GLOBAL INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

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Cite this article: Ratu Amilia Avianti. (2024). The Effectiveness of Online Learning Models and Assessment Methods in Improving Learning Competence in the Field of Mechatronics. Global International Journal of Innovative Research, 2(11).
https://doi.org/10.59613/global.v2i11.357

Received: October, 2024
Accepted: November, 2024

Keywords:
Online Learning, Assessment Methods, Learning Competencies, Mechatronics, Literature Studies

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Published by:

GLOBAL SOCIETY PUBLISHING

The Effectiveness of Online Learning Models and Assessment Methods in Improving Learning Competence in the Field of Mechatronics

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This study aims to analyze the effectiveness of online learning models and assessment methods in improving learning competencies in the field of mechatronics. With the development of information technology, online-based learning has become an important alternative in vocational education, including in the field of mechatronics which requires a combination of theoretical and practical knowledge. The approach used in this study is qualitative with a literature study method or library research, which traces various relevant literature sources from journal articles, books, and previous research reports. The results of the study show that the application of an online learning model supported by the right assessment method can significantly improve student competence. Learning models that involve active interaction, such as project-based learning and virtual simulations, are effective in developing the practical skills needed in the field of mechatronics. In addition, formative and summative assessment methods integrated in online learning allow for continuous monitoring and improvement of students' abilities. However, the effectiveness of online learning in this area still faces challenges, especially in terms of providing adequate infrastructure and stable technological support. This study concludes that the success of the online learning model in improving competence in the field of mechatronics depends on the selection of appropriate teaching methods and structured assessments. Recommendations are given for educational institutions to continue to develop interactive and innovative online learning models in order to be able to produce competent graduates in the field of mechatronics.

1. Introduction

Advances in information technology have changed various aspects of education, including learning in the field of mechatronics, which demands a combination of theoretical and practical skills (Widodo & Mawarsari, 2021). Mechatronics as a multidisciplinary field that combines mechanics, electronics, and informatics requires an interactive and flexible learning approach to develop student competencies (Hermawan, 2020). In this case, the online learning model has become one of the solutions that is able to answer the challenges of limited access and time flexibility faced in traditional education (Hidayat & Munawar, 2019). However, the effectiveness of online learning in fields that require practical skills is still a debate, especially in the context of how assessment methods can be effectively integrated to achieve optimal learning outcomes (Susanto, 2020).

Learning in the field of mechatronics is an educational process that emphasizes the mastery of multidisciplinary skills that include aspects of mechanics, electronics, and informatics. Mechatronics integrates these various disciplines to create complex and automated systems or products, such as robotics, automated control systems, and sensor-based technologies. Due to the complexity of this field, mechatronics learning demands a comprehensive approach that includes basic theory, laboratory practice, as well as real-world application projects. Learning not only focuses on understanding concepts, but also on developing adequate technical skills to design, build, and operate mechatronic systems (Widodo & Mawarsari, 2021).

In today's digital era, mechatronic education is increasingly encouraged to use online learning technology as a solution to improve educational accessibility and flexibility. Online learning in the field of mechatronics allows students to access theoretical materials and practical tutorials from a variety of global sources, as well as take part in virtual simulations that can mimic a real work environment. Although simulation technology and software support online mechatronics learning, there are challenges in terms of direct interaction with physical equipment, which is a critical component of understanding the operation of real systems. With this limitation, online learning in mechatronics must be equipped with interactive and collaborative learning methods so that students can still develop appropriate practical skills (Putra & Sari, 2020).

In addition, learning in the field of mechatronics requires an assessment model that is able to measure students' competence in theoretical understanding as well as technical skills. This assessment model should combine formative and summative methods that assess not only cognitive aspects but also motor skills and systems analysis. Assessment in mechatronics learning can take many forms, including problem-based projects, simulated exams, and

portfolio assessments that reflect students' ability to design and implement mechatronics solutions. This is necessary so that graduates in the field of mechatronics have adequate competencies to meet the needs of industries that demand high technical skills and a deep interdisciplinary understanding (Ramdhani & Dewi, 2019).

Previous studies have shown various advantages and disadvantages of online learning, but most of the research only focuses on theoretical aspects and has not explored in depth the integration of assessment methods in the context of mechatronic learning (Aisyah, 2021; Ramdhani & Dewi, 2019). This is where the research gap of this study lies, where there are still few studies that discuss how online learning models applied with the right assessment methods can comprehensively improve student competence (Saputra, 2018). This shows the urgency to examine the relationship between online learning models and assessment methods in creating effective learning in fields that demand practical skills, such as mechatronics (Putra & Sari, 2020).

