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STUDENT FEEDBACK SURVEY ON USING FLEXIBLE PAVEMENT DESIGN TOOL (FLEXIPAVD) IN LEARNING FLEXIBLE PAVEMENT DESIGN

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Abstract:

This study presents the findings from a survey conducted to gather student feedback on the efficacy and user experience of a teaching and learning tool for flexible pavement design, namely FlexiPavD. In most Malaysian universities, the Highway and Traffic Engineering course syllabus includes the design of flexible pavements. The student needs to go through a manual (more than 30 pages) to assist them in designing a flexible pavement. This process may result in human error in addition to wasting money, time, and paper. With this in mind, we develop a tool using Microsoft Excel to help assist students in carrying out the design process anytime and anywhere from hp, tablet, laptop, or pc. However, no matter how well the tool is developed, it will serve no purpose if the student does not benefit from it. Therefore, the survey aimed to evaluate the tool's impact on students' learning process and overall satisfaction. Data were gathered from a diverse cohort of 50 undergraduate students through an online survey platform to ensure ease of access and involvement. The results indicate a generally positive reception of the tool, with 90% of respondents being satisfied with the design tool, and 10% feeling neutral. It is concluded that the tool is pertinent to the teaching and learning process based on the fact that 92% of students concur that FlexiPavD is helpful for their learning process in flexible pavement design.

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FlexiPavD, Student Feedback, Teaching and Learning Tools, Flexible Pavement Design

Introduction

In the modern education landscape, the integration of advanced teaching and learning tools has become a fundamental component. The shift from traditional, lecture-based instruction to more dynamic, interactive learning environments that emphasize student-centred learning can be supported by using these tools, ranging from digital platforms and simulation software to collaborative online resources and interactive multimedia (Ong et al., 2020, Ubaidillah, et.al., 2020). The incorporation of advanced teaching tools in the curriculum is essential for enhancing the learning experience and engaging student interest in the particular subject matter.

In most Malaysian universities, flexible pavement design is taught as part of the Highway and Traffic Engineering syllabus. To assist in carrying out the design process, a revised version of the guidelines ATJ 5/85 (Pindaan 2013): Manual for the Structural Design of Flexible Pavement was introduced in 2013. The revised guidelines adopt a catalogue of pavement structures methods to speed up the design process and achieve a more cutting-edge road design (JKR, 2013). The student must print out the manual or scroll through a digital edition, where the process not only wastes paper, resources, and time but also increases the likelihood of human error. Therefore, a tool using Microsoft Excel was developed to assist students in carrying out the flexible pavement design process conveniently from computing devices such as desktop and laptop computers, smartphones, or tablets. The Excel spreadsheet was designed to produce the thickness of each flexible pavement layer in accordance with ATJ 5/85 (Pindaan 2013): Manual for the Structural Design of Flexible Pavement (Shah et al., 2022).

This survey aims to gather valuable feedback from students regarding the effectiveness and impact of teaching and learning tools specifically developed for flexible pavement design. The primary objective is to assess how these tools facilitate the learning process, the satisfaction of the student with the tools, and the effectiveness of the tools in contributing to a more engaging and interactive learning environment. From student perspectives, the strengths and areas for improvement of the tool can be identified, ensuring that the teaching method remains aligned with student needs.

Literature Review

The integration of teaching and learning tools in educational settings has been a topic of interest among researchers. Numerous studies have highlighted the positive perceptions students have toward teaching and learning tools. Ong et al. (2020) conducted a survey to determine the students' perceptions of using Google Classroom in their learning process. Using the 5-point Likert scale that provides five possible responses: 1 (Strongly Disagree), 2 (Disagree), 3 (Neutral), 4 (Agree), and 5 (Strongly Agree), the questionnaire consisted of 15 items to assess secondary school students' post-intervention opinions of using Google Classroom for learning. Based on the findings, students appear to have a positive opinion of utilizing Google Classroom and believe that Google Classroom can support their learning process.

