Development of an Assessment Model for Electric Circuit Courses Based on “Free Campus Learning (MBKM) According to Industry Needs” Using an Expert System

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ABSTRACT
The aim of the research is to develop an MBKM-based assessment model for electrical circuit courses according to industry needs by using an expert system to provide recommendations in determining implementation policies on campus. The aspects assessed are the validity, practicality and effectiveness of the model. The instruments used are observation sheets, interview guides and questionnaires for students, lecturers and industry. And also use tests to measure student learning outcomes. The research population at the Faculty of Engineering, Padang State University, sample selection using a purposive sampling technique was 55 students and 5 lecturers, and industry instructors. Descriptive data analysis techniques to measure the validity, practicality and effectiveness of the model. And also the test uses Structural Equation Modeling (SEM) using the SMART PLS application. The findings from the needs analysis of an expert system-based assessment model are that the results are very much needed. In line with the results of observations and interviews, it shows that there are still problems that occur in learning activities, assessment and MBKM, which requires the development of assessment models. Meanwhile, the results of expert validation produce data models, questions and websites (usability), information quality, information quality or interaction quality that are proven to be valid. Likewise, the practicality of the lecturers’ and students’ responses proved to be practical. For student learning outcomes, the average student learning outcomes are classified as good. These findings were novelty by using CAT technology, expert systems, MBKM, holistic assessment, and student assessment needs in industry. The suggestion for this research is to be able to add the latest technology to the MBKM assessment.

KEYWORDS: Assessment; Electrical Circuit course; MBKM; Expert System, industry.

1. INTRODUCTION
Exponential technological developments can threaten human resources, industry and the business world, and will have an impact on the qualifications and competence of the workforce. This also has an influence on vocational education which produces graduates who are ready to work. Skills are work-based and industry-oriented activities that aim to provide knowledge, skills and attitudes (Mohamad et al., 2012). Technological advancements have altered educational perspectives and practices, including online learning during the COVID-19 pandemic. Although learning activities continue to take place online, learning outcomes must always be consistent with the competency objectives provided in each course and in line with the program study vision and mission, which require competencies appropriate for the industry in the twenty-first century and the industrial revolution (Verawardina et al., 2020; Dabbagh & Kitsantas., 2012; Feladi et al., 2020; Nofrianto et al., 2020). In Indonesia, an educational program known as the Merdeka Belajar Kampus Merdeka (MBKM-Independent Campus, Freedom of Learning) has been launched by the Minister of Education and Culture to meet the challenges of the industrial revolution. This program promotes freedom of thought which is known as freedom of learning (Iwinsah, 2020) in order to improve educational quality (Anjelina et al., 2021). The MBKM program can be completed through online classes that allow students to select materials from their
own campus, other campuses, or the industrial world (Harjianto et al., 2021; Sudirnta et al., 2021).

The issue that has arisen recently is that the implementation of online learning during Covid-19 is still ineffective (Hamid et al., 2020; Febriananto et al., 2020) and incompatible with industrial needs (Clark & Mayer, 2012; Dabbagh & Kitsantas, 2012). Other issues cover the Indonesian students’ assessment results are still very low (Hanafi & Nurhizrah, 2020), there is a gap between independent learning assessment and educational attainment (Izza et al., 2020). MBKM implementation that has not been maximized, the assessment monitoring process that has not yet been clearly implemented, and evaluation instruments that are no longer relevant. In the electrical circuit course, the assessment procedure which is carried out online based on MBKM is still relatively new in Indonesia and has never been evaluated. Therefore, universities must exert significant effort to ensure that MBKM works effectively (Purwanti, 2021).

