

## MatVec: A ONE-STOP PLATFORM FOR IMPROVING STUDENT SKILLS IN MATRICE AND VECTOR CALCULATION

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### ABSTRACT

*Students who are lack of knowledge and awareness of skills in calculating matrices and vectors will struggle to solve mathematical problems involving vector calculus. To overcome the problem, thus 'MatVec' was developed as a one-stop platform consists of a video and a flipbook. These items provide students with simple and quick self-learning strategies available at any time and from any location. MatVec was created using digital technologies, highlighting the instructor's short video that covers a manual approach of determinant, dot product and cross product calculation so that students can polish their knowledge and understanding. MatVec centralizes its information in Google Classroom as the main platform and it has assisted students in improving their grades in their examination results. This can be clearly shown in the passing rate of the MAT455 final exam results for mechanical students at Universiti Teknologi MARA Cawangan Pulau Pinang for two consecutive semesters, the increment from 85.7% in semester March 2021-July 2021 to 96.6% in October 2021-February 2022. The improvement in students' grades suggests that the methodology of incorporating digital technologies as additional learning tools is significant and beneficial.*

**Keywords:** one-stop platform, matrices, vectors, self-learning, digital technologies

### Introduction

Mastery of matrices and vectors was required for calculus students in order to solve mathematical problems relating to vector calculus topics. Vector calculus is an important branch of mathematics and it relates two important branches of mathematics, namely vector and calculus. In mathematics, calculus inclusive of the study of changes, while vector represents a physical quantity that has a magnitude as well as a fixed direction. Before starting vector calculus, students need to recall some principles of vector algebra, such as representation, addition of vectors, determinant, dot product, and cross product. Calculus students who are lack of knowledge and awareness of skills in calculating matrices and vectors will struggle to solve mathematical problems involving vector calculus. Students need to have a solid base of appropriate mathematical content coupled with an equivalently strong set of mathematical process skills, allowing them to apply their knowledge successfully. Insufficient levels in basic mathematics will cause students to have trouble in solving the mathematical problem (Steve, 2019).

There are two principle reasons that contributed to the difficulties students face with vector calculus topics. First is the lack of knowledge and awareness of skills in calculating matrices and vectors. The second issue is the lack of basic skills in using a calculator or any software to calculate

matrices and vectors. In addition, the facts that this group of students have left calculus for more than two years and were not offered certain calculus courses during their diploma level are among the main reason of the poor performance. Thus, how successfully calculus students master matrices and vectors and how skillfully they apply both topics in their calculation of mathematical problems are crucial concerns. Therefore, it is important to develop a learning platform that aims to assist students in their preparation for the topic of vector calculus by recognising the problems in matrices and vectors.

Nowadays, there is a common focus on raising student achievement while integrating platform technology as a tool. Msomi (2018) found that when modern technology is used as a supplement to the traditional methods of teaching such as an e-learning platform, it could have a positive impact on the first-year mathematics students. According to Walker and Keeffe (2010), there may be changes in students' performance in mathematics if technology can be embedded in teaching and learning. Furthermore, Lin et al. (2017) confirmed that the application of blended learning by combining the Moodle online teaching platform with traditional instruction showed a significant effect on academic achievement. This method can assist them to learn mathematics at their own pace, while expressing their opinions and concerns on the topics. Overall, their research result indicated that the interaction of students in mathematics using an e-learning platform in the classroom creates prospects for gaining access and understanding various demonstrations of mathematical concepts (Forster, 2006; Swan, 2010). They concluded that the technology integration has the following benefits inclusive of the increment of the students' motivation, engagement, collaboration, as well as their hands-on learning opportunities. These allow them to increase the students' confidence, and technology skills at all level (Kevin, 2014).

In this study, we develop a one-stop platform for education and learning. The learning platform is called MatVec. MatVec is derived from the words "matrix" and "vector". The goals of MatVec are to assist students in enhancing their knowledge and understanding skills in the calculation of matrices and vectors. It also provides learners and educators with an interactive and comprehensive environment. In this innovation, we use digital technologies to make short videos highlighting the instructor's video that covers a manual approach, a short video showing how to use a scientific calculator and a Symbolab Calculator, also a flipbook that includes short notes, systematic examples. Not only that, we also provide live activities and exercises which contain gaming feature, allowing activities to be auto-marked and also a video and flipbook to provide students with simple and quick self-learning strategies that they can use anytime and anywhere. The utilisation of MatVec in Google Classroom is essential to streamline and organise these learning platforms.

