



Innovation in Computer-Based Interactive Learning Media to Support Student Learning at SMK Tiwikrama Mamuju

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Abstrak: Perkembangan teknologi digital yang semakin pesat telah mendorong lembaga pendidikan untuk mengintegrasikan media pembelajaran inovatif dan interaktif guna meningkatkan kualitas proses pembelajaran. Media pembelajaran interaktif berbasis komputer memberikan peluang untuk menciptakan lingkungan belajar yang menarik, fleksibel, dan berpusat pada peserta didik melalui pemanfaatan berbagai komponen multimedia. Penelitian ini bertujuan untuk mengembangkan media pembelajaran interaktif berbasis komputer dalam mendukung proses pembelajaran siswa di SMK Tiwikrama Mamuju, dengan fokus pada aspek validitas, kepraktisan, dan efektivitas media yang dikembangkan. Penelitian ini menggunakan pendekatan Research and Development (R&D) dengan model pengembangan ADDIE yang terdiri atas lima tahapan, yaitu Analysis, Design, Development, Implementation, dan Evaluation. Media pembelajaran yang dirancang mengintegrasikan berbagai komponen multimedia, meliputi teks, gambar, video pembelajaran, animasi, kuis interaktif, dan evaluasi digital dalam satu platform pembelajaran. Teknik pengumpulan data meliputi validasi ahli, angket respons guru dan siswa, observasi, serta tes hasil belajar. Validitas media dinilai melalui penilaian ahli media dan ahli materi, sedangkan kepraktisan dievaluasi berdasarkan respons guru dan siswa. Efektivitas media direncanakan untuk diukur melalui perbandingan hasil pre-test dan post-test serta angket motivasi belajar siswa. Pengembangan media pembelajaran interaktif ini diharapkan mampu meningkatkan partisipasi aktif siswa, memperkuat pemahaman konsep, mengembangkan literasi digital, serta mendukung pembelajaran mandiri. Selain itu, integrasi multimedia berbasis komputer diharapkan dapat membantu guru menyampaikan materi secara lebih efektif dan memberikan pengalaman belajar yang bermakna bagi siswa. Penelitian ini diharapkan memberikan kontribusi terhadap pengembangan inovasi pembelajaran digital serta menjadi alternatif penerapan media pembelajaran interaktif pada jenjang pendidikan menengah kejuruan.

Kata Kunci: Media Pembelajaran Berbasis Komputer; Pembelajaran Interaktif; Inovasi Digital; Model ADDIE; Pendidikan Kejuruan.

Abstract

The rapid development of digital technology has encouraged educational institutions to integrate innovative and interactive learning media to improve the quality of teaching and learning. Computer-based interactive learning media offer opportunities to create engaging, flexible, and student-centered learning environments through the integration of multimedia elements. This study aims to develop computer-based interactive learning media to support student learning at SMK Tiwikrama Mamuju, focusing on the validity, practicality, and effectiveness of the developed media. The study adopts a Research and Development (R&D) approach using the ADDIE model, consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation. The proposed learning media integrate text, images, instructional videos, animations, interactive quizzes, and digital assessments into a unified learning platform. Data collection involves expert validation, teacher and student questionnaires, observations, and learning achievement tests. The validity of the media is assessed by media and subject-matter experts, while its practicality is evaluated through teacher and student responses. Its effectiveness is examined through pre-test and post-test assessments and students' learning motivation. The development of interactive learning media is expected to facilitate active participation, strengthen conceptual understanding, enhance digital literacy, and support independent learning. Furthermore, integrating computer-based multimedia into classroom instruction is anticipated to help teachers deliver learning materials more effectively and provide students with meaningful learning experiences. This study is expected to contribute to digital learning innovation and provide a practical framework for implementing interactive learning media in vocational secondary education.

Keywords: Computer-Based Learning Media; Interactive Learning; Digital Innovation; ADDIE Model; Vocational Education.

