

## Learning Innovation: Development of a Digital Data Science Module for Vocational High School Students in the Software Engineering Program

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### ABSTRAK

Tujuan dari kegiatan pengabdian kepada masyarakat ini adalah untuk membuat modul pembelajaran online bidang ilmu data dengan sasaran siswa Program Rekayasa Perangkat Lunak di SMKN 1 Karawang. Kegiatan tersebut dilaksanakan pada tanggal 19 Juli 2024 dengan tujuan untuk meningkatkan keterampilan data science mahasiswa khususnya pada bidang pengolahan data, analisis data, visualisasi data, dan pengembangan algoritma. Kegiatan tersebut dilakukan dalam serangkaian tahapan: (1) Persiapan yang meliputi analisis program pendidikan lokal dan internasional: tinjauan literatur; (2) Pengembangan Modul, dimana dikembangkan modul digital kreatif dengan unsur interaktivitas untuk mendukung pendekatan Project Based Learning; (3) Pelatihan & Implementasi dimana modul diperkenalkan kepada siswa dan latihan praktik dilakukan; dan (4) Evaluasi yang meminta umpan balik mengenai pemahaman siswa dan kemungkinan perbaikan modul. Dengan metode terorganisir ini, diharapkan siswa akan memperoleh keterampilan yang dibutuhkan agar efektif dalam sektor teknologi dinamis yang semakin bergantung pada data.

**Kata Kunci:** Ilmu data, modul, pembelajaran online, program rekayasa perangkat lunak

### ABSTRACT

The purpose of this community service activity is to create an online learning module within data science targeting students in the Software Engineering Programme at SMKN 1 Karawang. The activity was conducted on 19 July 2024 with the aim of improving students' data science skills specifically in the areas of data processing, data analysis, data visualization, and algorithm development. The activity was done in a series of phases: (1) Preparation which included the analysis of local and international educational programmes: literature review; (2) Module Development, in which a creative digital module with elements of interactivity was developed in support of Project Based Learning approaches; (3) Training & Implementation where the module was introduced to students and practical exercises were performed; and (4) Evaluation in which feedback on students' comprehension and possible improvement of the module were sought. With this organized method, it is anticipated students will gain the required skills to be effective in the dynamic technology sector that is increasingly relying on data.

**Keywords:** Data science, module, online learning, software engineering program



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## INTRODUCTION

The place of information technology in modern society cannot be undermined, for its expansion is reaching numerous sectors, including education as well. In Indonesia, it is necessary to have a specific level of knowledge and skills, especially in information technology, and vocational high schools (SMKs) fulfill this task. However, the rapid growth of technologies such as big data and data science makes it necessary to change the vocational school programme in order to meet the needs of the market today. As pointed out by Smaldone, et.al, there is a high demand for data science in the job market, especially in the spheres of information technology[1]. Furthermore, as mentioned by Kiong et al., the use of educational digital modules has also been a new trend in education where learners teach themselves using interactive resources that are not hard to obtain[2]. As such, this service is seeking to address the gap by creating a digital data science module for use by software engineering students in vocational schools to improve their data technology competency.

At this point in time, this field of data science can be considered one of the most developing sectors within the realm of technology. It entails the processes of gathering, sorting, scrutiny, and expounding large amounts of data[3]. The current business ecosystem is such that there are demands for employees who are capable of handling data so that there is improved decision-making. Sadly, in real practice today, most of the contents of vocational schools across the nation of Indonesia still emphasize information technology programming and its applications development covering areas such as data science, which is gradually being accepted as an important course.

SMKN 1 Karawang, being one of the best vocational institutions in the context of Software Engineering, emphasizes the relevance of embedding data science in the curriculum to improve the ability of its students. Consequently, through this community outreach activity, this project should provide a practical case of how their electronic module can be used to assist in delivering basic data science skills to students of technical and vocational schools.

The objectives of this community service activity are to develop a comprehensive Digital Data Science Module tailored to vocational high school students, enhance their competence in basic data science concepts, and increase their practical skills in applying data-driven technologies. This module covers essential topics such as data processing, data visualization, and the use of basic algorithms, providing students with practical tools for school projects and preparing them for the workforce in technology fields. The initiative aims to boost students' understanding and ability to work effectively with data science principles, ensuring their readiness for real-world applications.

