interpreted using raw score improvement and mean-level normalized gain,  $g = (\text{posttest} - \text{pretest}) / (\text{maximum score} - \text{pretest})$ , in addition to the posttest t-test, effect size, and confidence interval for the posttest mean difference. School research-permission procedures were followed. Because the study involved school students, institutional permission, teacher coordination, parental consent or school-authorized consent procedures, student assent, anonymity, aggregate reporting, and secure storage of data files were applied to protect participants.

**Table 3.** Development and evaluation design

| Stage                         | Main activity   | Data/source  | Output                             |
|-------------------------------|---|--|------------------------------------|
| Needs analysis                | Observation, interviews, and student needs survey                                 | Teachers and students in three vocational high schools | Problem map and media requirements |
| Design                        | Learning objectives, storyboard, flowchart, soft-skill integration plan           | Curriculum and Network System Administration content   | Prototype specification            |
| Development                   | Web media construction, content integration, quizzes, video, and soft-skill tasks | Development team and product draft                     | Initial ILM product                |
| Testing and revision          | Expert validation and user trials   | 2 material experts, 2 media experts, 3 and 15 students | Revised product                    |
| Implementation                | Classroom use in experimental group   | 30 experimental and 30 control students                | Learning outcome data              |
| Evaluation and final revision | Analysis of feasibility, practicality, and effectiveness                          | Validation, questionnaires, pretest-posttest           | Final product                      |
| Dissemination and adoption    | Introduction of product to users  | Teachers and students                                  | Adoption-ready web learning media  |

## RESULT AND DISCUSSION

### *Development Needs and Product Design*

The needs analysis revealed that the existing learning process in the three vocational high schools was still dominated by teacher explanation, technical exercises, and conventional

learning media. Classroom observations focused on learning interaction, media use, students' opportunity to practise troubleshooting, and the visibility of communication, collaboration, discipline, responsibility, and critical thinking during Network System Administration lessons. Interviews with three teachers indicated that soft skills were considered important, but they were usually expected to emerge naturally during practice rather than being planned as explicit activities or assessment indicators. For example, students were often asked to complete configuration exercises individually, but they were rarely guided to report their troubleshooting logic, distribute team roles, or reflect on ethical technology use. These findings were transformed into product features such as a clearer dashboard, learning objectives for each unit, interactive exercises with feedback, collaborative project tasks, and reflection prompts connected to soft-skill indicators.

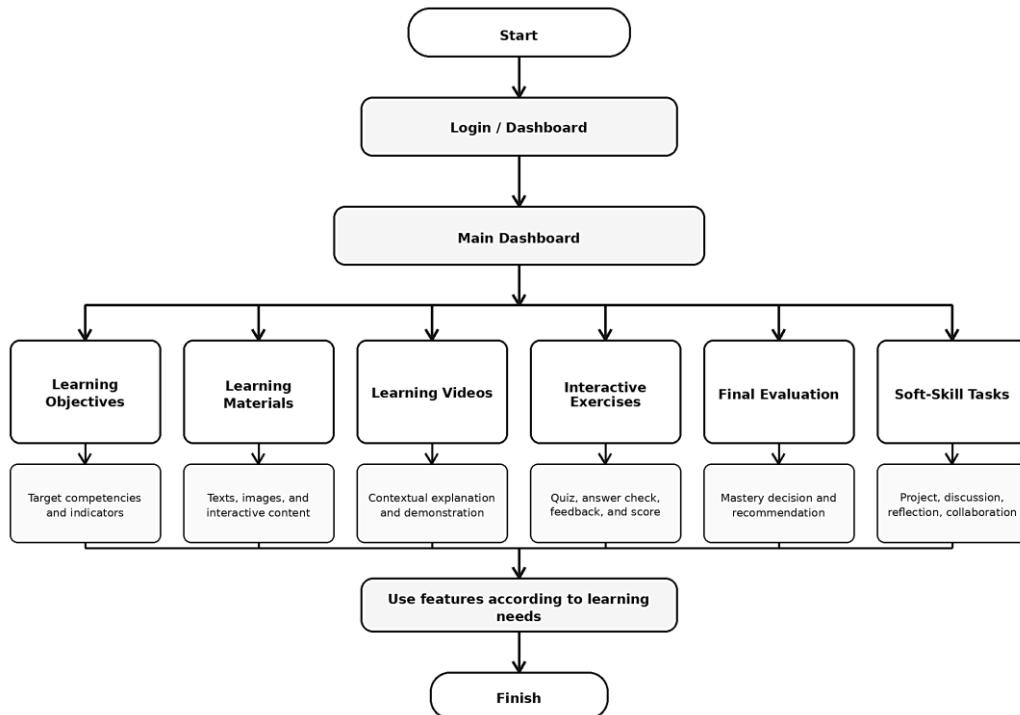
The student needs survey strengthened this diagnosis. The questionnaire was administered to 64 Grade XI students using a Likert-type response format, and the reported percentages represent students selecting agreement or high-need categories for each aspect. Most students considered soft skills important for future employment. The highest perceived need was work ethics (97.00%), followed by teamwork (93.00%), communication and leadership (92.00%), and time management (91.00%). Students also showed positive attitudes toward technology-based learning, with 89.20% agreeing that technology-supported learning could help improve their soft skills. Moreover, 77.00% preferred interactive and experience-based learning such as discussion, role play, or workplace simulation. These results demonstrate that students did not simply need more digital content; they needed a more engaging learning structure that allowed them to practise workplace-relevant behaviours.