To ensure the achievement of the desired goals, it is necessary to evaluate a program (Bazargan, 2007; Birjandi & Nosratinia, 2009; Piccardo et al., 2019). The implementation of the evaluation is also preceded by an assessment (Staub, 2017; Mahayuki et al., 2018; Ardana et al., 2017; Divayanaet al., 2017). An assessment of learning programs is required to determine how far the learning achievement of MBKM-based electrical circuit courses has progressed. According to (Haron et al., 2019), many institutions of higher education have digitalized assessments. Assessment is a technique for evaluating something through data collection and observation (Collins & O’Brien, 2011). Assessment models can take the form of online assessments, assessments based on portfolios, or assessments based on attitudes (Hasni & Marzuki, 2021) that take into account aspects of the candidate’s knowledge, skills, and attitudes (Winaryati, 2018; Chu et al., 2016; Sumarni, 2019). To assess students’ ability to complete education by combining the CAT (Computer Adaptive Test) based on Expert System as a means of measuring higher-order thinking skills in support of learning outcomes assessment using multiple-choice cognitive tests, attitudes, and skills. As a result of these issues, it is necessary to develop an assessment model in learning to determine its achievement. The majority of them continue to believe that assessment is performed only for students (Ambiyar et al., 2019) and applied exclusively to online learning activities (Ramadania & Aswadi, 2020; Sherly et al., 2021). Improvements and additions are made which include a measurement instrument for learning activities by creating an assessment model for electrical circuit course based on the MBKM program using an expert system, in the form of a computer-based adaptive test, as has been done in research (Nalova & Shalanyuy, 2017; Winarno, 2012; Li et al., 2015; Boeve et al., 2015; Liu et al., 2016; Van Buuren et al., 2017). The objective of the study is Development of an Assessment Model for Electric Circuit Courses Based on “Free Campus Learning (MBKM) according to industry needs” Using an Expert System, with the urgency of the research stemmed from the difficulty of lecturers in understanding and developing learning assessment models.

2. METHODOLOGY

This research method is research and development that adopts the Borg & Gall stages, by reducing the development stages into four development stages (Emzir, 2013). This research method is research and development followed 4 steps as shows in Figure 1. Based on Figure 1, the research stages are shown: namely 1). Data collection stage using preliminary studies, needs analysis. 2). The planning and design stage is designing models and other supporting products. 3). The Development Stage involves creating models and other supporting products. 4). The validation and trial stages carried out expert validation, practical testing, model implementation and effectiveness testing. Sources of research data from relevant research references in accordance with the research topic raised, literature studies were also carried out. The instrument uses observation sheets and interview guides and questionnaires for students, lecturers, industry and experts. As well as providing tests to assess student learning outcomes. Apart from that, the researcher also conducted a Focus Group Discussion involving 5 learning experts in vocational education, evaluation experts, Information Technology experts to determine the validity of the model developed and to assess that the instrument reliable and valid to use. The research population at the Faculty of Engineering, Padang State University, sample selection using purposive sampling technique was 55 students and 5 lecturers. Descriptive data analysis technique to measure the validity, practicality and effectiveness of the model developed. And also testing using Structural Equation Modeling (SEM) using the SMART PLS application (Asnur et al., 2020).

Figure 1: Development stages
3. RESULTS AND DISCUSSION

In this study, a novel approach to evaluating the educational pursuits of students is implemented. This approach consists of combining the MBKM-based electrical circuit assessment model with an expert system and according to industry needs. The research variables used as a reference for the design of the preliminary assessment model tested include the application model’s level, the expert system-based assessment model, the MBKM program, industry need, the model’s implementation success, and the impact caused by the model’s implementation. The outcomes of students’ educational experiences could be improved using this model. The following are the results of the development stages.

3.1 Data Collection and Analysis

3.1.1. Previous Research Results

In this step, data collection and analysis are carried out using literature reviews sourced from national and international journals, scientific articles, books on assessment models, instructions for implementing the MBKM program, and theories regarding the expert system, industry needs. From the results of the literature review, an in-depth study of the concept of the electrical circuit assessment model based on the MBKM using the expert system is performed. The results of the literature reviews are presented in Table 1. According to the findings of previous research, the assessment model to be developed is supported by relevant theories such as those concerning assessment, the MBKM program, expert systems, and industry needs. Previously, research on assessment models in online learning had been applied and had a good impact on results by providing recommendations for improving online learning through e-learning. These studies demonstrate that the findings of this study are more effective than traditional assessment models, indicating that they should be applied and further developed. This research also yields good results that have a positive impact on learning assessment activities that incorporate the role of technology. The positive impact makes a contribution that is different from the previous assessment, using CAT technology, expert systems, MBKM, holistic assessment. Recommendations from these findings can add new features to the website expert system that has been designed.

