CARTOON ILLUSTRATION IN TEACHING AND LEARNING RESEARCH STATISTICS

NURUL HIDAYANA MOHD NOOR[1*]

[1]Faculty of Administrative Science and Policy Studies, MARA University of Technology (UiTM), Malaysia

*Corresponding Author: hidayana@uitm.edu.my

Abstract: Learning media is an essential element, and it can be used as a messenger to help students learn more efficiently. Media can stimulate students to acquire knowledge and skills. Therefore, applied media learning is used. Cartoons play an essential role as a very effective means of conveying information to all groups. A cartoon illustration can stimulate the ideas and maturity of a person in evaluating something's message. This study aims to examine the usability of the cartoon illustration known as Funky Figure as a teaching aid for learning Statistical Package for the Social Sciences (SPSS) and the indirect influence of student engagement towards the perceived usability of a cartoon illustration and student adoption. Quantitative research methods were used, and 203 undergraduate research students were selected using survey and purposive sampling. Data was analysed using SPSS v23.0 software, and descriptive statistical analysis was used to explain the demographic profile. Structural Equation Modeling (SEM) analysis method and bootstrapping were used to test hypotheses and the mediating effect of student engagement. SEM analysis shows that the model of student engagement is a full mediator between perceived usability and student adoption of cartoon illustrations. The implications of this study can guide educators in preparing learning suitable for the 21st-century generation.

Keywords: Cartoon illustration, Perceived usability, Student adoption, Student engagement

1. Introduction

Employability skills play an essential role in ensuring the effectiveness of the education system in Malaysia. This issue has long been debated among scholars and academics. Various skills can be applied in students, namely communication skills, thinking skills, problem-solving skills, teamwork skills, continuous learning skills, information management, entrepreneurial skills, moral skills, and leadership skills. Numeracy and digital skills are among the most crucial skills that any graduate should possess before entering the workforce. By understanding the learners' numeracy and digital skills abilities, educators can create suitable learning outcomes, activities, and assessments, enabling them to acquire the skills. Research statistics require high numeracy and digital skills, which are challenging for some students. This is because students have differences, both in terms of intellectual and physical abilities (Hilton, 2020; Ssemugenyi, 2023). That difference causes differences in each student's learning behaviour, thus causing learning difficulties. Students who experience learning difficulties usually experience several obstacles that are shown by symptoms such as low or below-average performance (Hiver et al., 2020). In addition, students are also slow in doing tasks, and nonperformers cannot compete with the performers.

Learning statistical analyses involves using many software such as Python, R, SPSS, Stata, or Excel. Statistical Package for the Social Sciences (SPSS) is a software officially released by the International Business Machines (IBM). In terms of function, SPSS is one of the statistical applications that process the various data available to be displayed readily. SPSS is often used to calculate and process data for market researchers, survey companies, governments, educational researchers, health researchers, marketing organisations, and others (Pallant, 2020). In the beginning, SPSS was more often used for various statistical data processing needs for the social sciences. However, as time progressed, SPSS changed its function to aim at various sectors. Many people may have basic knowledge of data analysis, but they need to understand statistics more deeply, making them falter in using SPSS software, which has more complicated analysis (Legaki et al., 2020). SPSS is quite complex software with many features and functions for statistical analysis. Users who are new to SPSS may feel overwhelmed by the complicated interface. Before performing the analysis, the data must be appropriately arranged according to the format required by SPSS. Ignorance in this pre-processing step can cause errors in the analysis results (Kulas et al., 2021).

Moreover, not understanding when and how to use the appropriate statistical analysis method can cause a wrong or inaccurate interpretation of the analysis results. When encountering technical problems in using SPSS, such as error messages appearing or changing analysis settings, ignorance can make it challenging to find the right solution. In addition, ignorance in SPSS can cause a waste of time and effort in trying to achieve the desired analysis results (Pallant, 2020). Thus, students need learning media to facilitate the teaching and learning process. Learning media can be pictures, sound, video, text, or a combination. Ivan Petrovich Pavlov, better known as Ivan Pavlov, was a behaviourist (follower of behaviourism) and famous for his view of the strong relationship between stimulus and a person's response. The learning theory is generally connected with stimulus-response (Pavlov, 2023). Behavioural theories also explain the responses of living things by connecting what is experienced or becomes a stimulus for specific responses obtained from a particular environment (Hadamitzky et al., 2020).