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Introduction

The rapid development of information and communication technology has significantly transformed various aspects of human life, particularly in the field of education. Digital technology has become an essential component of modern educational systems, providing opportunities for teachers and students to engage in more innovative, flexible, and interactive learning experiences. The integration of technology into classroom instruction is no longer considered merely an additional teaching resource but has become an important strategy for improving educational quality and responding to the demands of twenty-first-century learning. Educational institutions are increasingly encouraged to adopt technology-based learning approaches that promote creativity, critical thinking, collaboration, communication, and digital literacy. In this context, computer-based interactive learning media represent a promising innovation for supporting effective teaching and learning processes, particularly in vocational secondary education.

Vocational education plays a strategic role in preparing students with the knowledge, practical skills, and technological competencies required in the modern workforce. Unlike general secondary education, vocational schools emphasize the integration of theoretical knowledge and practical competencies relevant to specific professional fields. Therefore, instructional approaches implemented in vocational schools should provide meaningful learning experiences that connect classroom knowledge with real-world applications. Computer-based interactive learning media can support these objectives by presenting instructional materials through multimedia elements, including text, images, animations, videos, simulations, and interactive assessments. These features enable students

to explore learning materials actively and independently while developing the digital competencies required in contemporary professional environments.

The Indonesian education system has undergone substantial transformation through the implementation of the Merdeka Curriculum, which emphasizes student-centered learning, differentiated instruction, and the development of essential competencies. This educational transformation encourages teachers to design learning experiences that accommodate students' diverse learning needs, abilities, and interests. Technology integration provides opportunities to implement these principles through personalized learning activities and interactive instructional resources. Computer-based learning media can facilitate flexible learning experiences by allowing students to access materials, complete exercises, receive feedback, and evaluate their understanding according to their individual learning progress. Consequently, the development of interactive learning media aligns with national educational priorities aimed at strengthening digital literacy and improving learning quality.

Despite the increasing availability of educational technologies, their effective integration into classroom instruction remains challenging. Conventional teaching approaches, including lectures, textbook-based explanations, and static presentations, may provide limited opportunities for active student participation when they are not accompanied by interactive learning activities. Such approaches can make it difficult for students to understand abstract concepts, particularly when instructional materials require visualization, demonstration, and practical application. In vocational education, these challenges are especially relevant because students are expected to acquire both conceptual

understanding and practical skills. Therefore, instructional innovation is necessary to create learning environments that encourage active engagement, independent exploration, and meaningful interaction with learning materials.

Computer-based interactive learning media offer several pedagogical advantages compared with instructional resources that provide information without meaningful interaction. Through multimedia integration, complex concepts can be presented using visual representations, instructional videos, animations, and interactive simulations. These components may help students understand learning materials more effectively by connecting verbal explanations with visual information. Mayer's (2021) Cognitive Theory of Multimedia Learning explains that meaningful learning can occur when learners actively process and integrate information presented through verbal and visual channels. Accordingly, appropriately designed multimedia learning environments can support knowledge construction, improve conceptual understanding, and reduce unnecessary cognitive processing during instructional activities.

Furthermore, interactive learning media can encourage students to become active participants rather than passive recipients of information. Interactive exercises, digital quizzes, simulations, and immediate feedback allow learners to monitor their progress and identify areas requiring improvement. Such features are consistent with constructivist learning principles, which emphasize the active construction of knowledge through experience, interaction, and reflection. When students are provided with opportunities to explore instructional content independently, they can develop greater responsibility for their learning activities. Nevertheless, the effectiveness of interactive media depends on instructional design quality, accessibility, technological

infrastructure, and the extent to which digital features support clearly defined learning objectives.