However, the needs analysis also identified an accessibility issue. While 73.60% of students reported sufficient access to technology, 26.40% still experienced difficulties related to stable internet access or adequate devices. This finding has two implications for product design. First, web-based media must be lightweight, easy to navigate, and usable on various devices. Second, teachers and schools should provide alternative access arrangements when learners experience technological barriers. In this study, the product was therefore designed with a simple dashboard, clear menus, readable materials, and activities that could be accessed through common browsers on computers or smartphones.

The final product contained ten main scenes: opening page, main dashboard, learning-objective page, material page, video page, interactive exercise page, final-evaluation page, evaluation-result page, soft-skills strengthening page, and closing page. The soft-skills strengthening page became the distinctive feature of the product. It did not present soft skills as separate motivational messages. Instead, soft skills were integrated into project tasks, discussion instructions, problem-solving prompts, and reflective questions. This design is consistent with the view that interactive learning media should facilitate active engagement and not merely transfer information. In vocational learning, such an approach is essential because students must learn how to apply technical concepts while communicating decisions, collaborating with peers, and demonstrating responsibility in completing tasks.

To make the developed product visible to readers, the prototype is presented through the product-flow architecture and selected interface screenshots. Figure 1 summarizes the navigation logic of the media from login/dashboard to learning objectives, materials, videos, interactive exercises, final evaluation, and soft-skill tasks. Figure 2 illustrates representative screens accessed by students, including the opening page, dashboard, learning content, video explanation, interactive quiz, and progress summary. These visual elements show that the product was designed to combine technical content, formative feedback, and explicit soft-skill tasks in a single browser-accessible environment rather than functioning only as a repository of digital text.

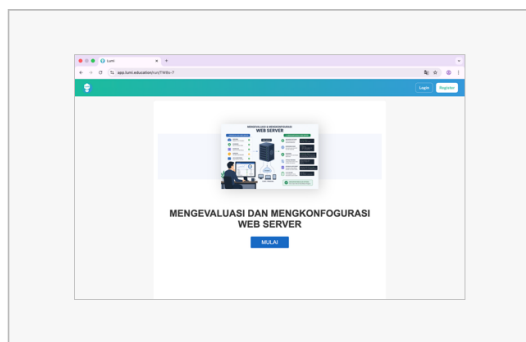
**Web-Based Interactive Learning Media Product Flow**



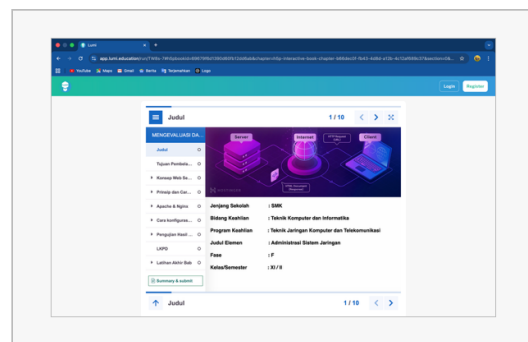
**Figure 1.** Product-flow architecture of the web-based interactive learning media.