<table>
<thead>
<tr>
<th>Researcher (Year)</th>
<th>Research Title</th>
<th>Research conducted</th>
<th>Impact</th>
</tr>
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<tbody>
<tr>
<td>Rudner &amp; Guo, (2011)</td>
<td>Computer Adaptive Testing for Small Scale Programs and Instructional</td>
<td>CAT implementation for small-scale cases</td>
<td>Decision measurement theory (MDT) as a basic model for computer adaptive testing when the goal is to classify examinees into one of a limited number of groups provides the effectiveness of CAT for testing cognitive skills and offers some theoretical considerations for linking learning outcomes and assessments.</td>
</tr>
<tr>
<td>Sithisak et al., (2011)</td>
<td>Cognitive Assessment Applying with Item Response Theory</td>
<td>Implementation of CAT to assess students’ cognitive abilities based on Bloom’s taxonomy</td>
<td>Clarifying the role of CBT can measure cognitive</td>
</tr>
<tr>
<td>Bruyn, et al., (2011)</td>
<td>Computer Base Testing-The Ideal Tool To Assess On The Different Levels of Bloom’s Taxonomy</td>
<td>The idea of CBT tools assesses students’ cognitive abilities based on Bloom’s taxonomy</td>
<td>In this article, Stufflebeam’s Context, Input, Process, and Product (CIPP) evaluation model is recommended as a framework to regularly guide the conception, design, implementation, and assessment of service-learning projects, and provide feedback and judgment of the project’s effectiveness for continuous improvement. Provides information to guide teacher decision-making, from organizing the classroom to assessing students and interpreting standardized tests.</td>
</tr>
<tr>
<td>Zhang et al., (2011)</td>
<td>Using the context, input, process, and product evaluation model (CIPP) as a comprehensive framework to guide the planning, implementation, and assessment of service-learning programs. Classroom concepts and applications.</td>
<td>Assessment of Learning using the CIPP method</td>
<td></td>
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</table>
3.1.2 Analysis of Model Development Needs

The need analysis of the assessment model in the electrical circuit course based on MBKM using the expert system industry needs is firstly carried out before designing the appropriate assessment model. The needs analysis includes questions about the learning experience, material analysis, student analysis, assessment, and the development of an assessment model. Based on the results of the quantitative needs analysis questionnaire of the lecturer’s response is shown in Figure 2. Figure 3 depicts a needs analysis in which the lecturer agrees to use the expert system to develop an assessment model for the MBKM-based electrical circuit course of industry needs.
According to Figure 2, the needs of students in the developed model are carried out to 55 students, indicating that they require an MBKM-based electrical circuit assessment model using an expert system industry need. The results of the needs analysis are based on the results of a qualitative needs analysis questionnaire from observations and interview guides. Observations regarding the implementation of learning and assessment yielded the following information as shown in Table 2. Based on Table 2, these observations indicate that there are still some issues occurring during the learning process, assessment, and MBKM activities, therefore it is necessary to develop an assessment model for learning that incorporates MBKM. According to the findings of the interviews, lecturers typically only assess the effectiveness of learning in relation to student learning outcomes. The interviews’ results further demonstrate that the assessment model used is not based on an expert system. Uncertainty about whether student learning outcomes have already covered the terms of cognitive, hard skills, and soft skills led to a gap in the online learning of electric circuits during COVID-19.

The concept’s implementation and monitoring of the MBKM assessment have not been clearly implemented and the evaluation instruments are not yet relevant and applicable. Lecturers expect the concept of an assessment model with holistic rubric and analytic rubric to facilitate the assessment. Then, a website-based system is also created. The interview results revealed that the lecturer desired innovation in carrying out learning assessments (Sholihah et al., 2023). In the meantime, according to the findings of student interviews, lecturers had not used an expert system to conduct assessments that could classify their learning outcomes. Students also expect that the assessment results will include a detailed score of learning. Moreover, they also desire an online CAT-based assessment. Students who have experience participating in MBKM activities for some time still struggle to understand the assessment results achieved, regardless of whether they are solely the result of MBKM activities or also include input from evaluations carried out by lecturers. Additionally, it is concluded that innovative learning assessments must be developed for students.