Learning motivation is another important consideration in developing computer-based interactive learning media. Students who demonstrate strong learning motivation are generally more willing to participate in instructional activities, complete assignments, and overcome learning difficulties. Keller's ARCS motivational model identifies four essential components of learning motivation: Attention, Relevance, Confidence, and Satisfaction. Interactive learning media can potentially support these components through attractive multimedia presentations, relevant instructional examples, appropriately challenging learning activities, and immediate feedback. For example, instructional videos and animations may capture students' attention, while practical simulations can demonstrate the relevance of learning materials to real-world situations. Interactive assessments may also strengthen students' confidence by allowing them to evaluate their understanding and recognize their learning progress.

At SMK Tiwikrama Mamuju, the development of computer-based interactive learning media is proposed as an educational innovation to support students' learning experiences. As a vocational educational institution, the school provides a relevant context for examining how digital instructional resources can be integrated into teaching and learning activities. The proposed media are designed to combine instructional materials, visual explanations, learning videos, interactive exercises, and digital assessments within an integrated learning environment. Through these features, students are expected to obtain more engaging and accessible learning experiences, while teachers may benefit from additional resources for presenting instructional content and monitoring learning

progress. However, the specific technological conditions, instructional challenges, and learning needs at SMK Tiwikrama Mamuju require direct investigation before conclusions regarding the effectiveness of the proposed innovation can be established.

The development of computer-based interactive learning media requires a systematic instructional design approach to ensure that the resulting product meets educational objectives and user needs. The ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation, provides a structured framework for developing and evaluating instructional products. During the analysis stage, students' learning needs, instructional challenges, and technological resources are identified. The design stage focuses on learning objectives, content organization, interface design, and interactive activities. Subsequently, the development stage involves producing and validating instructional media, while implementation examines their application in actual learning environments. Finally, evaluation assesses the validity, practicality, and effectiveness of the developed media to determine their suitability for educational use.

Previous studies on technology-enhanced learning have highlighted the potential of digital multimedia and interactive instructional environments to support student engagement and learning outcomes. However, the educational benefits of these technologies are influenced by instructional context, learner characteristics, and implementation strategies. Consequently, further investigation is necessary to determine how computer-based interactive learning media can be designed and implemented effectively in specific vocational school environments. The present study focuses on integrating multimedia instructional content, interactive learning activities, and digital assessment features

within a unified educational platform. Its proposed contribution lies in examining the development and educational suitability of this integrated learning media in the context of vocational secondary education at SMK Tiwikrama Mamuju.

Based on these considerations, this study aims to develop computer-based interactive learning media to support student learning at SMK Tiwikrama Mamuju and to examine their validity, practicality, and effectiveness. Specifically, the study seeks to identify instructional needs, design and develop interactive learning resources, evaluate their quality through expert validation and user responses, and investigate their potential contribution to students' conceptual understanding and learning motivation. The findings are expected to provide practical insights for teachers, educational institutions, and instructional media developers regarding the integration of computer-based technologies into vocational education. Furthermore, this study is expected to contribute to the advancement of digital learning innovation by offering a systematic approach to developing interactive educational resources that support meaningful, engaging, and student-centered learning experiences.

Method

This study adopts a Research and Development (R&D) approach to develop computer-based interactive learning media designed to support student learning at SMK Tiwikrama Mamuju. The research employs the ADDIE instructional development model, which consists of five systematic stages: Analysis, Design, Development, Implementation, and Evaluation. This model was selected because it provides a structured framework for identifying instructional needs, designing educational products, developing interactive learning resources,

implementing instructional innovations, and evaluating their educational quality. The study focuses on three essential indicators of product quality: validity, practicality, and effectiveness. A quantitative approach is proposed for analyzing expert validation scores, questionnaire responses, and learning achievement tests, while qualitative information from observations, interviews, and expert suggestions is used to support product improvement.

Research Setting and Participants

The research is designed to be conducted at SMK Tiwikrama Mamuju, West Sulawesi, Indonesia. The intended participants include vocational school students, subject teachers, media experts, and subject-matter experts. Students serve as the primary users of the developed learning media, while teachers provide information regarding instructional needs and evaluate the practicality of the product. Media experts assess technical quality, interface design, navigation, and interactivity, whereas subject-matter experts evaluate content accuracy, instructional relevance, and alignment with learning objectives. Student participants are to be selected using purposive sampling based on their involvement in the relevant learning activities. The final sample size, grade level, and subject area will be established during the preliminary investigation.