**Table 4.** Product components and embedded soft-skill functions

| Product component                        | Learning function  | Soft-skill integration                                    |
|--|--|---|
| Login/opening page                       | Entry point to access the web learning environment                                       | Responsibility and learning readiness                     |
| Main dashboard                           | Central navigation for all learning menus  | Self-management and independent learning                  |
| Learning objectives                      | Clarifies technical competencies and expected outcomes                                   | Goal orientation and accountability                       |
| Material and video pages                 | Presents Network System Administration content through text, visual, and video resources | Digital literacy and critical understanding               |
| Interactive exercises and feedback       | Allows students to answer questions, check responses, and receive scores                 | Problem solving, persistence, and reflective learning     |
| Final evaluation                         | Measures mastery after completing learning activities                                    | Achievement orientation and honesty                       |
| Soft-skill project/reflection activities | Connects technical tasks with collaborative and reflective activities                    | Communication, collaboration, creativity, and work ethics |



**(a) Opening page**



**(b) Main dashboard**

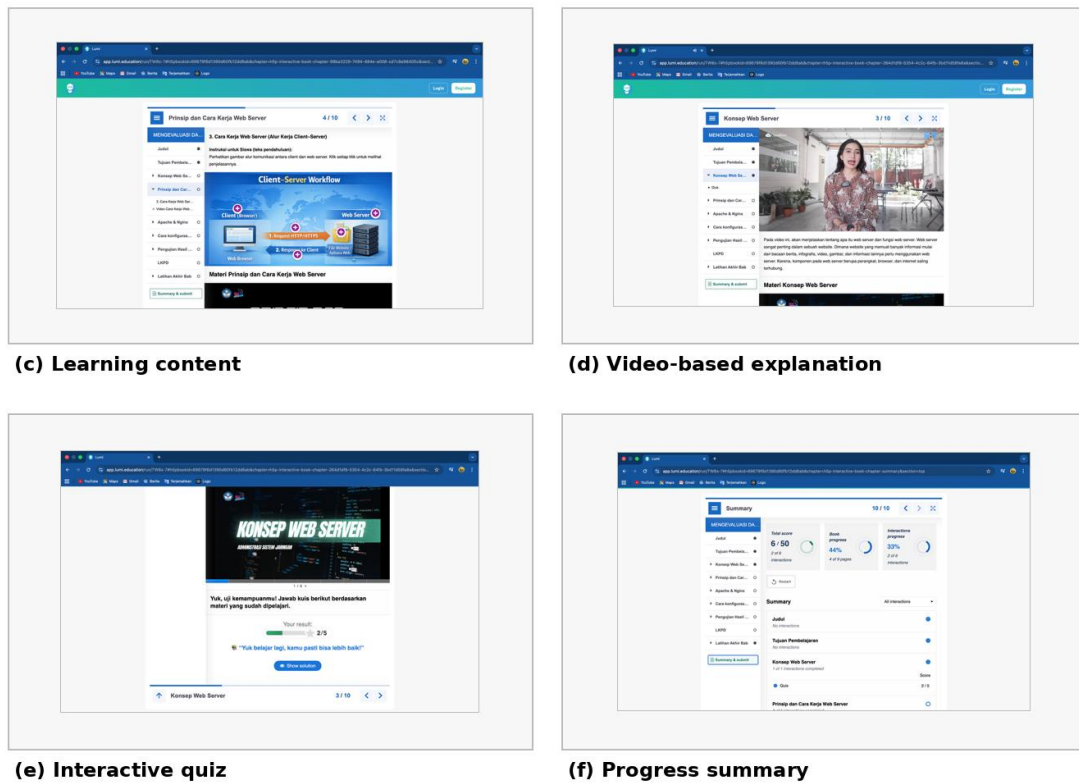


Figure 2. Selected screenshots of the developed web-based ILM product.