This literature study describes and reviews previous studies to clarify the shortcomings and advantages of online learning models in improving learning competencies, as well as assessment methods that support the sustainable development of students' abilities (Wijaya et al., 2022). The novelty of this study is the presentation of a new perspective on the importance of assessment methods in supporting the success of online learning, especially in technical fields such as mechatronics, which require evaluation of practical and theoretical abilities (Hartono, 2019). The purpose of this study is to analyze the effectiveness of online learning models and assessment methods in improving learning competencies in the field of mechatronics.

The benefit of this research is to provide recommendations for educational institutions in designing effective online learning models and assessment methods that support competency improvement in the field of mechatronics. The results of this research are expected to be a reference for the development of technology-based curriculum in the vocational field that focuses on practical skills and the proper application of theory (Nurhayati, 2021).

2. Method

This study uses a qualitative approach with the type of literature study research to analyze the effectiveness of online learning models and assessment methods in improving learning competencies in the field of mechatronics. This literature study research aims to identify, evaluate, and synthesize relevant previous research findings, resulting in comprehensive

conclusions regarding the topic being studied (Snyder, 2019). Literature studies are considered an effective method in understanding a broader perspective on the effectiveness of online learning methods in fields that require in-depth practical and theoretical skills (Arksey & O'Malley, 2005).

Data sources in this study include scientific journal articles, books, research reports, and other academic publications relevant to online learning and assessment methods in the field of mechatronics. The articles used are obtained from trusted scientific databases such as Google Scholar, Scopus, and ScienceDirect to ensure the validity and relevance of the data taken. The inclusion criteria for article selection include studies that discuss online learning, assessment methods, and their application in the field of mechatronics or vocational education that have similar characteristics. Meanwhile, exclusion criteria include irrelevant articles, studies with unverifiable methodologies, and low-quality publications (Kitchenham & Charters, 2007).

The data collection technique used is to review and review the literature in accordance with this research topic. Each article was carefully reviewed to identify key variables, key findings, as well as methods used in previous studies. The relevant articles were then grouped based on specific themes, such as online learning models, assessment methods, and their impact on mechatronics learning, to facilitate further data analysis (Boell & Cecez-Kecmanovic, 2015).

The data obtained was analyzed using the content analysis method, where each finding from previous research was identified and synthesized to obtain certain patterns in the context of the effectiveness of online learning and assessment methods. This analysis aims to gain a deep understanding of the factors that play a role in the success of online learning in the field of mechatronics, as well as how assessment methods can support the development of student competencies (Krippendorff, 2018). This approach allows researchers to draw relevant conclusions and provide practical recommendations for the development of online learning models in the growing field of technical education.

3. Result and Discussion

The following is a table of literature data that is the main finding in this study. The data presented is the result of a selection of several related articles regarding the effectiveness of online learning models and assessment methods in improving learning competence in the field of mechatronics. From several articles found, the following 10 articles were selected based on the relevance and quality of the research to be further analyzed in order to support this

literature study.

Author	Year	Title	Findings
Widodo & Mawarsari	2021	The Effectiveness of Technology-Based Learning in the Engineering Study Program	Technology-based learning improves theoretical and practical understanding.
Hermawan	2020	The Role of Mechatronics Learning in Vocational Education in the Industrial Era 4.0	Technical skills improve with a project-based approach.
Hidayat & Munawar	2019	The Effectiveness of Online Learning in Improving Student Competence	Online learning facilitates flexibility and accessibility.
Ramdhani & Dewi	2019	Study on the Effectiveness of Online Learning: A Comparison of Formative and Summative Assessment Methods	Formative and summative assessments improve student performance.

Putra & Sari	2020	Distance Learning and Its Challenges in the Field of Mechatronics	The main challenge is limited access to laboratory equipment
Nurhayati	2021	Development of Online Learning Curriculum to Improve Technical Competence	Online-based curriculum needs a structured assessment method.
Susanto	2020	Online Learning and Its Influence on Student Competence in the Engineering Field	Online learning is effective but requires practical assistance.
Saputra	2018	Alternative Assessment Methods in Engineering Education	Project-based assessments are more effective than traditional exams.
Hartono	2019	Implementation of Collaborative Learning Model in Vocational Education	Collaboration increases motivation and deep understanding
Wijaya, Santoso, & Handayani	2022	Integration of Online Learning and Assessment Methods in	Continuous formative assessment methods are

	Engineering Education	effective in student evaluation.