Development Procedures

The development process follows the five stages of the ADDIE model.

1. Analysis

The analysis stage focuses on identifying instructional problems, students' learning characteristics, and the technological resources available at SMK Tiwikrama Mamuju. Data are collected through classroom observations, teacher interviews, and an assessment of existing instructional materials. This stage examines students'

learning difficulties, teachers' instructional strategies, and the availability of computers and supporting infrastructure. The findings are used to establish instructional objectives and determine the essential features required in the proposed interactive learning media.

2. Design

During the design stage, the instructional media are systematically planned based on the findings of the needs analysis. Activities include determining learning objectives, organizing instructional materials, preparing storyboards, designing the user interface, and developing assessment instruments. The proposed media integrate text, images, instructional videos, animations, interactive exercises, and digital quizzes. Particular attention is given to navigation, readability, accessibility, and the relationship between multimedia components and instructional objectives. The design also includes the preparation of expert validation sheets, student questionnaires, and learning achievement tests.

3. Development

The development stage involves producing the computer-based interactive learning media according to the approved instructional design. Multimedia materials are integrated into a digital learning environment that allows students to access instructional content, complete exercises, and receive learning feedback. The product is subsequently reviewed by media and subject-matter experts. Media validation focuses on visual appearance, functionality, navigation, accessibility, and technical performance. Subject-matter validation examines content accuracy, clarity, relevance, and instructional suitability. Expert suggestions are incorporated into product revisions before classroom implementation.

4. Implementation

The implementation stage involves introducing the developed media into

classroom learning activities at SMK Tiwikrama Mamuju. Teachers provide guidance on accessing and using the media, while students engage with instructional materials and complete interactive learning activities. A one-group pre-test–post-test design is proposed to examine changes in students' learning achievement. Students complete a pre-test before using the media and a post-test after the learning intervention. Teacher and student questionnaires are also administered to evaluate the practicality and usability of the developed product.

5. Evaluation

Evaluation is conducted throughout the development process and after classroom implementation. Formative evaluation supports improvements in instructional content, multimedia presentation, and system functionality. Summative evaluation examines the validity, practicality, and effectiveness of the developed media. The evaluation results are intended to identify product strengths, limitations, and recommendations for further development.

Research Instruments and Data Collection

The research employs observation sheets, interview guidelines, expert validation instruments, practicality questionnaires, learning motivation questionnaires, and achievement tests. Observation and interview instruments are used to identify instructional needs and technological conditions. Expert validation sheets employ a Likert-type rating scale to assess media quality and instructional suitability. Teacher and student questionnaires measure usability, accessibility, attractiveness, and perceived instructional benefits. Learning motivation is examined using indicators adapted from the ARCS model, including Attention, Relevance, Confidence, and Satisfaction. Pre-test and post-test instruments measure

students' understanding of the selected instructional materials.

Data Analysis Techniques

Quantitative data are analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations. Expert validation and practicality questionnaire scores are converted into percentages using the following formula:

$$P = \frac{S}{S_{\max}} \times 100\%$$

where (P) represents the percentage score, (S) represents the obtained score, and $(S_{\max})$ represents the maximum possible score. The resulting percentages are interpreted using predetermined assessment criteria.

Learning improvement is examined by comparing students' pre-test and post-test scores. Normalized gain (N-Gain) is calculated using:

$$g = \frac{S_{\text{post}} - S_{\text{pre}}}{S_{\max} - S_{\text{pre}}}$$

where (S_{post}) represents the post-test score, (S_{pre}) represents the pre-test score, and $(S_{\max})$ represents the maximum achievable score. N-Gain values are classified into low, moderate, and high improvement categories. Qualitative information obtained from interviews, observations, and expert feedback is analyzed through data reduction, categorization, and interpretation. These findings are used to explain the quantitative results and guide further product refinement.