The aim of developing MatVec is to explore effective platform in digital technology in order to

improve the cognitive performance of calculus students, promote life-long learning and also to support self-learning strategies that are simple and efficient in measuring the academic performance on the students' final exam scores and enhancing their grades in matrices and vectors subjects. Thus, we applied the MatVet to students in e-Fundamental Engineering Seminar (eFES) for two consecutive semesters and monitor the students' performance and feedbacks from this platform.

## **Methodology**

### ***Product Development***

MatVec is made up of four components, as illustrated in Figure 1: Google Meet, live activities, YouTube and flipbook. The Google Meet includes an engaging live stream, managed by a facilitator who has experience in teaching calculus courses. Students are divided into groups and assigned a task. They must present the solutions. The facilitator will make comments and provide feedbacks. This two-way communication will improve students' understanding and calculation skills.

Students were then given notes and handouts in the form of pdf files and a flipbook. This pdf file and flipbook are available for download from Google Classroom. While short videos were created using digital technologies, emphasizing on the instructor's video that covers a steps-by-steps calculation. This will help students to improve their knowledge and understanding of the determinant, dot product and cross product topics. MatVec also includes a short video that shows how to calculate determinant, dot product, and cross product with a scientific calculator and a symbolab calculator. These brief videos are available on YouTube and students can watch the videos at any time and from any location. It can also be downloaded from the YouTube video and watch it later.

Moreover, live activities contain games created with Liveworksheets, Canva, and Genially. Liveworksheets can transform traditional printable worksheets into self-correcting interactive exercises that students can complete online and send to the facilitator. Canva and Genially both offer interactive learning tools. These live activities include auto-marked elements that allow students to repeat the exercise until they understand the topics.



Figure 1: The components of MatVec Model

### Data Collection

MatVec have been initially used in the e-Fundamental Engineering Seminar (eFES) in October 2021. This seminar is conducted for the third semester (*penerapan*) Mechanical Engineering students at Universiti Teknologi MARA, Cawangan Pulau Pinang, involving sixty-five students who were taking the Calculus for Engineer (MAT455) courses for that semester. The online five-point Likert-scale questionnaires were created using Google Form and for the data collection process. The link was share at the end of the Google Meet session. The obtained data were then analysed using Google Form - responses. Table 1 shows the research question for analysing student satisfaction of FES and using MatVec. This questionnaire was adapted from Student Satisfaction Survey developed by Nemanja (2019) and Pool of Questions for Seminar Evaluation developed by Friedrich-Alexander-Universität (2015).

Table 1: Research Question of Student’s Satisfaction

RQ	Item
1	FES is beneficial to ' <i>Penerapan</i> ' students and should be continued
2	The applications in the modules are very interesting and help to improve my skills in graphing, using e-calculator and solving matrix-vector problems
3	The Google Meet Session improves my basic understanding of MAT455, and all the lecturers are very helpful

The results of MAT455 final exams for mechanical students will also be analysed for three semesters: October 2019 - February 2020, March 2021-July 2021 and October 2021-February 2022. The seminars were handled solely through Google Meet during the semester of October 2019-February 2020. Students were not given any additional materials, such as videos, flipbooks or interactive exercises. Students were introduced to one-stop platform called eFES during the semesters of March 2021–July 2021 and October 2021–February 2021. MatVec was also used during this seminar.

**Result and Discussion**

Figure 2 shows the student’s satisfaction with joining FES. 52.3% of students strongly believe that FES is beneficial to *Penerapan* students and should be continued. Overall, 96.9% supports that FES is beneficial and contains elements that can help them recall their understanding and skills in calculating some calculus and algebra topics, such as matrices and vectors. Only 3.1% stays in natural or indecisive zone.