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Similarly, Warman (2022) investigated the students' perception of using Google Classroom in flipped English learning during the COVID-19 pandemic. According to Van Alten et al. (2019) and Lo et al. (2017), flipped learning/classrooms involve students watching instructional lecturer videos or reading materials before class or receiving computer-based individual instruction outside the classroom (Bishop & Verleger, 2013), followed by active learning activities in the classroom such as problem-solving assignments, discussions during class or interactive group learning. The study involved 227 university students in Pekanbaru, Riau, Indonesia, and found that participants had positive perceptions of using Google Classroom for flipped English learning during the COVID-19 epidemic. The majority of participants found Google Classroom easy to access (87.3%), useful (75.8%), and effective (75.3%) for flipped English learning. Responses from selected participants during the interview indicated that Google Classroom enhanced their collaboration and motivation in learning English.

Fitri Rahmawati et al. (2020) argued that learning via Google Classroom cannot be used to substitute for face-to-face lectures. The study used a descriptive qualitative approach and included 13 history education students as participants. The data was collected through in-depth interviews with all participants and analysed using descriptive analysis. The findings suggested that Google Classroom is easy to access by students and can be used in the lecture process. In spite of that, students agreed that Google Classroom is very effective for assignments but not in terms of materials delivery due to a lack of understanding of course topics through lectures using this application.

Mazlan et al. (2024) assessed the efficacy of e-learning tools in engaging students in the classroom. By using ARCS motivation model, the study examined the motivation of 200 international and Malaysian pre-university students studying economics and chemistry to use E-tools such as kahoot, quizzes, and blooket for learning. According to the findings, 93% of Economics students were more attentive as a result of the tools' use, while 79% viewed the use of E-learning tools to be relevant. 89% of Chemistry students said that they were more attentive in class, and 69% thought the E-Learning tools were useful. Furthermore, the E-learning tool enhanced the students' confidence. This may be observed in the fact that 85% of Economics and 70% of Chemistry students felt more confident in approaching the subject after using the tools.

Other studies have been carried out to assess students' perceptions using educational games and game-based student response systems in their learning process. Studies by (Rahmadani et al., 2024; Iman et al., 2021; Kaur & Nadarajan, 2020; Licorish et al., 2018) found that game-based learning using Kahoot! not only fun and exciting but also increase their learning motivation and engagement. A study by Wong et al. (2022) utilized a 7-point Likert scale ranging from 1 to 7 (1-Strongly Agree; 2-Agree; 3-Somewhat Agree; 4-Neither Agree nor Disagree; 5-Somewhat Disagree; 6-Disagree; 7-Strongly Disagree) to survey 42 computing foundation students about their usage of simulation games as learning tool in science and mathematics. The findings revealed the level of students' perceptions regarding simulation games is significantly at a high level with more than 80% of the respondents somewhat agreed to strongly agreed that simulation games cover the important elements of learning in a competitive context and valid portrayal of reality in obtaining relevant knowledge. They strongly agree that simulation games can serve as a learning tool to improve their learning.

Ibrahim et al. (2011) assessed the students' perception of using educational games in learning Introduction to Programming course. Two types of mini-online games have been designed and developed. The perceptions were measured using five constructs: motivation, attitude, cognitive development, game interface, and expectation using a 5-point Likert Scale. The study found that more than 80% of students agreed that games make the subject more interesting, are interested in using games in their future learning, prefer to do exercise in games compared to quizzes in class, enjoy using games to learn rather than traditional approach in class and want to learn all computer subjects through educational games.

Batamuliza et al. (2024) explored the students' perception of the use of interactive computer simulations (ICS) in their chemistry learning. Using a Likert scale on a sample of 160 participants, they found that 83% of students perceived ICS as highly effective in learning chemistry and encouraged individual learning, which supports interactive learning. Moreover, 80% of students agreed that utilizing ICS allowed them to complete their work in chemistry quickly and efficiently. Similarly, Banda & Nzabahimana (2023) examined how Physics Education Technology (PhET) interactive simulation-based learning affected students' motivation and academic achievement in learning oscillations and waves among Malawian secondary pupils. A quasi-experimental design with non-equivalent groups was utilized to study 280 secondary school students with a mean age of 17.5 from four schools in Blantyre metropolitan area, Malawi. The experimental group was subjected to PhET simulation-based learning, whereas the control group received conventional teaching methods. Pre- and post-tests were employed to collect academic accomplishment data, while motivational data was collected via questionnaires. The study's findings suggest that PhET simulation-based learning enhanced oscillation and wave learning. PhET simulation-based learning uses visualizations and instructional aids to help students understand content information, hence enhancing academic achievement and motivation levels.