Research Ethics

The study is designed to follow ethical principles, including voluntary participation, informed consent, confidentiality, and responsible data management. Permission

will be obtained from the school before conducting research activities. Participants' identities and individual assessment results will be protected, and collected information will be used exclusively for educational research purposes.

Catatan akademik: Metode ini merupakan rancangan sekitar 800 kata yang diadaptasi dari penelitian dalam file sumber, termasuk model ADDIE, validasi ahli, angket, desain one-group pre-test–post-test, dan analisis N-Gain. Jumlah sampel, mata pelajaran, kelas, durasi intervensi, serta hasil validasi di SMK Tiwikrama Mamuju belum tersedia sehingga tidak dibuat-buat.

Untuk artikel jurnal, bagian metode perlu disesuaikan kembali dengan pelaksanaan penelitian yang sebenarnya sebelum dinyatakan sebagai penelitian yang telah selesai.

RESULTS AND DISCUSSION

The first stage of the research focuses on identifying the instructional needs associated with implementing computer-based interactive learning media at SMK Tiwikrama Mamuju. The needs analysis is structured around three main components: existing instructional practices, students' learning requirements, and the availability of technological infrastructure. These components provide a foundation for determining the characteristics of interactive learning media suitable for vocational education.

The source study identifies several issues relevant to technology-supported instruction, including the need to integrate instructional materials, multimedia presentations, learning activities, and assessments within a unified platform. It also highlights the importance of computer availability, internet connectivity, and students' access to digital learning resources.

These findings provide useful considerations for designing the proposed media at SMK Tiwikrama Mamuju, although their relevance to the school must be confirmed through local observations and interviews.

The proposed needs analysis is intended to establish whether existing instructional resources sufficiently support students' conceptual understanding, independent learning, and active classroom participation. Its findings will guide the selection of multimedia features and determine the technical requirements for classroom implementation.

4.2. Development of Computer-Based Interactive Learning Media

The development of computer-based interactive learning media follows the ADDIE instructional design model, which includes Analysis, Design, Development, Implementation, and Evaluation. The proposed product combines instructional content, multimedia resources, interactive activities, and digital assessment tools within an integrated learning environment.

The instructional design incorporates textual explanations, illustrations, educational videos, interactive exercises, and digital quizzes. These components are intended to provide multiple opportunities for students to engage with instructional materials and demonstrate their understanding.

The source document describes a web-based learning system with separate user functions for administrators, teachers, and students. Its main features include login access, a learning dashboard, instructional materials, assignments, quizzes, learning results, and profile management. These features can serve as a development reference for the proposed computer-based learning media.

Table 1. Proposed Features of Computer-Based Interactive Learning Media

Component	Description	Instructional Function
Learning dashboard	Main navigation interface	Organizes learning activities
Digital materials	Text, images, and explanations	Supports conceptual understanding
Instructional videos	Multi-media presentations	Visualizes learning content
Interactive quizzes	Digital assessment activities	Evaluates understanding
Assignment management	Submission and monitoring features	Supports independent learning
Learning results	Scores and feedback	Monitors learning progress

The integration of these components is intended to establish a more structured digital learning environment. However, implementation at SMK Tiwikrama Mamuju must be verified before the features can be reported as a completed research product.

4.3. Results of Expert Validation

Expert validation is designed to determine whether the developed media meet instructional and technical quality requirements. The validation process involves media experts and subject-matter experts who assess different aspects of the product.

Media experts evaluate interface design, navigation, readability, visual consistency, interactivity, and system functionality. Subject-matter experts examine instructional content, accuracy, relevance,

clarity, and alignment with learning objectives.

The source research uses expert validation as an essential component of product evaluation. Its methodological framework can be adapted to assess the proposed media at SMK Tiwikrama Mamuju.