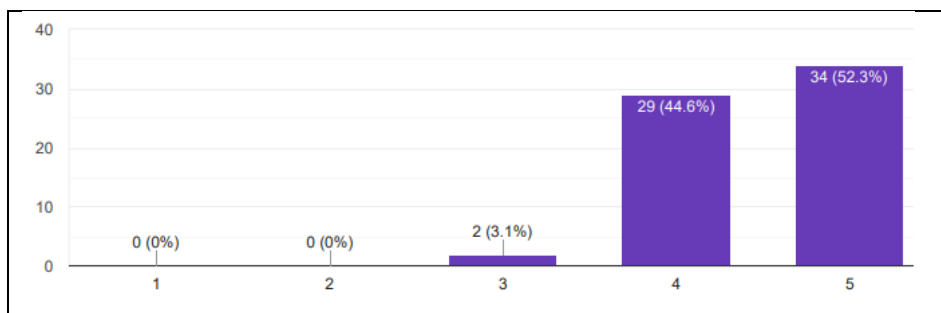


Figure 2: Student’s satisfaction joining FES

Figure 3 shows that 56.9% of students are well-satisfied with the material provided in FES. They believe that the modules' applications are very interesting and that they will help them improve their skills in graphing, using an e-calculator and solving matrix-vector problems. MatVec, for example, includes an interactive element that can stimulate their interest during their revision.

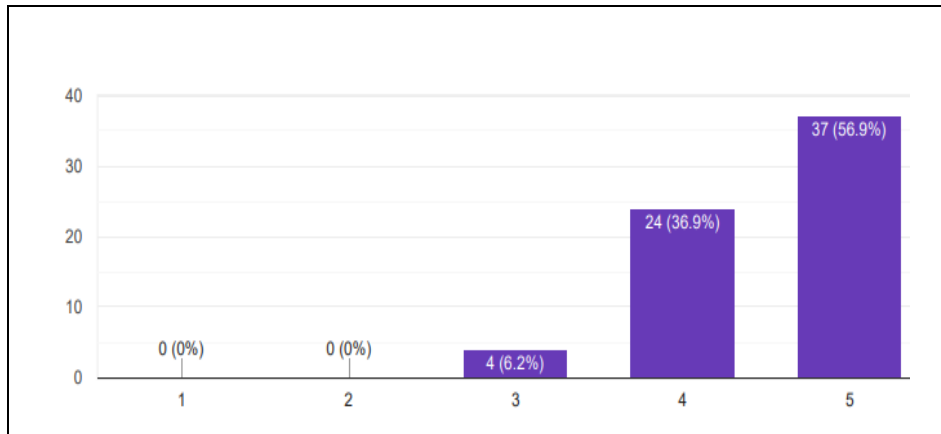


Figure 3: Student’s satisfaction with material provided in FES

Figure 4 shows the student’s satisfaction with Google Meet session. 58.8% of students agree that the Google Meet Session improves their fundamental understanding of MAT455. This expected outcome is due to the two-way communication and active interactions between students and facilitators during the Google Meet session.

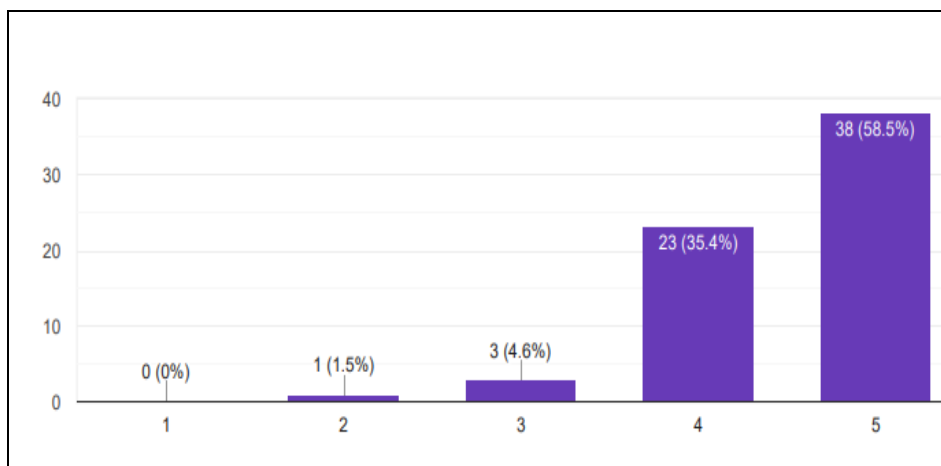


Figure 4: Student’s satisfaction with Google Meet session

Figure 5 depicts the MAT455 final exam results for mechanical students over three semesters. The chart shows that the passed results are consistent for the first two semesters, which were during the implementation of FES and eFES. Following the second eFES, the passing rate increased from 85.7% to

96.6%. The strong students' acceptance rate on the the internet-based learning style where they can revise borderlessly using the one-stop platform that eFES provides, made the outcomes possible.