This continuous relationship between the responses that arise and the stimuli provided is then defined as a learning process (Olson & Ramírez, 2020). Educators can apply the lessons learned from classical conditioning in the classroom. A positive and supportive environment can reduce students' anxiety and fear (Akpan, 2020). Learning media can help students to understand the subject matter more efficiently, interestingly, and pleasantly. One learning media that can be easily made is learning media from cartoon illustration. Visualization can be a powerful cognitive tool in solving statistical problems; this is an essential skill in learning and applying statistics and building a positive character for students (Sica et al., 2022). Learning statistics is expected to refer to the principle of active student learning and learning how to learn, whose details are contained in four pillars of education, namely: (1) learning to know, (2) learning to do, (3) learning to be, and (4) learning to live together (Howson & Kingsbury, 2023; Schiavio et al., 2021).

Traditional teaching and learning processes, such as using PowerPoint slides in lecture sessions, lead to a lack of attention and an inability to motivate students. A study conducted by Oderinu et al. (2020) found that the teaching and learning process is less quality and less

effective if the educator does not use appropriate teaching aids. Some students must be given learning support in the teaching and learning process to ensure they are clear and achieve the learning objectives (Junwei et al., 2020). Therefore, educators play an essential role in helping students to build cognitive skills to achieve learning objectives. Using creative techniques in teaching and learning sessions will trigger the nature of inquiry in students (Taylor et al., 2022). From a constructivist point of view, learning should be an active process where knowledge is built based on prior knowledge, and the learning process must occur actively between educators and students. Shaista Saiyad et al. (2020) stated that good teaching and learning materials are practical and capable of attracting interest and motivating students to continue to be involved in the teaching and learning process.

This proves that the teaching and learning process affects the active involvement of students in cognitive building (Martzoukou, 2020). Supported by previous studies (e.g., Unsworth, 2020; Knapp et al., 2022), a cartoon illustration known as Funky Figure was developed to ensure that students get maximum learning regarding emotions and learning performance. This study was carried out to see the usability of the cartoon illustration in increasing student engagement and adoption. Thus, the study's main aim was to examine the influence of the usability of cartoon illustrations in increasing student adoption. The second is to examine the mediation effect of student engagement toward the relationship between the usability of the cartoon illustration and student adoption. Past studies have discovered that student engagement is an essential indicator in determining academic achievement and an important aspect of avoiding dropouts among students (Lim et al., 2023; Qiao et al., 2023).

Empirically, this study is among the few papers that examine the mediation model of student engagement in the education sector in a developing nation like Malaysia. Most studies have examined the direct effect relationships (e.g., Ferreira et al., 2020), and most of it has focused on common e-learning platforms and applications such as YouTube, Kahoot, MOOC, and others, while the usage of cartoons in learning is still limited. Furthermore, this paper extends engagement to the learning process by showing how students' engagement impacts the adoption of cartoon illustration in the tertiary education environment. Theoretically, the study adds new insights to the current learning literature. This study is unique and different from previous studies because the researcher wants to test the research model supported by previous studies and the developed teaching aid, which is Funky Figure. Past researchers have emphasized the aspect of creativity in teaching and learning (da Silva Caixeta et al., 2021; Dinghan & Yue, 2022), but not many educators have built and designed cartoon-based aids.

Therefore, this study is very significant because it can answer whether the method of using cartoons in learning can be accepted and used for SPSS learning. Educators should emphasize the quality of feedback delivered to students and ensure the use of teaching aids is sufficient and in good condition to create effective learning for students. The poor student performance and low acceptance rate are due to the absence of teaching evaluation in assessing the effectiveness of teaching aids (Bromage et al., 2022).

