Mathematics Blended Learning System Based on Vocational Realistic Education (VRE): SMK Widiatmika Case Study

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Abstract. The concept of Vocational Realistic Education (VRE) does not only refer to the experiences and realities around students but is integrated into various problems in the world of work. Mathematics teachers at vocational institutions need to design new methods that are synergistic with developments in digital technology. One model that facilitates vocational school students to carry out this learning is Blended Learning (BL). Several previous studies have shown that BL and the integration of realistic learning concepts have a significant effect on students' mathematics learning outcomes. Several gaps and problems were found related to the implementation of hybrid mathematics learning at Widiatmika Vocational School partners, including the media used, did not integrate the implementation of concepts learned in the industry, the absence of BL media means students cannot explore learning resources, and providing industry field cases by industry practitioners through guest class activities cannot be carried out. It is deemed necessary to develop a support system that supports the implementation of VRE-based BL at Widiatmika Vocational School. The main output of this research is a mathematics blended learning system in the form of VRE-based e-learning, product posters, and publication of scientific articles in international proceedings. Apart from this system, additional output is also produced in the form of publication of scientific articles in accredited national journals and IPR.

Keywords: Blended, Industry, VRE

1 Introduction

The vocational education program is an education system designed to prepare certain knowledge, skills, and competencies for students to enter the world of business and industry (DU/DI) (Cedefop, 2017). The characteristics of students who take part in learning at different vocational institutions are seen from their age level, educational background, and cognitive abilities, especially memory performance (Alloway et al., 2013). Learning for vocational program students is focused on the development and application of the skills acquired (Shrestha, 2016). This area of expertise can be

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obtained when learning is carried out with supporting media or equipment (Basori et al., 2023).

Furthermore, the mathematics learning paradigm in the vocational school environment is directed at implementing the concepts taught (realistic mathematics-based). Mathematics teaching must be linked to reality and mathematics is a human activity (Gravemeijer, 1994). Mathematical abstract objects are represented by concrete objects as a bridge to enter the knowledge that students already have (Saleh et al., 2018). Students more easily understand mathematical concepts by looking for connections between the material being studied and the problems around them (Özkaya & Yetim, 2017). Through this approach, learning is felt as a personal experience, not someone else's experience that the student has not experienced (U.S., 2012). The realistic vocational-based mathematics learning referred to here refers to the concept that the real problems presented are not only defined as something that exists in students' lives (reality) but are also integrated and can be found implementing the concept in problems at DU/DI. This is done so that vocational program students understand how to use mathematical concepts in carrying out analysis and calculations while doing internships or working in industry.

The rapid transformation of education after the COVID-19 pandemic has resulted in mathematics teachers at vocational institutions needing to design new methods that are synergistic with developments in digital technology. This is caused by the application of new technology and methods in learning to encourage students to master the required professional skill competencies (Asarta & Schmidt, 2020; Trujillo Maza et al., 2016). One model that facilitates vocational school students to carry out this learning is Blended Learning (BL). BL combines synchronous and asynchronous learning by integrating technology (Graham, 2013; Graham & Dziuban, 2007). This approach combines conventional learning with activities that use computers, tablets, smartphones, and other technology to make it more interesting for students than just regular face-to-face or online learning (Capone et al., 2017). Several previous studies have shown that the integration of the BL model can improve learning outcomes and students' critical thinking abilities (Budhyani et al., 2022; Lin et al., 2017; Mutaqin et al., 2016; Putri et al., 2023; Samritin et al., 2023). This is because the use of learning media in class significantly increases student scores compared to classes that do not use it (Ayuni et al., 2022). Widiatmika Vocational School as an institution implementing vocational education, organizes hybrid learning. However, based on observations and interviews conducted by researchers at partner schools, several problems were found as follows: Mathematics teaching carried out in class does not yet combine the use of IT media and face-to-face interaction in an integrated manner. The learning carried out is still limited to exploring textbooks which contain a collection of theories and formulas. The media and teaching tools used do not integrate applicable concepts according to the student's major. Furthermore, the absence of an e-learning system means teachers only carry out mathematics learning online using Zoom and Google Drive which have limited features in preparation, implementation, and evaluation. The use of learning media is one of the important factors that influence the formation of vocational school graduates' competencies (Widiyanto, 2013). Students cannot explore learning resources optimally because online interactions are only a substitute for