### **The Relevance of Data Science in Vocational Education**

The increasing prominence of data science in today's world is due to its wide range of applications in various sectors including business, healthcare, manufacturing and information technology among others. This has seen the increasing demand for vocational education, especially in Software Engineering programmes which call for the acquisition of capabilities needed in industry innovation 4.0 development that depends largely on competence in data science. Companies are in need of skilled employees who understand the importance of data analysis in decision-making. This illustrates the necessity of data science in an industrial environment[4]).

### **The Role of Innovative Approaches in Learning**

Educational innovations, particularly new teaching methods, technologies, and even curricular designs, have dominated the education literature for quite some time now. In this case, the incorporation of such innovations as digital modules in the learning process can improve the ease, interactivity, and engagement with learning materials. Furthermore, the literature highlights that advantages such as time and access flexibility can be beneficial to the course and vocational education in particular [5]. In the context of vocational high schools (SMK), appropriate teachers' content delivery helps students appreciate the practical aspects of the acquired knowledge and the relevance of the subject to their future employment.

### **Developing Digital Learning Modules**

Digital modules, if well designed, can act as proper interventions that lead to better learning outcomes among students. Digital modules facilitate learning at the learner's convenience and incorporate multimedia to cater for different learners. Mulhayatiah et al., were able to show that the use of modules with appropriate design, which are aligned with instructional design principles, can lead to increased student participation and improved student academic performance[6]. In the design of this particular module a number of elements including project-based learning and real-life case studies were introduced in order to encourage active learning.

### **Project Based Learning**

Project-Based Learning (PBL) has relevance to data science education as the skills are generally more practically learnt. According to Haatainen and Aksela, project-based learning not only develops technical skills in a student but it also fosters critical and problem-solving skills in a student[7]. It allows students to be exposed to real data and in this way, they can be taught the entire data life cycle from capturing, to processing, analyzing and presenting the data for strategic decision-making.

## METHOD

This activity was carried out through several stages designed to ensure the achievement of objectives, as follows:

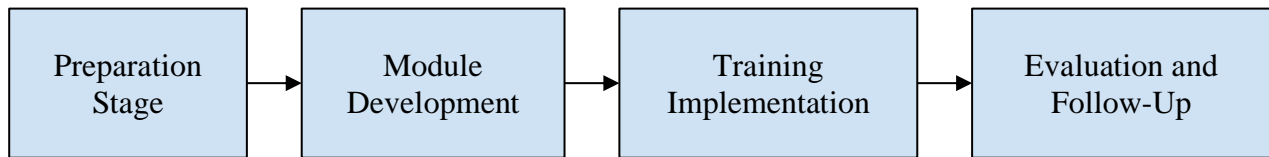


Figure 1. Community Services Stage

### Preparation Stage

In this stage, the researchers undertook an examination of the curriculum of the Software Engineering Programme at SMKN 1 Karawang and explored some literature pertaining to data science materials for vocational high school students. The module was created in such a way as to promote active learning by students through the use of project-based pedagogy.

### Module Development

The module content was developed based on some of the fundamental principles of data science which include an introduction to data types and data, three basic algorithms such as linear regression and classifications, as well as data visualization techniques applicable in the business environment. The module was covered in an interactive space and incorporated practical exercises which were meant to support the students' understanding of the content.

### Training Implementation

The training took place at SMKN 1 Karawang on 19th July 2024 with the participation of students from grades XI and XII. In this training session, the students learned how to use the digital module and even received an introduction to data science basics through project demonstrations as well as through the introduction of commercial practice.

### Evaluation and Follow-Up

To enhance the assessment of the module and also its evaluation, there was an evaluation where students were grouped and given a set of quizzes and mini-projects applying the concepts taught in the module. These evaluation results were incorporated in enhancing and perfecting the module before it was rolled out to other schools.