Table 5. Summary of needs-analysis findings

| Dimension             | Key finding   | Percentage                 | Design implication  |
|-----------------------|---|----------------------------|---|
| Soft-skill importance | Students considered soft skills important for work readiness          | 93.50%                     | Soft skills must be explicit in learning activities                   |
| Priority soft skills  | Work ethics, teamwork, communication, leadership, time management     | 91.00%-97.00%              | Tasks should include responsibility, collaboration, and communication |
| Technology acceptance | Students believed technology-based learning could support soft skills | 89.20%                     | Web-based platform is acceptable to most users                        |
| Learning preference   | Students preferred interactive and experience-based learning          | 77.00%                     | Include projects, discussion, simulation, and quizzes                 |
| Technology access     | Some students faced internet or device barriers                       | 26.40% reported difficulty | Use lightweight, flexible, browser-accessible design                  |

**Expert Validation of the Web-Based Interactive Learning Media**

Expert validation was conducted to determine whether the product was suitable before being tested with students. The material validation results showed that the media was highly feasible. Material Expert 1 gave an overall score of 92.50%, while Material Expert 2 gave 100.00%, resulting in an arithmetic mean material-feasibility score of 96.25%. The strongest aspects were suitability of material, soft-skill integration, and instructional implementation. The main revision suggestions concerned the need to strengthen learning objectives in each unit and to ensure that assessment tasks were more closely connected to the material and simulation activities. These revisions were important because vocational students need clear links between technical concepts, practice tasks, and performance criteria.

Media validation also indicated high feasibility. Media Expert 1 gave an overall score of 82.14%, while Media Expert 2 gave 99.37%, producing an arithmetic mean media-feasibility score of 90.76%. The validators evaluated functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability based on the adapted ISO/IEC 25010 quality dimensions. Functional suitability and portability were among the strongest dimensions, indicating that the product had relevant features and could be accessed across devices. Performance efficiency and usability received lower but still acceptable scores in the first validation, suggesting that interface clarity, navigation consistency, and technical responsiveness needed improvement. After revision, the product became more stable and more suitable for use in classroom implementation.

The expert-validation findings are consistent with previous evidence that web-based interactive media can be valid and practical for vocational learning when developed through systematic R&D procedures (Ferdiansyah & Irfan, 2021). They also align with broader educational technology literature showing that media quality depends not only on attractive visual design but also on instructional coherence, usability, interactivity, and feedback. In this study, the validation process improved both dimensions: pedagogical quality through better alignment between learning objectives and assessment, and technological quality through clearer navigation and more reliable functions.

**Table 6.** Expert-validation results

| Validation area              | Validator 1 | Validator 2 | Mean   | Category        |
|------------------------------|-------------|-------------|--------|-----------------|
| Material/content feasibility | 92.50%      | 100.00%     | 96.25% | Highly feasible |
| Media/technical feasibility  | 82.14%      | 99.37%      | 90.76% | Highly feasible |

### ***Practicality of the Media in User Trials***

The practicality test was conducted in three stages. The one-to-one trial with three students produced an overall practicality score of 69.00%, categorized as practical. At this early stage, students responded positively to the product, but several aspects still needed simplification. The relatively moderate score can be understood because first-time users often require clearer instructions when navigating a new digital learning environment. This stage was useful for identifying basic readability, navigation, and interface issues before the product was tested in a larger group.

The small-group trial with 15 students produced a higher practicality score of 74.00%, also categorized as practical. Students found the product useful because it contained varied learning resources, including material, videos, exercises, and feedback. The accessibility aspect reached 80.00%, suggesting that the web format supported flexible learning. However, the soft-skills and interactivity dimensions still required improvement, particularly in making collaborative tasks clearer and ensuring that feedback helped students understand their learning progress. The revision after this stage therefore focused on making the soft-skill tasks more concrete and improving the flow between technical exercises and reflective questions.

The expanded field trial with 64 students produced an overall practicality score of 95.71%, categorized as highly practical after recalculation from the seven reported dimensions. The dimensional scores were engagement and motivation (95.00%), user friendliness (95.00%), soft-skill development (96.00%), learning satisfaction (97.00%), interactivity (95.00%), relevance (97.00%), and accessibility (95.00%). These findings indicate that the revised product was easy to use, relevant to vocational learning, and perceived by students as helpful for both technical understanding and soft-skill development. The increase from 69.00% to 95.71% across the three stages demonstrates the value of iterative R&D. Practicality was not assumed at the beginning; it was improved through user feedback, expert suggestions, and product revision.

From a pedagogical perspective, the practicality results suggest that students are more likely to accept digital media when the media provides meaningful interaction rather than merely presenting digitalized text. Features such as quizzes, feedback, video resources, and project-

based soft-skill tasks made the learning experience more active. This finding supports recent studies showing that interactive media can increase learning engagement and competence development in vocational education (Roemintoyo & Budiarto, 2025). The result also reinforces the argument that digital learning in vocational settings should be designed around learning actions: observing, practising, discussing, solving problems, and reflecting.