Khasawneh and Obadat (2013) studied the benefits of incorporating DARWin 3.1 in the Pavement Engineering course. DARWin stands for Design, Analysis, and Rehabilitation for Windows, is a computerized pavement design tool based on The American Association of State Highway and Transportation Officials (AASHTO) Guide for the Design of Pavement Structures. In this study, 16 students completed a 10-question survey at the end of the semester using a 5-point Likert Scale (1 - strongly disagree or 20% student satisfaction; 2 - disagree or 40% student satisfaction; 3 - partially agree or 60% student satisfaction; 4 - agree or 80% student satisfaction; 5 - strongly agree or 100% student satisfaction). The findings revealed that DARWin 3.1 improves the learning experience for students and makes the class more enjoyable. Moreover, 100% of students strongly agreed that the software was user-friendly. The study suggested that having the students build and utilize Excel models instead of AASHTO software will improve students' understanding of pavement design processes.

Most of the studies indicate a positive perception of advanced learning tools in terms of their ability to enhance comprehension. However, some negative feedback was also presented, such as in game-based learning, where students thought that recreational usage of Kahoot! in lecture sessions restricted material coverage and wasted valuable lecture time (Licorish, 2018). Using Google Classroom has challenges such as students living in remote locations had restricted access to internet connections, lack of physical interactions (Warman, 2022), and difficulty understanding the lecture materials (Fitri Rahmawati et al., 2020). Learning using computer simulation can be challenging due to a lack of computer abilities, resulting in a lower

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proficiency in using ICS (Batamuliza et al., 2024), tools may be too complex (Magana et al., 2012), or errors in network design that are difficult to identify (Ahmad, 2022).

While the integration of advanced teaching and learning tools has advantages and benefits for the teaching and learning process, it also has drawbacks. Hence, it is crucial to assess the student feedback and perceptions of using these tools in their learning process.

Flexible Pavement Design (FlexiPavD) Tool

Based on the recently revised JKR's guidelines, a Microsoft Excel spreadsheet was used to develop this tool. The primary menu that links to the other spreadsheets is located in the first sheet, as seen in Figure 1. The design input, design factors, catalogue of pavement structures, example, and exercise are the five main spreadsheets in FlexiPavD. This is the latest version (version 3.0) of FlexiPavD. The previous versions, Version 1.0 did not include an exercise or an example (Shah et al., 2022), while Version 2.0 does not include an exercise.

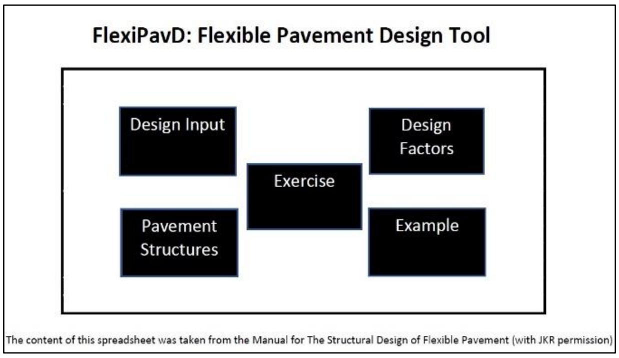

Figure 1: Main Menu of FlexiPavD

In Design Input, there are entries for the traffic category, sub-grade category, and pavement type as shown in Figure 2. Students can select one item from each drop-down list entry that contains these data:

- Traffic Category: T 1, T 2, T 3, T 4 or T 5
- Sub-grade Category: SG 1, SG 2, SG 3 or SG 4
- Pavement Type: Conventional flexible: granular base, Deep strength: stabilized base, stabilized base with surface treatment or full depth: asphalt concrete base