face-to-face learning. The use of online platforms is also less than optimal because teachers currently prefer to deliver material conventionally. This is reinforced by previous studies which state that many teachers are still not adaptive in carrying out digital learning (Papadakis et al., 2018). The assumption that occurs is that changes in learning, especially technology, disturb the comfort of teachers who are not used to using IT media (López et al., 2019). Widiatmika Vocational School Partners has 21 MoUs with industries operating in the hospitality, culinary, and multimedia sectors. One of the agreements between the Vocational School partners and DU/DI is to hold a teaching practitioner program that brings in industry representatives to provide guest classes and industry field cases to be completed according to the disciplines studied at the Vocational School. However, the different schedules between practitioners and guest class schedules and the absence of a BL system mean that the implementation of mathematics learning involving industry is not optimal. This has implications for the fact that mathematical concepts are still abstract and students lack understanding regarding how and why mathematics material is studied in vocational schools. Learning that is carried out without using a variety of learning methods will affect students' ability to grasp the concepts presented by the teacher (Sukirman et al., 2022).

2 Methodology

2.1 Research Stages/Research and Design (RnD)

The research proposed in this proposal is planned to be carried out within 6 months. The development stages carried out refer to the ADDIE development model which consists of analysis, design, development, implementation, and evaluation. (Sugiyono, 2019). In its implementation, modifications were made to the development, implementation, and evaluation stages by applying research steps to the Tetra-Helix Model Concept produced in the previous year (Putrawan & Ayuni, 2022). The main output produced is a VRE-based e-learning system. Apart from this, additional output is also produced in the form of product trial documents. The document includes an analysis of the implementation of the system being developed, and an analysis of questionnaire responses from students, teachers, and industry practitioners. The effectiveness of the system used can be seen from the output of vocational school students' mathematics learning outcomes after the research is completed. The trial results documents were analyzed statistically using data collected from all research subjects involved. The description and development stages are presented as follows.

Analyze. This stage carries out a needs analysis and curriculum analysis. A needs analysis was carried out to observe the initial environment, the conditions of the ongoing teaching and learning process and any problems faced by students and teachers, the mathematics learning media being used in vocational schools, as well as the innovations needed as outputs of research collaboration. Curriculum analysis is carried out to determine the material and competency demands that must be mastered by students.

Design. This stage is divided into two phases, namely designing research instruments and designing a mathematics blended learning system. The research instruments prepared include validity test sheets, system implementation sheets, and response questionnaires from students, teachers, and DU/DI partners. Meanwhile, system design is carried out based on the results of the needs analysis carried out in the previous stage.

Develop. This stage carries out FGD and system prototyping with the following details.

Focus Group Discussion. This stage involves representatives of DU/DI, academics, teachers, and researchers. Discussions were held to gain a comprehensive understanding of the condition of students, the curriculum and mathematics content provided during learning, as well as the types of competencies required by DU/DI. This is done to find out potential problems presented in the system being developed so that the content raised can support links and matches between DU/DI and vocational school partners.

Prototyping. This phase carried out the design of a prototype mathematics blended learning system in the form of VRE-based e-learning. Development is carried out while taking into account the review of related literature as well as the results of relevant previous research. The preparation of teaching content is adapted to the material presented in the syllabus and used directly or indirectly in practice in industry. This process was also accompanied by validation carried out by 2 experts in the fields of mathematics education and educational technology.

Product Implementation and Evaluation. The mathematics blended learning system prototype which had been declared valid, was then tested on a limited basis involving a small number of Widiatmika Vocational School students and DU/DI partners representing the entire population. The selection of students is adjusted to the teaching content and problems in the industry being prepared. Even though the teaching material presented in the device is the same, the presentation of the material and the realistic problems raised are different. This depends on the industry and competency areas studied by students. In the research carried out, limited product trials were carried out to find out the implementation of blended learning which was structured based on the stages of the model developed. The evaluation results from the limited trial implementation are then analyzed for further revision. The system improvements resulting from the revision were then applied to field trials involving all vocational schools and DU/DI partner students who have an MoU with Widiatmika Vocational School.

Dissemination. This phase carried out in the form of presenting research results to stakeholders to obtain suggestions and improvements to the model developed.

The flow diagram of the research implementation stages described above is presented in the following chart.