Table 7. Practicality-test results

| Trial stage       | Number of students | Overall score | Category         | Main interpretation   |
|-------------------|--------------------|---------------|------------------|---|
| One-to-one trial  | 3                  | 69.00%        | Practical        | Basic usability acceptable; early revisions needed                              |
| Small-group trial | 15                 | 74.00%        | Practical        | Improved clarity and accessibility; collaboration tasks revised                 |
| Field trial       | 64                 | 95.71%        | Highly practical | Product accepted as easy, relevant, interactive, and useful after recalculation |

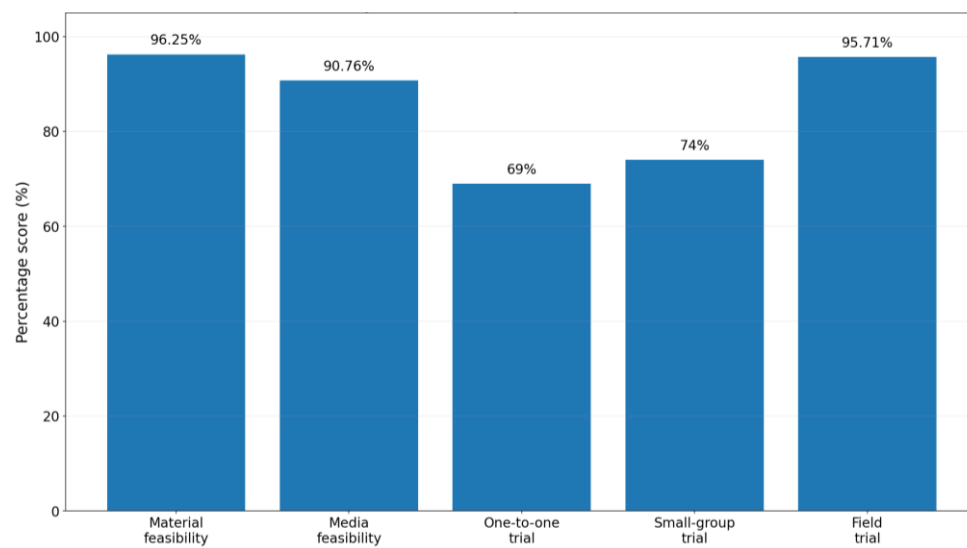


Figure 3. Feasibility and practicality profile of the developed ILM product.

### ***Effectiveness in Improving Learning Outcomes***

The effectiveness test compared learning outcomes between an experimental class using the developed web-based interactive media and a control class learning without the developed media. The experimental class had a mean pretest score of 59.37 and a mean posttest score of 88.83, indicating a mean raw improvement of 29.47 points. The control class had a mean pretest score of 76.67 and a mean posttest score of 79.67, indicating a mean raw improvement of 3.00 points. Because the control class started from a higher pretest mean, the analysis was not interpreted from posttest comparison alone. The mean-level normalized gain was therefore added to address baseline differences, with the experimental class reaching  $g = 0.73$  and the control class reaching  $g = 0.13$ .

The posttest comparison showed a statistically significant difference between the two classes,  $t(58) = 2.44$ ,  $p = .018$ , with a medium effect size, Cohen's  $d = .63$ . Based on the reported means, sample sizes, and  $t$  value, the 95% confidence interval for the posttest mean difference was approximately [1.65, 16.67]. These results indicate that the developed media was associated with a substantial improvement in students' understanding of Network System Administration. The effect is pedagogically meaningful because the product combined technical material, visual explanation, independent practice, feedback, and soft-skill-oriented activities. However, because intact classes were used and the pretest means were not equivalent, the results should be read

as strengthened R&D evidence of learning improvement rather than as a definitive causal estimate.

The effectiveness pattern is consistent with previous studies showing that web-based interactive learning media can improve critical thinking and learning achievement (Saputra et al., 2025) and with vocational R&D findings that website-based interactive media can be valid, practical, and effective in school contexts (Ferdiansyah & Irfan, 2021). The present study extends this line of work by showing how product features can be organized around both technical learning and soft-skill practice. Nevertheless, the study does not claim direct improvement in soft skills because soft-skill performance was not independently measured through observation rubrics or workplace-simulation scores. The contribution is therefore best understood as design integration: employability-oriented behaviours were made more visible, structured, and assessable within technical learning tasks.