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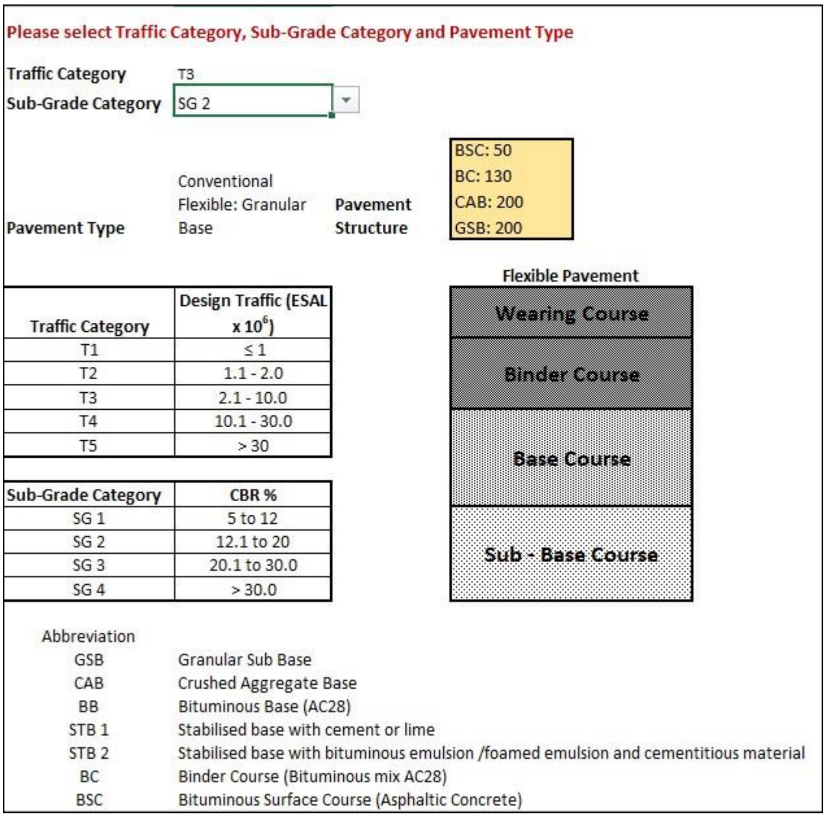
Please select Traffic Category, Sub-Grade Category and Pavement Type

Traffic Category T3
Sub-Grade Category SG 2

Pavement Type Conventional Flexible: Granular Base

Pavement Structure
BSC: 50
BC: 130
CAB: 200
GSB: 200

Traffic Category	Design Traffic (ESAL x 10^6)
T1	≤ 1
T2	1.1 - 2.0
T3	2.1 - 10.0
T4	10.1 - 30.0
T5	> 30

Sub-Grade Category	CBR %
SG 1	5 to 12
SG 2	12.1 to 20
SG 3	20.1 to 30.0
SG 4	> 30.0

Abbreviation	
GSB	Granular Sub Base
CAB	Crushed Aggregate Base
BB	Bituminous Base (AC28)
STB 1	Stabilised base with cement or lime
STB 2	Stabilised base with bituminous emulsion /foamed emulsion and cementitious material
BC	Binder Course (Bituminous mix AC28)
BSC	Bituminous Surface Course (Asphaltic Concrete)

Figure 2: Design Input of FlexiPavD

Prior to selecting these entries, the student must manually compute the design traffic and subgrade CBR using the equation given in Design Factors (Figure 3). The traffic category and sub-grade category must be established manually using the data provided in Figure 2. By selecting the required traffic category, sub-grade category, and pavement type, the thickness of each layer (refer to pavement structure cell) will be produced as stated in the pavement structure catalogue. The VLOOKUP function is used to generate the output which can be seen in Figure 4.

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EQUATIONS

1. Design Traffic (Number of ESALs) for the Design Lane and Base Year Y_1 (First Year of Design Period)

$$ESAL_{Y1} = ADT \times 365 \times P_{CV} \times 3.7 \times L \times T$$

or

$$ESAL_{Y1} = [ADT_{VC1} \times LEF_1 + ADT_{VC2} \times LEF_2 + \ldots] \times 365 \times L \times T$$

where
$ESAL_{Y1}$ = Number of ESALs for the Base Year
ADT = Average Daily Traffic
P_{CV} = Percentage of CV (Un-Laden Weight > 1.5 ton)
L = Lane Distribution Factor (Table 2)
T = Terrain Factor (Table 3)
ADT_{VC1} = Average Daily Number of Vehicles in each Vehicle Class
LEF = Load Equivalence Factors (Table 1)