### 3.2 Product Planning and Design Stage

The process begins with the design of the conceptual framework of the model, followed by the design of an expert system-based website. The conceptual framework of the model design can be seen in Figure 4. The framework of an assessment model for electrical circuit courses using an expert system based on MBKM is developed based on a number of factors, including the assessment that was previously used in learning.

<table>
<thead>
<tr>
<th>No.</th>
<th>Results of observations</th>
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<tbody>
<tr>
<td>1</td>
<td>Gap is still existing in the learning process</td>
</tr>
<tr>
<td>2</td>
<td>The implementation of MBKM in the Faculty of Engineering has not yet reached its full potential.</td>
</tr>
<tr>
<td>3</td>
<td>The assessment of MBKM is not yet applicable and relevant; This issue led to some confusion among the lecturers.</td>
</tr>
<tr>
<td>4</td>
<td>Learning assessments have not been fully carried out online</td>
</tr>
<tr>
<td>5</td>
<td>According to observations of learning activities, lecturers typically conduct conventional assessments.</td>
</tr>
<tr>
<td>6</td>
<td>Some students perform the task manually and are unaware of the learning outcomes achieved.</td>
</tr>
<tr>
<td>7</td>
<td>The implementation of the assessment model in learning process has not been varied</td>
</tr>
<tr>
<td>8</td>
<td>The assessment is still not based on an expert system</td>
</tr>
<tr>
<td>9</td>
<td>The preparation of assessment materials by lecturers for the implementation of learning is still lacking.</td>
</tr>
<tr>
<td>10</td>
<td>The student learning achievement is still not optimal</td>
</tr>
<tr>
<td>11</td>
<td>The assessment has not adjusted to industry needs</td>
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</tbody>
</table>
activities, desires to increase student competencies, and learning achievement. This study also combines several assessment models that include holistic rubrics, analytic rubrics, MBKM concepts, MBKM evaluations, and expert systems industry needs in order to create a computer-based adaptive test (Mata & Pai, 2023). This study helps to develop an improvement strategy that has an instrument for measuring learning programs. It is important to measure the gap between planning and reality in order to make recommendations for enhancing MBKM learning to be more effective and efficient and to produce assessment model products, applications, and assessment guidelines in the university environment. The assessment model website based on expert system that has been created includes features to describe courses, working instructions, question descriptions, question categories that show high, medium, and low levels of difficulty, question instructions, time durations, question input, scoring weights, and the results of the classification of student grades that include feedback and thorough descriptions of their accomplishments. The assessment model can be accessed on the link or URL www.assessmenmataasiswa.com.

3.3. Development Stage

At the development stage, steps are produced Development of an Assessment Model for Electric Circuit Courses Based on “Free Campus Learning (MBKM) according to industry needs” Using an Expert System. The following are the stages of the model: (1) In accordance with MBKM policies and guidelines for students, lecturers and universities, (2) TVET Online learning, (3) Expert system-based assessment industry needs and (4) Holistic assessment. The stages of the model can be seen in Figure 5.

![Figure 4: The conceptual framework of the assessment model design](image4)

![Figure 5: Stages Assessment Model for Electrical Circuit Courses Based on MBKM Using an Expert System Industry](image5)
3.3.1 Expert System Website Development Data

The display page of the developed website for the expert system-based assessment industry needs model is shown in Figure 6 and Figure 7.

Figure 6: List of Available Exams

Figure 7: Exam Details and Description

3.4. Validation and Testing Stage

In the validation and trial stages, expert validation, practical testing, model implementation and effectiveness testing are carried out.

3.4.1 Validity Results

The purpose of the validation results is to determine the level of validity of the models, questions and websites developed. For website validation by expert programmers, then validation of the assessment model is carried out by assessment experts. Figure 8 shows the results of expert validation produced model data of 0.81, questions of 0.85 and overall average results of 0.84.