Nevertheless, the effectiveness result should be interpreted carefully. The experimental and control classes differed at pretest, with the control class having a higher initial score. This imbalance is common in school-based quasi-experimental R&D studies, but it limits the strength of causal claims. The stronger conclusion is that the developed media is feasible, practical, and associated with substantial learning improvement in the experimental class, as supported by raw gain, mean-level normalized gain, posttest difference, effect size, and confidence interval. Future studies should employ randomized assignment where possible or use individual-level ANCOVA to control for pretest differences. In addition, future research should measure soft-skill performance directly through observation rubrics, project artefacts, peer assessment, portfolios, and workplace-simulation tasks rather than relying only on student responses and learning-outcome tests.

**Table 8.** Learning-outcome comparison

| Class   | n  | Pretest mean | Posttest mean | Raw improvement / normalized gain             | Interpretation                                    |
|---|----|--------------|---------------|---|---|
| Experimental: ILM integrated with soft skills | 30 | 59.37        | 88.83         | 29.47 / 0.73                                  | Large classroom improvement after media use       |
| Control: conventional/non-developed media     | 30 | 76.67        | 79.67         | 3.00 / 0.13                                   | Limited improvement                               |
| Posttest comparison                           | 60 | -            | -             | t = 2.44; p = .018; d = .63; CI [1.65, 16.67] | Significant posttest difference; baseline caution |

### ***Implications for Vocational Technology Learning***

The findings have several practical implications for vocational technology learning. First, teachers can use the product as an instructional ecosystem that organizes objectives, materials, videos, exercises, feedback, projects, and reflection in one learning flow. Second, schools need to support the implementation of web-based media through stable internet access, device availability, and teacher orientation. Third, soft-skill integration should be accompanied by assessment evidence such as project reports, observation rubrics, peer assessment, portfolios, and workplace-simulation tasks. These implications are important because digital media will not automatically improve learning unless the product is connected to teacher facilitation, infrastructure readiness, and visible assessment of both technical competence and employability-oriented behaviours.

In Network System Administration, soft skills can be embedded without reducing technical depth. Students can practise collaboration through troubleshooting tasks, communication through reporting configuration results, character through disciplined completion of exercises, creativity through proposing solutions, citizenship through ethical

technology use, and critical thinking through analysing server problems. This integration is relevant to Industry 5.0 discussions because human-centred skills remain necessary even in technology-intensive work environments.

The web-based format can also support flexible and independent learning if schools provide adequate access and teacher guidance. UNESCO-UNEVOC emphasizes that the digital transformation of TVET affects curriculum, teaching, learning organization, digital skills, and institutional readiness. Therefore, adoption of the product should be accompanied by teacher orientation, school infrastructure support, and periodic revision of content according to industry developments.

### **Discussion**

The findings of this study indicate that the development of web-based interactive learning media integrated with soft skills responds to a central problem in vocational education: the gap between technical competence and workplace readiness. The needs analysis showed that students perceived work ethics, teamwork, communication, leadership, and time management as highly important for future employment. This finding confirms that soft skills are no longer supplementary attributes in vocational learning but have become core employability competencies in technology-driven labour markets. Polakova et al. (2023) argue that Industry 5.0 requires workers who can combine digital competence with human-centred skills such as critical thinking, communication, creativity, flexibility, and problem solving. Similarly, Kyllonen (2013) emphasizes that soft skills are increasingly valued in the workplace because they shape how individuals collaborate, adapt, and perform in professional contexts. The present study therefore strengthens the argument that vocational schools should make soft skills explicit, assessable, and embedded in technical learning activities.

The product's relevance can be explained by the nature of Network System Administration itself. Learners do not only need to know the definition of web servers or configuration commands; they must also diagnose errors, test alternative solutions, communicate technical procedures, and maintain responsible digital behaviour. This explains why students responded positively to interactive and experience-based activities such as discussion, simulation, role play, and project tasks. Suroto et al. (2024), Inderanata and Sukardi (2023), and Wahyudi et al. (2023) similarly show that work readiness depends on a combination of individual competence, learning process, interpersonal skills, and school-industry expectations. The present product differs from digital-content repositories because it reorganizes learning around actions: reading, watching, practising, reporting, collaborating, reflecting, and evaluating.