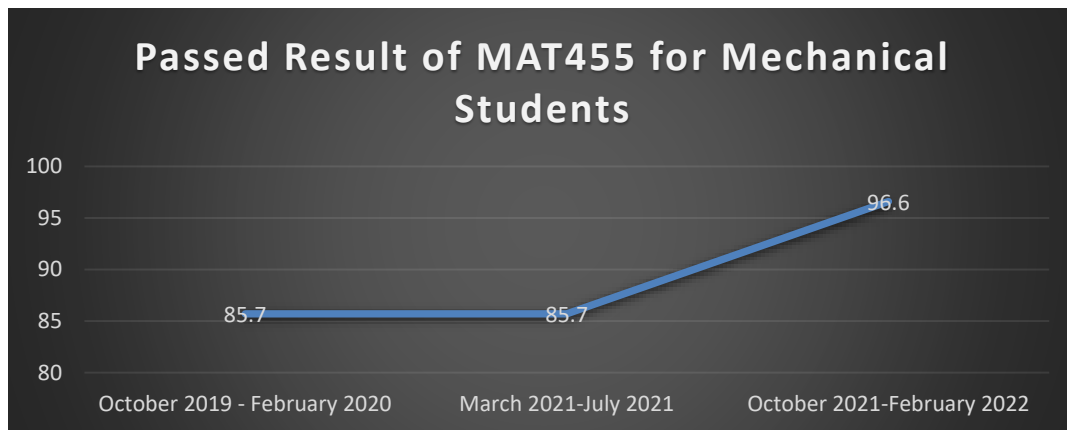


Figure 5: Final exam results for mechanical students over three semesters

### Conclusions

This study investigates the effectiveness of MatVec learning platform adoption and implementation in enhancing the students' learning skills and performance of students' grades. The use of MatVec contributed to the success of their examination results, as evidenced by the passing rate of the MAT455 final exam results for mechanical students at Universiti Teknologi MARA, Cawangan Pulau Pinang, which increased from 85.7% in semester March 2021-July 2021 to 96.6% in October 2021-February 2022. The fact that the improvements in the students' grades suggest that the applications of hybridizing and integrating digital technologies as additional learning tools is significant and beneficial. This is because of the development of MatVec were designed by considering the theories of learning and the understanding of the students' psychological needs and interests in comprehending the problems. Thus, MatVet fulfilled as one of the solutions as a one-stop platform model. It provides students with simple and quick self-learning strategies by using digital technologies, assist students in repeating exercises because live activities can be auto-marked and presents the correct answer, systematically directs and assists students' attention to the content as the flipbook was designed to be short, straightforward and appealing. Thus, it provides engaging experience between students and educators.

Furthermore, MatVec can be considered as an effective learning platform for students, as it allows them an opportunity to construct knowledge, and also allows possible collaboration with peers and learning groups within and beyond the classroom environment. Different learning strategies can

also be provided to students with different learning backgrounds, to create successful learning experiences.

Finally, students positive feedbacks on the use of the MatVec learning platform after experiencing it during the eFES seminar supports the effectiveness of this platform. Most students successfully demonstrated their ability to overcome the difficulties in solving matrices and vector problems that were given to them in the seminar. Therefore, it can be suggested that one way to improve the performance of calculus students is through embedded technologies such as MatVec, which can be used as a monitoring tool in measuring the students' performance. This platform can help to reduce the failure rate among calculus students and provide instructional practises that enhance the maximum effects on instruction and student outcomes. According to Msomi (2018), due to the large use of technology in the world we are living in, there is no doubt that the use of technology in teaching and learning has great impacts on how students perceive and absorb knowledge. Thus, it is very essential and unavoidable to use integrated tool such as MatVet if we are to make a lasting impact on how students learn and comprehend knowledge.

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