2. Design Traffic (Number of ESALs) for the Design Period (Design Life in Years)

$$\text{Design Traffic } ESAL_{DES} = ESAL_{Y1} \times [(1 + r)^n - 1]/r$$

or

$$\text{Design Traffic } ESAL_{DES} = ESAL_{Y1} \times TGF$$

where
$ESAL_{DES}$ = Design Traffic for the Design Lane in one direction (determine the Traffic Category)
r = Average Annual Traffic Growth Factor for Design Period
n = Number of Years in Design Period
TGF = Total Growth Factor (Table 4)

3. Sub-Grade Strength

$$\text{Design Input Value} = \text{Mean} - (\text{Normal Deviate} \times \text{Standard Deviation})$$

where
Design Input Value determine the Sub-Grade Category

Figure 3: Equations in Design Factors

Catalogue of Pavement Structures

Pavement Structures for Traffic Category 1: < 1.0 million ESALs (80 kN)

Pavement Type	SG 1	SG 2	SG 3	SG 4
Conventional Flexible: Granular Base	BSC: 50 CAB: 250 GSB: 150	BSC: 50 CAB: 200 GSB: 150	BSC: 50 CAB: 200 GSB: 100	BSC: 50 CAB: 100 GSB: 100
Deep Strength:Stabilized Base	BSC: 50 STB 2: 100 GSB: 200	BSC: 50 STB 2: 100 GSB: 150	BSC: 50 STB 2: 100 GSB: 100	BSC: 50 STB 2: 100 GSB: 100
Stabilized Base with Surface Treatment	GSB: 300 or STB 2: 250	GSB: 300 or STB 2: 250	GSB: 250 or STB 2: 200	GSB: 250 or STB 2: 200

Pavement Structures for Traffic Category 2: 1.0 to 2.0 million ESALs (80 kN)

Traffic Category 2	SG 1	SG 2	SG 3	SG 4
Conventional Flexible: Granular Base	BSC: 140 CAB: 200 GSB: 150	BSC: 140 CAB: 200 GSB: 150	BSC: 120 CAB: 200 GSB: 100	BSC: 100 CAB: 200 GSB: 100
Deep Strength:Stabilized Base	BSC: 120 STB 2: 150 GSB: 200	BSC: 120 STB 2: 150 GSB: 150	BSC: 100 STB 2: 120 GSB: 150	BSC: 100 STB 2: 120 GSB: 150
Full Depth: Asphalt Concrete Base	BSC: 50 BB: 100 GSB: 250	BSC: 50 BB: 100 GSB: 200	BSC: 50 BB: 100 GSB: 150	BSC: 50 BB: 80 GSB: 150

Figure 4: Catalogue of Pavement Structures

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Methodology

Likert scales are widely used in educational and psychological research to assess attitudes, perceptions, beliefs, and other aspects. Most variables in educational research typically rely on self-report measures employing Likert rating scales, as they are not directly observed (Alkharusi, 2022). Originally the scale consisted of five points, however other scale variants as low as three and as high as ten or more can be utilized.

In this study, a five-point Likert scale survey was adopted and designed with statements related to various aspects of FlexiPavD as a teaching and learning tool. The five-point scale provides a compromise between detail and simplicity, by offering a neutral midpoint, giving respondents a balanced option between two opposing perspectives (Joshi et al., 2015). Moreover, it gives researchers enough data to conduct statistical analyses without overwhelming respondents (Revilla et al., 2014). Students were asked to rate their level of agreement/perception with each statement on a scale of 1 to 5, as shown in Table 1. The description of each scale depends on the items or statements of the FlexiPavD aspects.

Table 1: Information on The Tested Items in The Questionnaire on Students' Satisfaction, Relevance, Helpfulness, and Effectiveness of FlexiPavD

No.	Items	Likert Scale	Description
1	How satisfied are you with FlexiPavD?	1	Very dissatisfied
		2	Dissatisfied
		3	Neutral
		4	Satisfied
		5	Very Satisfied
2	How relevant and helpful using FlexiPavD for your learning process in flexible pavement design?	1	Not Relevant & Not Helpful
		2	Somewhat Relevant & Helpful
		3	Neutral
		4	Relevant & Helpful
		5	Highly Relevant & Very Helpful
3	Please rate the effectiveness of the tool.		
	• User-friendly	1	Strongly disagree
	• Convenience	2	Disagree
	• Content	3	Neutral
	• Time-saving	4	Agree
	• Interactive	5	Strongly Agree

The questionnaire was distributed through an online survey platform, and responses from 50 undergraduate students from a diverse cohort were gathered. Participation from students was voluntary, and their responses were anonymised to ensure confidentiality and avoid bias. The information from all respondents on each item is calculated to obtain a weighted mean and then interpreted using an interval (refer to Table 2) that translates into the tendency for each item as suggested by Pimentel (2010).