The design findings also show that digital transformation in vocational learning is pedagogical rather than merely technological. The media was developed as a lightweight web-based platform with clear navigation, learning objectives, materials, videos, interactive exercises, evaluation results, and soft-skill strengthening activities. Timotheou et al. (2023) note that the impact of digital technologies in schools depends on institutional readiness, teacher capacity, instructional design, and learning culture, while Haleem et al. (2022) emphasize that digital technologies become educationally valuable when integrated into teaching and assessment. In this study, the product was accepted because it reduced navigation complexity, provided feedback, and connected technical tasks with soft-skill prompts. Thus, the result suggests that interactivity, feedback, and task authenticity are more important than the mere presence of a web platform.

The expert validation results indicate that the developed media had achieved strong feasibility before classroom implementation, as reflected in the high evaluation of both material quality and media quality. This feasibility was reinforced through the adaptation of ISO/IEC 25010 quality dimensions, which enabled a more systematic assessment of instructional relevance, technical functionality, usability, reliability, security, maintainability, and portability. The finding is consistent with Ferdiansyah and Irfan (2021), Saputra et al. (2025), and Roemintoyo and Budiarto (2025), but the present study adds a clearer link between validation evidence and soft-skill-oriented product features.

The practicality findings further show that product quality improved through iterative trials. The practicality score increased from 69.00% in the one-to-one trial to 74.00% in the small-group trial and 95.71% in the expanded field trial after recalculation from the seven-dimensional scores. This progression indicates that student feedback played an important role in improving navigation clarity, task readability, interactivity, and soft-skill integration. Bond et al. (2020) and Bedenlier et al. (2020) show that educational technology supports engagement when it encourages behavioural, affective, and cognitive participation. In this study, the increase in practicality occurred because revisions made the interface clearer, the collaboration tasks more concrete, and the relationship between technical exercises and reflection prompts more visible.

The effectiveness findings indicate that the experimental group demonstrated a more pronounced learning improvement after engaging with the developed media than the control group. This gain is pedagogically defensible, as the media integrated technical content, visual explanation, autonomous practice, formative feedback, and project-oriented tasks that collectively supported more active and meaningful learning. Noetel et al. (2021), van der Kleij et al. (2015), and Chen and Yang (2019) help explain why these features matter: video can support conceptual understanding, feedback can correct errors and guide progress, and project tasks can increase meaningful engagement. However, the non-equivalent pretest means mean that this evidence should be interpreted as strong learning-improvement evidence within R&D implementation, not as a fully controlled causal estimate.

Another important contribution of this study is the integration of soft skills into technical learning rather than separating them as additional character education. In the developed media, soft skills were embedded in project tasks, discussion instructions, problem-solving prompts, evaluation activities, and reflective questions. This design supports the argument that soft skills are best developed through situated practice, not through abstract explanation alone. Coelho and Martins (2022) found that digital training for soft skills is possible when online environments provide experiential, interactive, and reflective learning opportunities, while Sailer and Homner (2020) show that interactive elements can support motivational and behavioural outcomes when they are connected to meaningful learning tasks. Still, because this study did not directly measure soft-skill performance through independent rubrics, the contribution should be framed as operationalizing and structuring soft-skill development rather than proving measurable soft-skill improvement.

Theoretically, the findings support the view that effective vocational learning media should be grounded in an integrated framework that connects cognitive mastery, experiential learning, digital interactivity, and employability-oriented soft skills. The developed web-based media extends conventional instructional media theory by showing that digital learning environments become more meaningful when they do not merely deliver content but also structure learners' actions through practice, collaboration, reflection, feedback, and project-based problem solving. In this sense, the study refines the assumption that interactivity is primarily a technical feature; instead, interactivity should be understood as a pedagogical mechanism that enables students to construct technical understanding while simultaneously exercising communication, teamwork, responsibility, time management, and ethical digital behaviour. The findings also suggest that soft-skill development in vocational education is more theoretically coherent when embedded within authentic technical tasks rather than treated as a separate moral or character component.