This table summarizes the articles that are the main basis for analyzing the effectiveness of online learning models and assessment methods in mechatronics learning. Each selected article makes a special contribution, both in highlighting the advantages of online learning, the challenges in its implementation, and the importance of appropriate assessment methods to support competencies in the field of engineering and mechatronics.

The interpretation of the data from the literature table presented shows various perspectives on the effectiveness of online learning and assessment methods in the context of improving competence in the field of mechatronics. In general, most articles support the use of technology-based learning in vocational education, including mechatronics. For example, research by Widodo and Mawarsari (2021) states that technology-based learning can enrich students' theoretical and practical understanding, which is important for engineering fields such as mechatronics. This shows that digital technology can make a positive contribution in facing the challenges of vocational education, especially in terms of limited physical access in laboratories or learning locations far from technical facilities.

Furthermore, articles by Hermawan (2020) and Hidayat & Munawar (2019) support this argument by showing that the flexibility and accessibility offered by the online learning model help students in managing their study time independently. This is especially relevant in the context of mechatronics, where college students or students need to access a variety of learning resources without being limited to space and time. The research also highlights the importance of project-based learning to improve students' technical skills, which is relevant to the needs of the mechatronics industry that prioritizes practical skills and high technical ability.

However, the results of several studies also reveal challenges in the implementation of online learning in fields that require hands-on practical skills, such as mechatronics. For example, Putra and Sari (2020) stated that limited access to laboratory equipment is one of the main obstacles. This challenge emphasizes the need for adequate technological infrastructure so that online learning can be effective in this field. In addition, Susanto (2020) added that although online learning is effective in theory, in practice it requires mentoring or direct

practicum sessions to ensure that students' technical skills can develop optimally.

In line with these challenges, research by Ramdhani and Dewi (2019) and Wijaya et al. (2022) emphasizes the importance of appropriate assessment methods in online learning. Assessment methods, especially formative and summative, can be used to monitor and evaluate students' learning progress on an ongoing basis. Formative assessment allows teachers or teachers to provide constructive feedback to students so that they can improve their abilities in the early stages. In the context of mechatronics, this continuous formative assessment is very helpful for students in identifying their weaknesses and improving their technical skills before moving on to the final assessment.

Research by Saputra (2018) and Nurhayati (2021) also shows that alternative assessment methods, such as project- and portfolio-based assessments, are more effective than traditional exams for areas that require practical skills such as mechatronics. Project-based assessments allow students to demonstrate their competence in real applications, which is crucial for the field of engineering. These articles support that the integration of practical assessment methods in online curricula has a positive impact on students' competencies, encouraging them to learn more deeply and apply theoretical knowledge in practical contexts.

Overall, the findings conclude that online learning can be effective in improving competence in the field of mechatronics if supported by structured and sustainable assessment methods. The analyzed studies show that the challenges of online learning in the field of mechatronics can be minimized by the use of simulation technology and assessment methods that are adaptive to the practical needs of students. The recommendation that emerges from these findings is the importance of collaboration between educational institutions and industry to provide a learning platform that is not only theoretical, but also applicable in accordance with the demands of competencies in the field of mechatronics.

Discussion and Analysis

The findings of this literature study show that online learning can be an effective method in mechatronics education, with the note that its application must be accompanied by appropriate strategies and relevant assessment methods. Today, online learning is increasingly becoming the norm in education, especially after the COVID-19 pandemic which forced many institutions to switch from face-to-face learning to online mode. In this context, the flexibility of online learning provides significant advantages for students who may have difficulty physically accessing campus or laboratory facilities. However, in fields such as

mechatronics that require a lot of hands-on practice, online learning requires additional technological support to be effective (Widodo & Mawarsari, 2021).

One of the prominent approaches in online learning in the field of mechatronics is the use of simulation technology. Simulations allow students to learn technical skills in a virtual environment that approaches real-world situations. Based on the theory of constructivism introduced by Piaget, students can learn more effectively when they actively build understanding through direct experience. Simulation in online learning allows students to "try and fail" without the risk of damaging expensive equipment, which is one of the main obstacles in engineering education (Hermawan, 2020). The use of this simulation reinforces the theory of constructivism, where authentic learning experiences can encourage students to understand concepts more deeply.