Figure 8: Expert Validation Results

Meanwhile, the website validation results are as shows in Figure 9. Figure 9 shows the results of website validation validated by experts produced usability data of 0.85, information quality of 0.83, information quality of 0.87 and overall average results of 0.83.

Figure 9: Website validation results

3.4.2 Practical Results

The aim of the practicality results is to determine the level of ease in using the models, questions and websites developed and tested on lecturers and students. The lecturer practical results are shows in Figure 10. Figure 10 is the results of the lecturer’s practicality produced model data of 0.86, questions of 0.87 and overall average results of 0.86.

Figure 10: Website validation results

The results of lecturer practicalities on the website are shows in Figure 11. Figure 11 shows the results of lecturers’ practicality on the website produced usability data of 0.84, information quality of 0.84, information quality of 0.89 and overall results of 0.86 Figure 12 shows the students’ practical results produced model data of 0.86, questions of 0.85 and overall average results of 0.85.

Figure 11: Lecturer Practicality Results on the Website

Figure 12: Student Practicality Results

The results of student practical work on the website are shows in Figure 13. Figure 13 shows the results of student practicality on the website produced usability data of 0.87, information quality of 0.86, information quality (interaction quality) of 0.88 and overall average results of 0.87.

Figure 13: Student Practical Results on the Website

Figure 14: Student Learning Outcomes
3.4.3 Effectiveness Results

Meanwhile, for effectiveness results, the test questions consist of 35 questions, which are created taking into account the level of difficulty of the questions, validity of the questions and reliability of the questions. The questions are also made by paying attention to the level of questions that are classified as High order thinking. Figure 14 shows that the student learning results obtained from the pretest were 36.70, and the posttest results were 80.30.

3.4.4 Model Assessment Testing

The process of developing this model has three important aspects which have become the main focus, namely testing validity, practicality and effectiveness. Validity tests are carried out to ensure that this model is able to measure the desired variables accurately and reliably in producing consistent results. Practicality is another consideration, ensuring that this model can be applied in real situations in a way that is efficient, economical, and can be implemented easily. The effectiveness of the model is another very important aspect, where the model must be able to achieve its main objectives with significant results. This model must be able to provide valuable insight into the variables being observed. The results of the validity, practicality and effectiveness tests are the main basis for creating models between variable trials for assessment. In this context, Smart PLS was chosen as a powerful analytical tool to identify key factors that influence the variables in the model. Apart from that, Smart PLS is also used to carry out statistical tests needed to test hypotheses and measure the significance of the relationships between variables in the model. The results of analysis using Smart PLS will provide a deep understanding of the complexity and interaction of variables in the model, which in turn will provide valuable insight for assessing the model being developed.

Figure 15 shows the results of modeling with Smart PLS that within the framework of testing the validity, practicality and effectiveness of the model for the MBKM-based assessment model, it was found that the loading factor for each indicator and variable had a value above 0.6.
This indicates that each component in the model has a significant contribution in measuring the desired aspects. Apart from that, the analysis results also reveal the existence of a positive path between the variables in the model. This means that the distribution of relationships and impacts from the three trials that have been carried out on the MBKM-based assessment model tend to be high and have a positive impact. In other words, the model that has been developed has good quality and is able to make a positive contribution to the understanding and evaluation of the MBKM-based model. These results provide confidence that the model can be used as an effective tool in supporting the MBKM-based assessment process with supporting results.

In the analysis of the construct data shown in Table 3, it needs to be emphasized that an AVE score that exceeds 0.5 on the same matrix as the data and variables analyzed is an important indicator regarding data interpretation.