2. Literature Review

2.1 Classical Conditioning Theory

This study adapted classical conditioning theory. The theory founded by Ivan Petrovich Pavlov (1849-1936) emphasizes on behaviour or natural behaviour. The basis of this theory is that learning occurs due to the relationship between stimulus and response. Learning occurs because of the association between two stimuli, called conditioning (Akpan, 2020). In the classical conditioning theory pioneered by Ivan Pavlov, he produced several essential concepts in the teaching and learning process. The concept includes i) generalization, ii) discrimination, iii) elimination, and iv) relearning (Olson & Ramírez, 2020). Generalisation means that the same stimulus will produce the same response. For example, Ali would be worried whenever a research methodology test is held. Ali also worries whenever an SPSS test is conducted because the two subjects are related. Thus, the anxiety in both subjects has been generalised. Next, discrimination occurs when individuals only respond to certain stimuli (Pavlov, 2023). A study on dogs found that the dogs only responded to the sound of the bell but not to sounds other than the bell.

Next, elimination or extinction occurs when a familiar stimulus is not accompanied by a non-familiar stimulus (Hadamitzky et al., 2020). In Pavlov's study, the sound of a bell was not accompanied by an unaccustomed stimulus (meat). In this case, the sound of the bell will not stimulate the dog over time. The final response will be deleted. Finally, relearning refers to how an organism learns a new response or response happens in stages (Pavlov, 2023). The more often the organism tries, the stronger the dominance becomes. From this theory, educators need to be aware that stimulus and response have a connection that can be habituated or learned. The link between stimulus and response can be strengthened through training (Hadamitzky et al., 2020). The more often the stimulus is associated with a response, the stronger the habitual response.

In learning, deletion can occur if reinforcement is not given (Pavlov, 2023). This means that if a behaviour is not reinforced through rewards, the behaviour may be disappeared. The relationship between the researcher's study and Pavlov's theory is that they use cartoons to attract interest or stimulate students' motivation and the adoption of cartoons to learn SPSS. Initially, students were found to be less stimulating to focus on learning. The use of cartoons will undoubtedly be exciting and easy to learn. Carter and Hartley (2021) and Qian et al. (2020) results have shown that students paid more attention to cartoon stimuli than to natural stimuli. Thus, cartoons are stimulated to increase individual potential. The stimulus can be physical, social, or psychological. In this case, stimulation through cartoons aims to increase a person's learning ability, creativity, or even intelligence (Peiró-Signes et al., 2021; Sharifah Norul Akmar Syed Zamri et al., 2020).

2.2 Perceived Usability of Cartoon Illustration

Creative learning approaches, such as cartoon illustrations, create an exciting and different learning experience from traditional approaches (Schiavio et al., 2021; Sica et al., 2022). Cartoon illustration helps students develop valuable critical thinking skills in everyday

54

life and the future (Foster & Shah, 2020; Jahnke & Liebscher, 2020). Previous studies have found that the use of teaching aids has a positive effect on the academic excellence of students (Abdulrahaman et al., 2020). Students can remember to use teaching aids that involve pictures and visuals (Skenteridou & Tsiakis, 2021). A variety of delivery methods teaching is an essential component for motivating students' interest in learning. The learning process and teaching in the lecture room using teaching aids are critical to positively affecting students (Alam, 2022).

Cartoons are the most widespread forms of instructional media, and previous studies have found the cartoon concept made learning more fun, improved critical thinking, promoted problem-based learning, and captured student interest and attention, which led to student achievement (da Silva Caixeta et al., 2021; Dinghan & Yue, 2022). Cartoons promote humor and entertainment and enable students to participate actively in classroom activities. Cartoons are an effective medium of communication because students find it easier to absorb information, and humor attracts the students to understand the message delivered (Martzoukou, 2020). Since cartoons are composed of images and symbols, they remain in the minds of individuals for a long time (Unsworth, 2020; Knapp et al., 2022). As a result, it is easy to remember the knowledge learned.