However, the main obstacle to online learning in the field of mechatronics is the limited infrastructure, especially in developing countries, which are not fully ready to provide supporting technologies such as high-performance computers and reliable simulation software. This is a relevant challenge in the implementation of online learning in Indonesia, where access to technology is often limited (Putra & Sari, 2020). In this case, the findings from the literature table that show that online learning is effective but constrained by device limitations become relevant. The author argues that there needs to be policy support from the government and institutions to ensure equal access to technology for vocational students.

On the other hand, assessment methods also play a key role in improving student competence in online learning. Based on the theory of formative evaluation, assessments that are carried out gradually or continuously provide direct feedback to students so that they can improve their performance quickly. Ramdhani and Dewi (2019) showed that formative assessment can increase students' motivation to learn because they feel helped in identifying their shortcomings from the beginning. In the context of mechatronics, where practical skills are important, formative assessments can help students improve their technical competencies on an ongoing basis.

Project-based assessment is also an effective method in mechatronics online learning. Based on the theory of project-based learning, students can further develop analytical and creative skills when faced with real projects that require problem solving. This is consistent with the findings of Saputra (2018), where project-based assessments show effectiveness in measuring students' ability to apply theory into practice. The authors argue that this method is particularly relevant for the field of mechatronics, which requires technical skills as well as

the ability to think critically in solving problems.

However, online learning is not without its drawbacks. Susanto (2020) stated that, although online learning can improve cognitive competence, students' practical abilities are often underdeveloped due to limited interaction with physical equipment. In the context of engineering education, motor skills and hands-on experience play important roles that cannot be fully simulated virtually. This shows that although online learning can enrich theoretical understanding, live practicum sessions are still needed for students to get a complete experience. The author's opinion is that a hybrid learning model that combines online and face-to-face methods may be an effective solution.

In line with these challenges, the support of educational institutions and government policies is urgently needed to facilitate the technological infrastructure needed in online learning, especially in fields that require practical skills such as mechatronics. This includes the provision of affordable or even free simulation software as well as increased internet access in remote areas (Nurhayati, 2021). The author argues that this support will greatly help increase the effectiveness of online learning in the vocational field.

Overall, online learning supported by the right assessment method can provide positive results for student competence, but with the note that this learning must be adjusted to the characteristics of the field of mechatronics. The findings of this study show that project-based and formative assessment methods have a great contribution in helping students achieve the required technical competencies. With the application of simulation technology and integrated assessment methods, online learning can be optimized for engineering fields that require practical skills.

The effectiveness of online learning in the field of mechatronics will increase if educational institutions can implement technology that supports students' practical experience and conduct periodic evaluations of the assessment methods used. Thus, these findings show that the integration of online learning models and appropriate assessment methods is an important step in improving student competence in the field of mechatronics.

4. Conclusion

The results of this literature study conclude that online learning has great potential in improving learning competence in the field of mechatronics, especially when accompanied by appropriate assessment methods. The online learning model provides flexibility and

accessibility that is much needed by students, especially in today's digital era. In the context of mechatronics, simulation-based learning technology is an important tool to provide virtual practical experiences that are close to reality. This allows students to develop technical skills without having to be in a physical laboratory all the time, so online learning can be a viable alternative in engineering education.

However, the effectiveness of online learning in the field of mechatronics also faces challenges, especially in terms of infrastructure limitations and motor skills that are difficult to develop without hands-on practice. The findings suggest that the main challenge of online learning is the lack of access to physical laboratory equipment, which is an important factor in fields that require practical skills. While simulation and project-based assessment technologies can help fill this gap, online learning in engineering needs to be complemented by face-to-face practicum sessions or hybrid learning models that combine online and physical practice for more optimal outcomes.

Based on the results of this study, it is recommended that further research can explore more deeply the hybrid learning model in the field of mechatronics that combines online learning with physical practice. In addition, further research is also expected to examine the effectiveness of more sophisticated simulation technology in supporting online learning, as well as evaluate the implementation of more innovative assessment methods such as competency-based assessment. Other recommendations include research on the impact of government policies on the provision of technology infrastructure to support online learning in vocational institutions, to ensure equitable and effective learning across the region.

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