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Table 2: The Description of Perception Level

Likert Scale	Interval	Description
1	1.00 – 1.79	Strongly disagree
2	1.80 – 2.59	Disagree
3	2.60 – 3.39	Neutral
4	3.40 – 4.19	Agree
5	4.20 – 5.00	Strongly Agree

Source: (reproduced from Pimentel, 2010)

The weighted mean can be calculated by multiplying the number of students with the corresponding scale divided by the total number of students. For example, if 10 students choose 3 (Neutral), 20 students choose 4 (Agree) and 20 students choose 5 (Strongly Agree), therefore the weighted mean is

$$Weighted\ Mean = \frac{(10x3) + (20x4) + (20x5)}{50}$$

$$= 4.2$$

Based on the weighted mean value of 4.2, the perception level can be suggested as strongly agree as shown in Table 2.

Results and Discussion

According to the question "How satisfied are you with FlexiPavD?" 38% of students rated their overall satisfaction with the teaching and learning tools as "Very Satisfied," while 52% rated it as "Satisfied". The remaining 10% of students were "Neutral" regarding the FlexiPavD. Based on a calculated weighted mean of 4.28, the descriptive interpretation or tendency of students' satisfaction level is very high. The high percentage of students expressing satisfaction (90% combined for "Very Satisfied" and "Satisfied") indicates a significant positive response to the teaching and learning tools (refer to Figure 5).

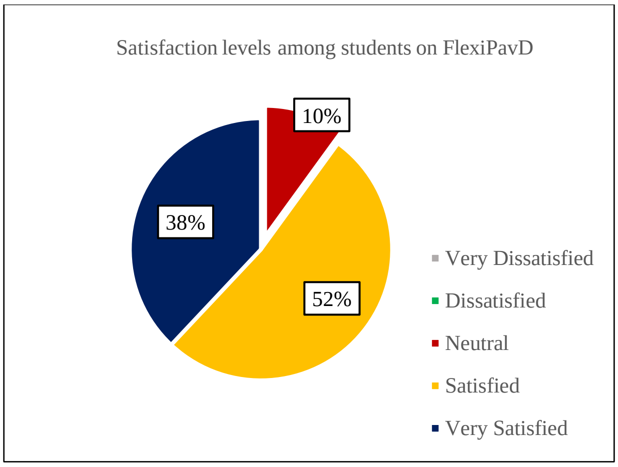

Figure 5: Percentage of Satisfaction Level Among Students on FlexiPavD

From Figure 6, 42% of students rated the teaching tools as "Highly Relevant and Very Helpful" to their learning process in designing flexible pavement. 50% of students indicated that the tool was "Relevant and Helpful" while the remaining students had a neutral opinion of the tool, and

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none of them had a negative opinion of FlexiPavD. A highly favourable response to the teaching and learning tool is indicated by the significant majority of students (92%) expressing "Highly Relevant and Very Helpful" and "Relevant and Helpful" on the relevance and helpfulness of using this tool for their learning process in flexible pavement design. With a weighted mean of 4.34, FlexiPavD is regarded as effective in facilitating their learning process.