Cartoons in teaching only will be effective if it has good perceived usability (Peiró-Signes et al., 2021; Sharifah Norul Akmar Syed Zamri et al., 2020). In general, usability is how the system or product is developed and how easy it is to use (Nor Sahkkina Kadir & Mohd Ikhwan Hadi Yaacob, 2022). Each feature helps improve overall understanding at an early stage and is essential to ensure users know what to do and what is happening. This situation supports strengthening the mental understanding of the students' model, which aligns with the cognitive scientists' recommendations. Attitudes and perceptions of usefulness are influenced by the degree to which potential users expect the approach to be free of effort (perception of ease of use) and the effect of usability on the use of the approach (Sit et al., 2020). Next, the notion of the usefulness of an approach refers to the measurement of an individual's belief that the use of an approach will benefit the people who use it (Ferreira et al., 2020). The use of cartoon illustrations is effective for learning SPSS. It effectively increases understanding of learning content, improves performance and student achievement, and attracts student attention to follow SPSS learning.

The most critical usability feature is designing an easy-to-use interface display. This essential feature parallels the requirement factor, which refers to the extent to which the approach is easy to operate in solving user objectives (Taylor et al., 2022). The information presentation and display factors are two factors that affect readability. Consensus has been reached among experts, where the first ranking position for usability features is to use visuals that are easy to understand and to present information that is not fibrous (Tuli & Mantri, 2021). The usability feature of the interactive factor is also being able to observe objects through various perspectives (Alhadreti, 2021). This feature can make it easier for students to understand learning more authentically and deeply. Because of that, the experts agree that the feature is at the top of the perceived usability list.

Previous studies have found that the perceived usability of cartoons as teaching aids positively influences student engagement and adoption intention (Abdinejad et al., 2021; Carter & Hartley, 2021; Qian et al., 2020). Amusement, favourable outcomes, and an excellent visual appearance will boost usage (Bromage et al., 2022). Students are engaged when there they are attracted to it. To attract students, the teaching aids must be planned to include personalization and aesthetics and must be designed to delight the students (Mingchao & Liping, 2023). To utilise this approach entirely, students must trust that the aid matches their needs and values. Hence, this study hypothesises:

H1: Perceived usability positively influences student adoption of cartoon illustration in learning.
H2: Perceived usability positively influences student engagement.

2.3 The Mediating Effect of Student Engagement

Student involvement generally includes three factors or domains with the most critical dimensions: affective, behavioural, and cognitive (Lim et al., 2023). Affective involvement is understood as students' feelings and emotions towards learning. The student's feelings include feelings towards educators and peers. It describes the students' happiness and seriousness in completing assignments and other tasks (Shafiq & Parveen, 2023). In addition, negative feelings such as fear, worry, and boredom also describe their emotions. Jian and Eryong (2023) state students' feelings about learning activities reflect intrinsic motivation. Students who experience high affective involvement enjoy learning and are happy to attend class. Next, student behavioural engagement is defined as allocating time to tasks, student behaviour during learning, attendance at class, and students acting actively in class discussions (Ya & Hew, 2023).

According to Leksuwankun et al. (2023), behavioural involvement refers to students who are diligent in classroom learning and are active in extracurricular activities. At the same time, cognitive engagement refers to the amount and type of cognitive strategies students use (Li et al., 2023). It emphasizes the intellectual and students' mastery of academics, efforts, results in work, and learning strategies. In learning activities, students use deep processing strategies or surface processing strategies. Deep processing is associated with the cognitive elaboration of learned material, while surface processing involves memorization, repetition of exercises, and other activities that involve superficial contact with the learned material (Venn et al., 2023). Students who experience deep processing have a meaningful understanding and retention of the material learned (Sowmia et al., 2023). In short, cognitive involvement is described as an individual characteristic that facilitates Interaction in the classroom context and promotes good academic achievement (Qiao et al., 2023). Engagement strongly predicts academic achievement and relates to student performance (Yi & Linjia, 2023). Therefore, student involvement and achievement are mutually related to each other. Hence, this study hypothesizes:

H3: Student engagement mediates the relationship between perceived usability and student adoption of cartoon illustration in learning.