Table 2. Expert Validation Reporting Framework

Validation Aspect	Assessment Focus	Result
Content quality	Accuracy and relevance	To be assessed
Instructional design	Alignment with objectives	To be assessed
Interface design	Layout and readability	To be assessed
Navigation	Ease of accessing features	To be assessed
Interactivity	Functionality of activities	To be assessed
Technical quality	System performance	To be assessed

The validation results should be calculated from actual expert assessment scores. Recommendations provided by validators should subsequently be used to revise the instructional content and improve the technical performance of the media.

4.4. Results of Media Practicality Assessment

The practicality assessment focuses on determining whether the interactive learning media can be used effectively by teachers and students during classroom instruction. Practicality is evaluated through questionnaires addressing ease of use,

accessibility, visual appearance, instructional usefulness, and overall user experience.

Teacher responses are intended to identify the extent to which the media facilitate instructional delivery, assignment management, and student assessment. Student responses focus on navigation, clarity of instructional materials, attractiveness of multimedia features, and accessibility of learning activities.

The assessment also considers possible implementation barriers, including device availability, internet stability, and differences in students' technological familiarity. These factors are important because a technically functional learning platform may still encounter difficulties when implemented in classrooms with limited infrastructure.

Actual questionnaire responses from SMK Tiwikrama Mamuju are required to determine whether the developed product meets the predetermined practicality criteria.

4.5. Results of Learning Effectiveness Assessment

Learning effectiveness is evaluated through a proposed one-group pre-test–post-test design. The pre-test measures students' initial understanding of selected instructional materials, while the post-test examines their achievement after participating in learning activities supported by the developed media.

The difference between pre-test and post-test scores is analyzed to identify changes in learning achievement. Normalized gain analysis is also proposed to determine the magnitude of improvement.

Table 3. Student Learning Achievement Reporting Template

Assessment Indicator	Result
Number of students	To be reported
Mean pre-test score	To be reported
Mean post-test score	To be reported

Mean N-Gain	To be calculated
Improvement category	To be determined

In addition to learning achievement, students' motivation is evaluated through the ARCS framework, consisting of Attention, Relevance, Confidence, and Satisfaction. The questionnaire results are intended to describe students' perceptions of the learning experience.

The source study reports the use of pre-test, post-test, N-Gain, and ARCS motivation assessments. Nevertheless, its findings cannot be transferred directly to SMK Tiwikrama Mamuju. School-specific data are necessary before conclusions about learning improvement or motivational outcomes can be established.

Overall, the proposed evaluation framework provides a systematic basis for assessing the validity, practicality, and effectiveness of computer-based interactive learning media in vocational education.

DISCUSSION

The development of computer-based interactive learning media represents an important approach to educational innovation, particularly in vocational secondary schools where instructional activities are expected to integrate theoretical knowledge with practical competencies. Digital learning environments provide opportunities to present instructional materials through various multimedia formats and facilitate meaningful interactions between students and learning content.

The proposed development at SMK Tiwikrama Mamuju emphasizes the integration of multimedia instructional materials, interactive exercises, and digital assessments within a unified learning platform. This approach reflects the increasing importance of technology-

supported learning environments in contemporary education.

The educational value of interactive learning media, however, should not be determined solely by the presence of technological features. Effective instructional innovation requires alignment between learning objectives, content organization, learner characteristics, and assessment strategies. Multimedia components should support the learning process rather than function merely as visual enhancements.

The ADDIE model provides a systematic framework for achieving this alignment. By organizing development activities into analysis, design, development, implementation, and evaluation, the model encourages instructional designers to consider both pedagogical requirements and technological feasibility.

5.2. The Role of Multimedia in Supporting Conceptual Understanding

One of the principal advantages of computer-based interactive learning media is their capacity to present instructional materials through complementary verbal and visual representations. Multimedia learning environments can combine written explanations, illustrations, animations, videos, and interactive activities to support students' understanding of instructional concepts.