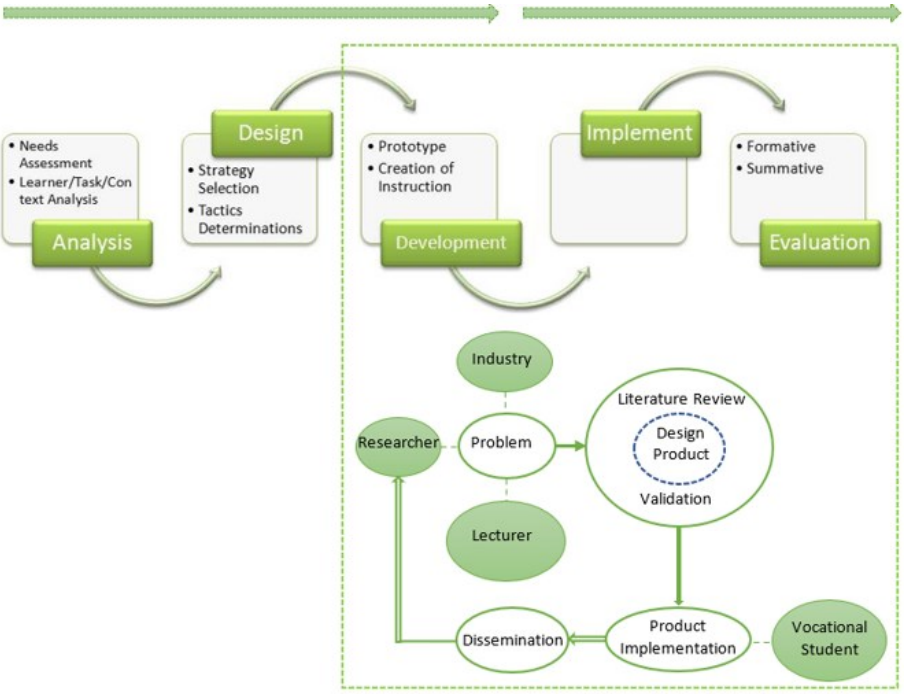


Figure 1. ADDIE's core elements are based on the tetra-helix model concept

2.2 System Development Procedures

The development of a VRE-based mathematics blended learning system at the Prototyping stage above, follows the procedures established in the software development life cycle as depicted in the following chart.

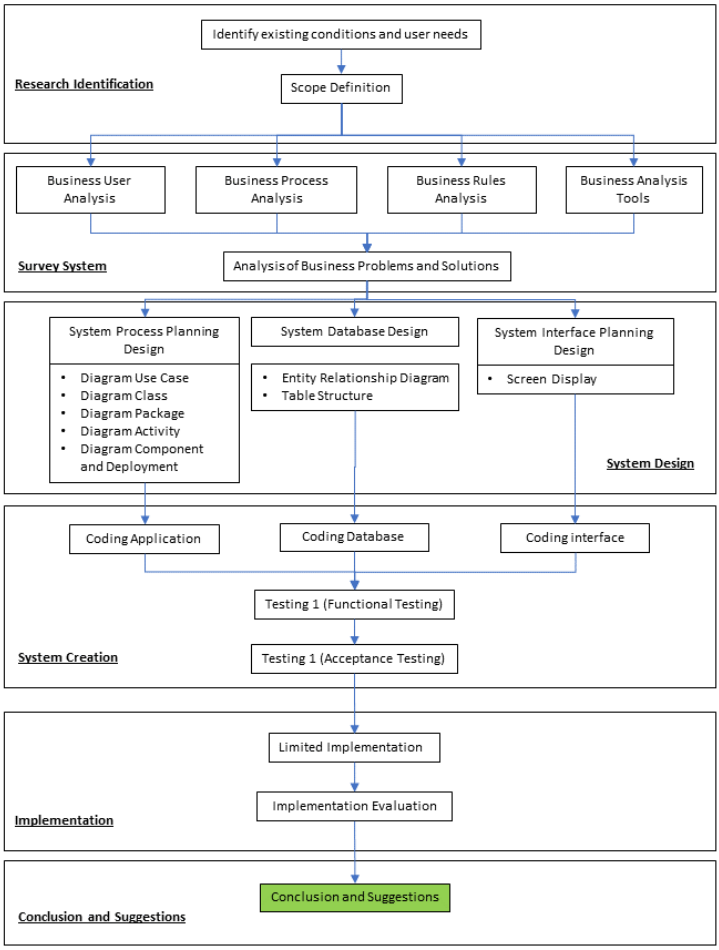


Figure 2. System development life cycle

System Survey. At this stage, there are two activities carried out, namely identifying the conditions of existence and user needs and defining the scope of work. Identification of existing conditions is carried out by interviews, observation, and study of existing documentation. Meanwhile, user needs surveys are carried out using limited online surveys.

System Analysis. System analysis is carried out after the conditions of existence and user need have been indicated and the scope of application and work has been defined. Several points analyzed at this stage include business users, business processes, business rules, business tools, business problems, and solutions.