56

### 2.4 Funky Figure: Online Cartoon Illustration for Learning SPSS

Peiró-Signes et al.' (2021) study has found that many university students have difficulties when facing statistics-related tasks, leading to a high level of anxiety and poor performance. On the other hand, Bromage et al. (2022) found that statistics anxiety and low motivation lead to negative attitudes towards statistics subjects. Sharifah Norul Akmar Syed Zamri et al.'s (2020) results show a difference between the mean attitude score before and after exposure to compelling and exciting learning methods. Students show more positive acceptance and reflection after being exposed to an interactive teaching approach. Thus, more interactive SPSS guides must be available in universities to prepare and help students analyse the quantitative data. SPSS has established itself as the most popular statistical software in Malaysia. Funky Figure helps provide a complete statistical method, SPSS, which can be used even by people unfamiliar with statistics and computers. To facilitate the understanding of the material, each topic is accompanied by cartoons and step-by-step examples, starting from how to use SPSS processes with specific statistical procedures and interpreting the output of SPSS. The material is divided into three parts:

Part 1: Explain the statistical data before processing with SPSS.
Part 2 explains how SPSS processes data using various statistical procedures.
Part 3: The complementary part displays the results and an SPSS video (YouTube).

This guide is aimed at statistical users who want to avoid being bothered with tedious statistical manual calculations. The guide also combines the usage of YouTube to encourage self-learning and is an educational instrument that improves learning innovatively and creatively; according to the findings of Kalburgi et al. (2023), the advantages of YouTube videos in self-learning activities with quick feedback and reinforcement. In addition, the findings of previous studies also show that student achievement in learning is closely related to the teacher's teaching methods in the classroom. The guide covers critical topics such as data cleaning, reliability tests, normality tests, t-tests, ANOVA tests, Pearson correlation, and multiple regression. The instructors introduced Funky Figure in March 2024 to undergraduate students in the Faculty of Administrative Science and Policy Studies, Universiti Teknologi MARA (UiTM). It has been fully utilized and shared with final-year students who undertook the final research project. Almost 400 students have used Funky Figure. Figure 1 shows a sample of a Funky Figure illustration.
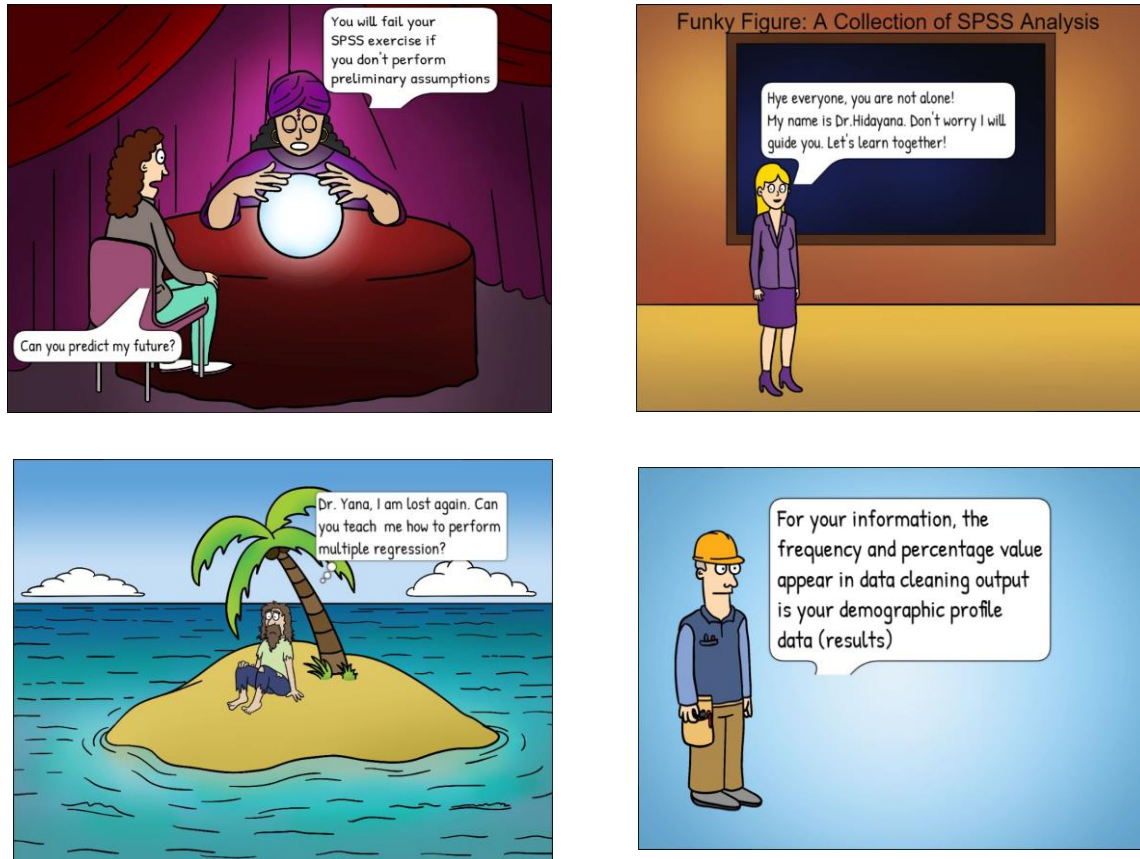