According to Mayer's (2021) Cognitive Theory of Multimedia Learning, learners construct meaningful knowledge by selecting, organizing, and integrating information from verbal and visual representations. This theoretical perspective suggests that well-designed multimedia materials may support conceptual understanding when their components are appropriately organized.

In vocational education, multimedia resources can be particularly useful for explaining procedures, demonstrating

technological processes, and illustrating concepts that are difficult to communicate through verbal explanations alone.

For example, instructional videos may demonstrate practical procedures, while interactive simulations can provide opportunities for students to explore relationships between concepts and their applications. These features may help students connect theoretical knowledge with vocational learning activities.

Nevertheless, multimedia integration requires careful instructional planning. Excessive visual information, unnecessary animation, and complicated navigation may increase cognitive demands and distract learners from essential instructional content.

Therefore, the proposed media should prioritize clarity, relevance, accessibility, and meaningful interaction to maximize their educational potential.

5.3. Interactive Learning Media and Student Engagement

Student engagement is an important dimension of effective teaching and learning. Interactive learning media can provide opportunities for students to participate actively through digital exercises, quizzes, assignments, and immediate feedback.

Unlike instructional environments that primarily involve one-way information delivery, interactive learning systems allow students to respond to instructional materials and monitor their learning progress.

This characteristic is consistent with constructivist perspectives, which emphasize the active role of learners in developing knowledge through experience, exploration, and reflection.

Interactive quizzes and digital assessments may support student engagement by providing immediate information about learning performance. Feedback can help students recognize incorrect responses,

identify areas requiring improvement, and revisit relevant instructional materials.

However, increased interaction with a digital platform does not automatically indicate deeper learning. The quality of engagement depends on whether interactive activities encourage meaningful cognitive processing and support clearly defined instructional objectives.

For this reason, the proposed media should include learning activities that require students to apply knowledge, solve problems, and reflect on their understanding rather than merely select answers.

5.4. Learning Motivation and the ARCS Model

Learning motivation represents another important consideration in evaluating interactive learning media. The ARCS model developed by Keller provides a framework for examining four motivational dimensions: Attention, Relevance, Confidence, and Satisfaction.

The Attention dimension concerns students' interest and concentration during learning activities. Multimedia presentations, interactive exercises, and visually engaging instructional materials may help attract and maintain attention.

Relevance refers to the extent to which instructional materials correspond to students' needs, interests, and learning objectives. In vocational education, instructional activities that reflect practical applications and professional contexts may strengthen students' perceptions of learning relevance.

Confidence relates to students' expectations of success and their ability to complete learning tasks. Clearly structured materials, progressive exercises, and constructive feedback can potentially support this dimension.

Satisfaction concerns the positive experiences associated with completing

learning activities and recognizing achievement. Digital feedback and visible learning progress may contribute to students' sense of accomplishment.

The ARCS framework therefore provides a useful theoretical foundation for evaluating motivational aspects of the proposed media. Nevertheless, actual motivational effects must be established through empirical data collected from participating students.

5.5. Validity, Practicality, and Effectiveness of Learning Media

The quality of computer-based interactive learning media can be evaluated through three interconnected dimensions: validity, practicality, and effectiveness.

Validity concerns whether the instructional content and technological design meet established educational requirements. Expert assessment is essential for identifying weaknesses in content accuracy, interface organization, navigation, and instructional suitability.

Practicality concerns whether teachers and students can use the media efficiently under actual classroom conditions. An instructional product may demonstrate strong technical quality but remain difficult to implement because of limited devices, unstable internet connections, or insufficient user familiarity.

Effectiveness concerns whether the developed media contribute to the intended learning outcomes. Pre-test and post-test assessments can provide evidence of changes in students' learning achievement, while motivation questionnaires offer information about their learning experiences.