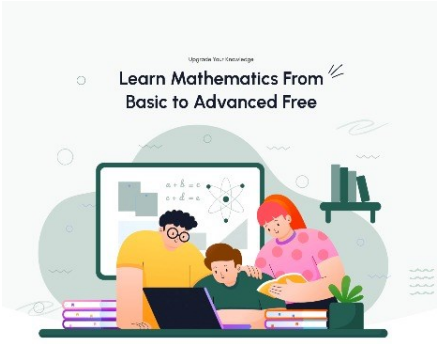
System Design. The system design stage is divided into three types, namely system process design, system database design, and system interface design.

System Creation (Coding). System Creation (Coding) is carried out after all the design designs have been completed. System creation includes creating a system database, application program, testing and evaluation, and user manual.

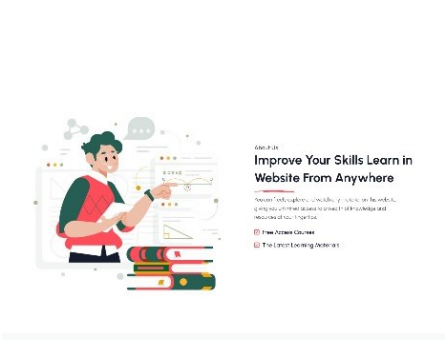
System Implementation. This stage is limited overall testing carried out, the mathematics blended learning system in the form of VRE-based e-learning is ready to be implemented in wider field trials.

3 Result and Discussion

The research carried out succeeded in developing a mathematics-blended learning prototype in the form of a learning website prototype that is ready to be used by Widiatmika Vocational School partners. The resulting website still needs to be developed in a limited testing stage before being used in a wider scope. Figure 3 shows the user interface of the product produced in the research.



(a)



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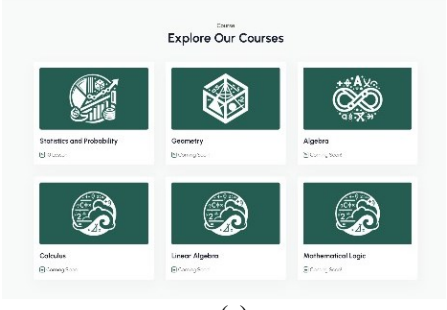

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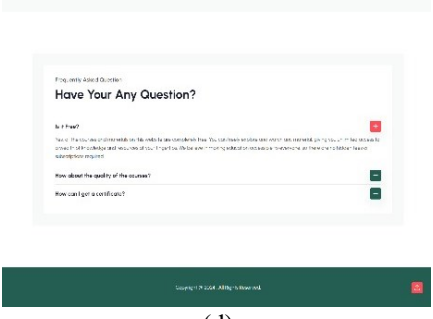

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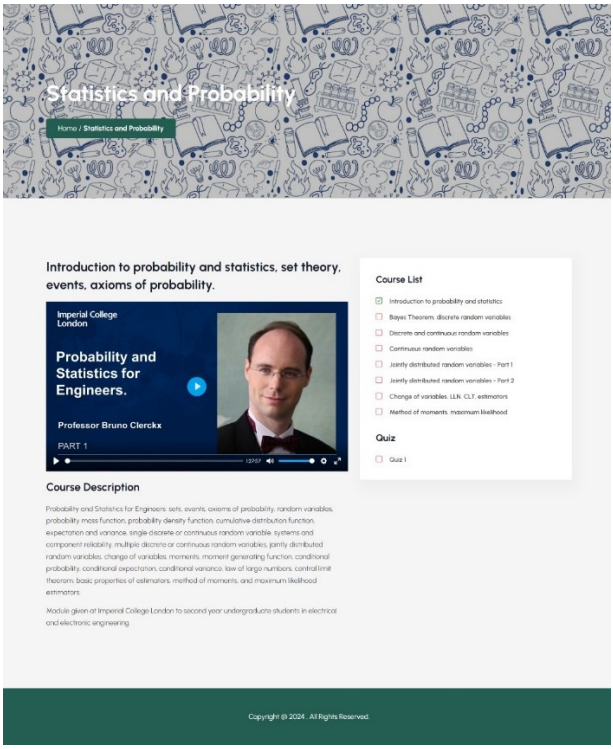

(f)

Figure 3. The user interface of the mathematics blended learning prototype

Further activities that will be carried out in this research are improvements to the products produced as well as limited testing to determine the implementation of media in vocational school learning. Apart from this, the research results obtained will also be disseminated at international conferences whose main output will be international proceedings.

4 Conclusion

This research has succeeded in developing a prototype blended learning system based on Vocational Realistic Education (VRE). However, it is necessary to carry out comprehensive development and additional material content that is tailored to the needs of user partners.

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