Pedagogically, the study implies that teachers in vocational schools need to design digital learning as an ecosystem of guided experience, not simply as an online repository of materials. The integration of videos, simulations, independent practice, formative feedback, discussion, reflection, and project-oriented activities can increase student engagement by making learning more active, visible, and connected to workplace situations. These features may also support students' confidence and emotional readiness because learners are given clearer task structures, opportunities to practise, immediate feedback, and collaborative spaces for negotiating technical problems. From a policy perspective, the findings indicate that vocational digitalization should

be accompanied by institutional support for infrastructure, teacher capacity, soft-skill assessment, responsible digital behaviour, and students' digital well-being. Schools and policymakers should not only invest in platforms and devices but also develop guidelines for authentic online interaction, ethical use of technology, media literacy, feedback culture, and psychosocial support so that digital learning environments contribute to both employability and students' social-emotional development.

The novelty of this study lies in its attempt to develop and evaluate web-based interactive learning media that integrates soft skills directly into Network System Administration learning. Unlike many digital learning products that focus mainly on content delivery, this study positions soft skills as operational learning behaviours embedded in project tasks, technical problem solving, discussion, reporting, evaluation, and reflection. Methodologically, the study contributes by combining needs analysis, expert validation, iterative practicality testing, and classroom effectiveness evaluation within an R&D framework, thereby offering a more comprehensive account of how a vocational learning product can be designed, revised, and implemented. This contribution expands the literature on vocational educational technology by demonstrating that technical competence and workplace readiness can be addressed simultaneously when digital media are designed around authentic tasks, learner interaction, formative feedback, and reflective soft-skill prompts.

Several limitations should be acknowledged when interpreting the findings. The study was conducted within a specific vocational education context and involved non-equivalent groups, which may limit the generalizability and causal strength of the effectiveness evidence. In addition, soft-skill development was operationalized through learning activities, product responses, project tasks, and reflection prompts rather than measured through independent performance-based rubrics, longitudinal observation, or workplace simulation. Future research should therefore employ stronger quasi-experimental or mixed-method designs, use individual-level data analysis such as ANCOVA or matched-group comparison, include larger and more diverse samples, and develop validated soft-skill assessment instruments involving teacher observation, peer assessment, portfolios, and industry-based performance tasks. Further studies may also examine the long-term impact of web-based vocational media on students' employability, digital identity formation, responsible online behaviour, confidence, collaboration, and readiness to participate in technology-driven workplaces.

## **CONCLUSION**

This study aimed to develop and evaluate web-based interactive learning media integrated with soft skills for Network System Administration learning in vocational high schools. The findings demonstrate that the developed media responded to the instructional need for a learning environment that simultaneously supports technical mastery, digital engagement, and employability-oriented soft-skill development. Through a systematic R&D procedure integrating needs analysis, design, development, validation, iterative trials, implementation, and final revision, the product was shown to be feasible, practical, and pedagogically meaningful for vocational learning. The expert validation results confirmed the instructional and technical quality of the product, while the practicality trials indicated that students perceived the media as accessible, engaging, interactive, and relevant to their learning needs. The effectiveness findings further suggest that students who learned through the developed media experienced more substantial learning improvement than those who learned through conventional or non-developed learning resources. These findings answer the research questions by showing that web-based interactive media can be developed systematically, validated rigorously, implemented practically, and associated with meaningful learning improvement in a vocational technology context.

The study contributes theoretically by extending the understanding of interactive learning media from a content-delivery tool into a structured pedagogical ecosystem that integrates technical learning, formative feedback, project-based practice, reflection, and soft-skill

operationalization. Practically, the findings imply that vocational teachers should design digital media not merely as online repositories, but as guided learning environments that promote active engagement, collaboration, communication, critical thinking, responsibility, and workplace-oriented problem solving. Nevertheless, this study is limited by its specific vocational context, the use of intact classes, the relatively short implementation period, and the absence of independent performance-based measurement of soft-skill development. Future studies should therefore involve larger and more diverse samples, stronger quasi-experimental or mixed-method designs, longer implementation periods, and validated soft-skill assessment instruments such as observation rubrics, peer assessment, portfolios, and workplace simulations. Overall, this study offers a forward-looking contribution to vocational educational technology by demonstrating that digital learning media can become a strategic bridge between technical competence and workplace readiness when designed around authenticity, interactivity, feedback, and employability-oriented learning behaviours.

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