However, the proposed one-group pre-test–post-test design has methodological limitations. Without a comparison group, observed score improvements cannot be attributed exclusively to the intervention because other factors, including repeated

testing, instructional support, and students' prior learning experiences, may influence outcomes.

Consequently, the interpretation of effectiveness should remain cautious and should be supported by appropriate statistical analysis and transparent reporting.

5.6. Implications for Vocational Education

The proposed development has several potential implications for teaching and learning at SMK Tiwikrama Mamuju. For teachers, integrated learning media may provide additional resources for presenting instructional content, organizing learning activities, and monitoring student progress.

For students, interactive multimedia resources may create opportunities for independent exploration, self-assessment, and repeated engagement with instructional materials.

At the institutional level, the development of digital learning resources may support broader efforts to strengthen technology integration and digital literacy in vocational education.

Nevertheless, sustainable implementation requires appropriate infrastructure, teacher professional development, technical maintenance, and continuous evaluation.

The proposed innovation should therefore be understood as a complementary instructional resource rather than a replacement for teacher guidance, practical training, or direct classroom interaction.

5.7. Research Limitations and Future Directions

Several limitations must be considered when interpreting the proposed research. First, implementation at a single vocational school may restrict the generalizability of findings to institutions with different

technological resources and student characteristics.

Second, the one-group pre-test–post-test design limits causal interpretation. Third, questionnaire-based evaluations may be influenced by students' subjective perceptions and response tendencies.

Future research should consider including comparison groups, larger samples, multiple vocational schools, and longer implementation periods. Additional investigations may examine learning retention, digital literacy development, system usability, and the relationship between interactive learning activities and practical vocational competencies.

Ultimately, computer-based interactive learning media have the potential to support more engaging and accessible instructional experiences when their development is grounded in educational needs and supported by systematic evaluation. The proposed study at SMK Tiwikrama Mamuju offers a context for examining these possibilities, while its actual contribution to learning achievement and motivation remains to be established through empirical implementation.

Conclusion

This study proposes the development of computer-based interactive learning media as an educational innovation to support teaching and learning activities at SMK Tiwikrama Mamuju. The proposed learning media are designed using the ADDIE development model, consisting of Analysis, Design, Development, Implementation, and Evaluation. By integrating multimedia components such as text, images, instructional videos, animations, interactive quizzes, and digital assessments, the developed platform is intended to provide a more engaging, flexible, and student-centered learning environment. The integration of these features is expected to facilitate

instructional delivery, encourage active student participation, and provide opportunities for independent learning. Furthermore, the systematic development process offers a framework for ensuring that the instructional media are aligned with students' learning needs, educational objectives, and technological requirements.

The evaluation framework emphasizes three essential aspects of instructional media quality: validity, practicality, and effectiveness. Expert validation is intended to assess the appropriateness of instructional content, interface design, navigation, and technical functionality, while teacher and student responses will provide information regarding usability and accessibility. Learning effectiveness is proposed to be examined through pre-test and post-test assessments, normalized gain analysis, and learning motivation questionnaires based on the ARCS model. These evaluation procedures are expected to provide evidence regarding the potential contribution of interactive learning media to students' conceptual understanding, learning motivation, and engagement. However, conclusions about actual improvements in learning outcomes cannot be established until empirical data from SMK Tiwikrama Mamuju have been collected and analyzed.

Overall, computer-based interactive learning media offer a promising approach to supporting digital transformation in vocational secondary education. Their integration into classroom instruction may help teachers present learning materials more effectively while providing students with opportunities to develop digital literacy, independent learning skills, and practical understanding. The proposed innovation also highlights the importance of combining technological development with appropriate instructional strategies to create meaningful learning experiences. Future research should examine the implementation of these media

using larger samples, comparison groups, and longer evaluation periods to determine their effectiveness and sustainability. The findings are expected to contribute to the development of innovative, accessible, and technology-supported learning environments in vocational schools, particularly at SMK Tiwikrama Mamuju.

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