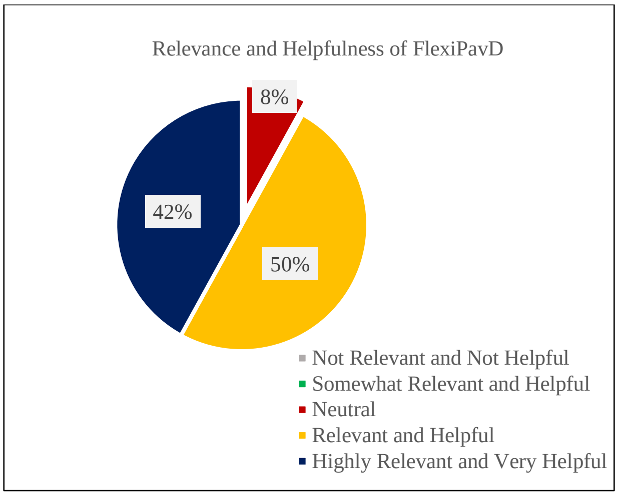

Figure 6: The Relevance and Helpfulness of FlexiPavD in The Process of Learning Flexible Pavement Design

As shown in Table 3 and Figure 7, the effectiveness of the tool has been assessed based on five criteria: user-friendly, convenience, content, time-saving, and interactive. 80% of students found FlexiPavD to be user-friendly, comprehensible, and easy to navigate, which improved their learning experience in flexible pavement design. On average, user-friendly was rated 4.12 (Agree). Convenience was rated 4.26 on average, which means that the students strongly agreed on the convenience and accessibility of this tool, noting that it could be accessed at anytime and anywhere. 82% of students agree (mean = 4.12) that FlexiPavD's content is relevant and assisted them in the designing of flexible pavement. They strongly agreed that FlexiPavD helps them in saving time. 82% of students considered the tools to be interactive (mean = 4.18). The remaining students (20% or fewer) held a neutral opinion of the tool, and no student disagreed with the tool's effectiveness.

Table 3: Descriptive Statistic of Students' Perception on The Effectiveness of FlexiPavD

No	Items	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5	Mean
1	User-friendly	-	-	10 (20%)	24 (48%)	16 (32%)	4.12
2	Convenience	-	-	8 (16%)	21 (42%)	21 (42%)	4.26
3	Content	-	-	9 (18%)	26 (52%)	15 (30%)	4.12
4	Time-saving	-	-	7 (14%)	21 (42%)	22 (44%)	4.30
5	Interactive	-	-	9 (18%)	23 (46%)	18 (36%)	4.18

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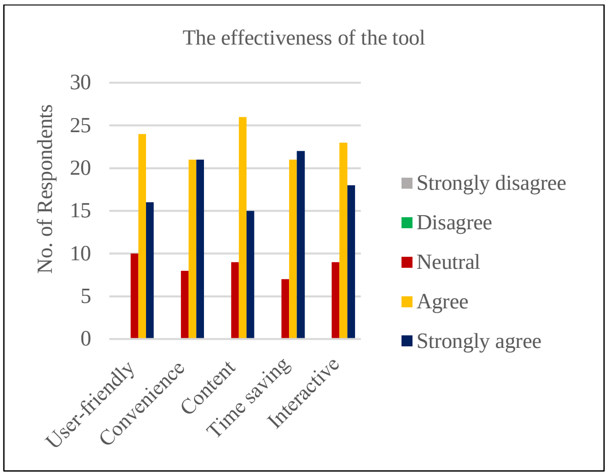

Figure 7: The Effectiveness of FlexiPavD

The survey findings provide direct and transparent input from students, offering insights into the teaching and learning tools. This insight is vital for the continuous improvement of engineering education where educators can optimize tools for greater accessibility, relevance, and effectiveness to meet the needs and preferences of students, making engineering and sustainability concepts more accessible.

Conclusion

According to the survey results, FlexiPavD as a teaching tool for flexible pavement design is extremely valuable to students. The results indicate a generally positive reception of the tool, with 90% of respondents being satisfied with the design tool, and 10% feeling neutral. It is concluded that the tool is pertinent to the teaching and learning process based on the fact that 92% of students concur that FlexiPavD is helpful for their learning process in flexible pavement design. On the effectiveness of the tool, students rated the tool's efficacy at a high level, with more than 80% on each item. Nonetheless, continuous improvements and updates will further maximize the benefits of FlexiPavD in the educational process.

While this study provides valuable insights into students' perceptions of teaching and learning tools, there are some limitations of the study that present opportunities for further research. The sample size was limited to students from a single institution, which may impair the findings' applicability to other educational environments. Future research should consider a control group that does not use the tool for comparison purposes. It is also worthwhile to examine the effects of using the tools on student performance.

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