<table>
<thead>
<tr>
<th>Table 3: Data construct in Smart PLS</th>
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<tbody>
<tr>
<td>Cronbach’s Alpha</td>
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<tr>
<td>Assessment Model</td>
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<tr>
<td>Effectiveness</td>
</tr>
<tr>
<td>Practicality</td>
</tr>
<tr>
<td>Validity</td>
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</tbody>
</table>

This shows that the variables used as indicators in this research have good quality in describing the concepts studied. Furthermore, a high AVE score also reflects that the relationship between variables in the model has a strong and reliable distribution. Thus, these results provide a strong basis for analysis within the Assessment Model Based on MBKM framework, ensuring that the data used and the relationships between variables meet high standards and are reliable in the context of this study (Simeru & Lubis, 2022). The Discussion of the findings are, development of science and technology has an impact on various fields, such as education, social, economic and industrial. The need for labor in industry will change so that the production process continues so that the industry can survive (Pardjono et al., 2018). The learning paradigm is oriented toward learning in the twenty-first century, which corresponds to the development of the Industrial Revolution and is relevant to technological developments, so that student competencies are required relevant to the world of work and industry. Additionally, the educational policy about Merdeka Belajar Kampus Merdeka (MBKM - Independent Campus, Freedom of Learning) has recently emerged, necessitating seriousness for its full implementation. An assessment must be done in order to determine the success of the MBKM learning program, particularly in the electrical circuit course.

The findings show that it is necessary to develop an assessment model, besides that an assessment model and an expert system website have been designed with features that support computer-based assessment activities and can be accessed online. The findings show different results from the previous assessment which did not yet contain the MBKM concept nor was it based on a website that was still conventional, and did not yet contain the concept of a holistic assessment. The results of the developed model design adopt a holistic assessment model, MBKM and expert system, industry needs. The designed website for this assessment model can be accessed online at www.assessmentmataasiswa.com which includes features to describe courses, working instructions, question descriptions, question categories that show high, medium, and low levels of difficulty, question instructions, time durations, question input, scoring weights, and the results of the classification of student grades that include feedback and thorough descriptions of their accomplishments. The needs analysis findings are required and will serve as the foundation for designing the conceptual framework of the assessment model and website based on the expert system. In line with the results of observations and interviews, it shows that there are still problems that occur in learning, assessment and MBKM activities, thus requiring the development of assessment models. Meanwhile, the expert validation results produced data models, questions and websites (usability), information quality, information quality or interaction quality which were proven to be valid. Likewise, the practicality of the lecturers’ and students’ responses proved to be practical. For student learning outcomes, the average student learning outcomes are classified as good. The findings are in line with which proves the assessment of summative assessment through tests. Assessment can be carried out using a computer-based test/exam adaptation model (CAT) through an expert system/expert system carried out to avoid subjective judgments in evaluating training results. It was concluded that the results of research on the development of an assessment model for electrical circuit courses based on “Independent Campus Learning (MBKM) according to industry needs” using an expert system showed that the model developed was very necessary, valid, practical and effective. These findings provide a novelty that is different from previous assessments which only used CAT technology, expert systems, MBKM according to industry needs, holistic assessments.

4. CONCLUSION

According to results of research on the Development of an Assessment Model for Electric Circuit Courses Based on “Free Campus Learning (MBKM) according to industry needs” Using an Expert System, it shows that the model developed is very necessary. The findings are relevant to the observation and interview results that
show there are still gaps existing in the learning activities, assessment process, and MBKM implementation, industry needs. Therefore, the developed assessment method already includes many features and is based on the website besides its function that already utilizes the expert system. All available features can be used to support the online assessment activities. According to the findings of a study An Assessment Model for Electrical Circuit Courses Based on MBKM Using an Expert System indicates that the developed model is highly required. The findings are relevant to the observation and interview results that show there are still gaps existing in the learning activities, assessment process, and MBKM implementation. Therefore, the developed assessment method already includes many features and is based on a website besides its function that already utilizes the expert system. The validation results of the model development are also valid, practical and effective. These findings provide a novelty that is different from previous assessments which only used CAT technology, expert systems, MBKM according to industry needs, holistic assessments. The suggestion for this research is to be able to add the latest technology to the MBKM assessment.

ACKNOWLEDGMENTS

The researcher would like to thanks the LP2M Institute of Padang State University for funding this research through the PNBP program for 2022. The researcher also expresses gratitude to all parties involved in the research’s execution especially lecturers and students from the Faculty of Engineering, UNP. As well as the research team who has carried out the research.

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