## RESULT AND DISCUSSION

### Creation of the Digital Module

Thanks to the current practice, the implemented digital data science module successfully addressed several important topics relevant to the specific vocational upper secondary school curriculum concerning the software engineering students. The module was designed around engaging activities to promote active learning and further comprehension of the concepts taught. It encompassed data visuals, data modification as well as data analysis and its simple simulation with free software including Python, Pandas, and Google Colab, which could be used by both students and educators at a low cost. Several digital media formats were incorporated into the module to facilitate students' understanding of the coverage. These were in the format of videos that acted as instruction manuals demonstrating the processes involved in data science, accompanied by explanatory text. In addition, the nature of the module included the use of real industry cases to help students attain a creative understanding of the knowledge that they are likely to apply in future jobs. For instance, students were shown how to analyze

sales data or predict customer behavior using data science concepts to demonstrate applicability in business. Furthermore, interventional materials were presented to students, providing them with the opportunity to try analyzing the datasets themselves using the knowledge they possessed.

To keep the students interested in the content of the module and to also allow them to assess themselves, game-like attributes such as quizzes and badges for completing certain tasks were utilized. Students were given tasks involving the generation of visual illustrations or performing some elementary computations and were evaluated based on the level of correctness and depth of the output. These techniques made the learning process more engaging, which is important for enhancing retention and application of skills within a technical context, such as the field of data science.



Figure 2. Meeting module development

### Enhanced Understanding and Skill

The effectiveness of the module has been further evaluated by assessing the students through pre- and post-tests. The findings revealed that many students benefited in terms of their comprehension of some fundamental aspects of data science. Specifically, larger percentages of the students were able to acquire relevant skills in the processes of data acquisition, data processing, and data analysis. They were able to carry out basic tasks such as data scraping, data framework creation and performed rudimentary tasks like plot generation using bar plots and scatter plots using Matplotlib and Seaborn Python libraries.

A key skill in the area of data science is the ability to perceive the data presented and be able to interpret trends, and this module enabled students to feel more competent in such areas. Many students also began to develop algorithmic thinking, meaning that they could understand how algorithms like linear regression or decision trees function, although the practical application of these algorithms was not covered in this module.

Moreover, throughout the entire module, participants were motivated to engage in group discussions and peer interactions to enhance problem-solving abilities. This collaborative method also helped students to think about different problems, debug and troubleshoot their codes, and practice various visualization techniques which further deepened their comprehension.

### Participant Feedback

So far, both students and teachers have given wonderful reviews. In the students' opinion, the digital module was more interesting and much easier than working in a physical classroom. The active part of the module was well received by many as the visuals and practical elements made cognitively demanding data science topics less challenging. In addition to this, on-demand access to the module materials on platforms like Google Colab allowed students to view the modules at their convenience and pace, thus appealing to varying degrees of learning speed and style.

It was noted by the teachers how students have improved their performance and how the students have shown an increased interest in the topics related to data science. They were particularly impressed by the fact that the module offered skills that would be useful to the students in the workplace. There were, however, constructive suggestions from both students and teachers that could be useful in the enhancement of the module in the future. A lot of students wanted more in-depth subjects to be included such as machine learning, deep learning and more advanced forms of data analysis such as clustering and classification.

These recommendations also show how students seek more complex data science tools and methods and this can be done in the future revision of the module. Teachers also suggested more assessments that would make students apply their data science knowledge in complex real-world situations. These recommendations not only seek to improve the interest of the students but also help in preparing the students for the challenges of the workplace by making the scope of the module broader in future.



Figure 3. Photo session with the community service team

## CONCLUSION

Through this community engagement endeavor, a digital data science module was developed which can be used autonomously by vocational high school learners. The module did not only improve students' competence in data processing but also increased their inclination towards information technology. It is anticipated that this module will be permanently incorporated in the curricula of SMKN 1 Karawang and other schools that might need such material.

In order to make it better, further development is required including the integration of more advanced concepts like machine learning and predictive analytics. Furthermore, the module can be used in other vocational institutions that have comparable programmes so as to increase the scope and the effectiveness of this initiative. Collaboration with industry partners in the design and evaluation aspects of the module will also enhance the relevance of the skills taught to the industry today.

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