57
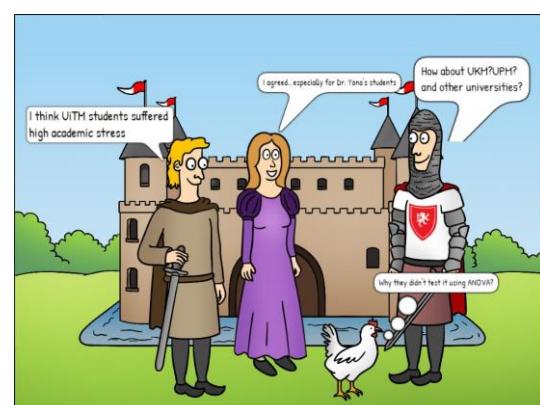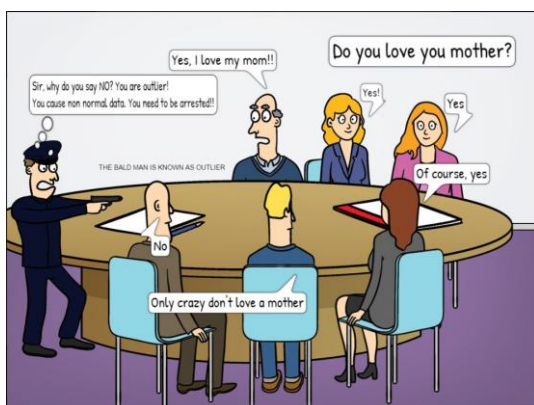
Figure 1. Sample of Funky Figure Illustration (Source: Author's work)

3. Conceptual Framework

A research model guides the researcher in developing research questions, refining the hypotheses, and evaluating variables. Based on the classical conditioning theory and empirical studies (Abdinejad et al., 2021; Carter & Hartley, 2021; Qian et al., 2020), the study proposed the influence of perceived usability on adoption intention. Cartoons create amusement and favorable learning outcomes (Bromage et al., 2022). This relationship could be strengthened by student engagement. With interactive materials such as cartoons, students are more motivated to involve themselves in the learning process. It has made learning more interactive and fun and helped keep students motivated and interested in their studies. Other researchers, such as Ritanjali Panigrahi et al. (2021) and Shin and Bolkan (2021), have also studied student engagement as a mediator. However, more studies still need to be examining the engagement from the context of cartoon illustrations as a teaching aid.

Based on Figure 2, the conceptual framework of this study provides an overview of the relationship between several variables. The mediation model is where the mediating variable modifies the influence of the independent variable on the dependent variable. This study assumes that perceived usability affects student adoption, where student engagement is postulated as a mediator. In particular, the conceptual framework of this study provides guidance on the planning of this study in line with the objective being studied.
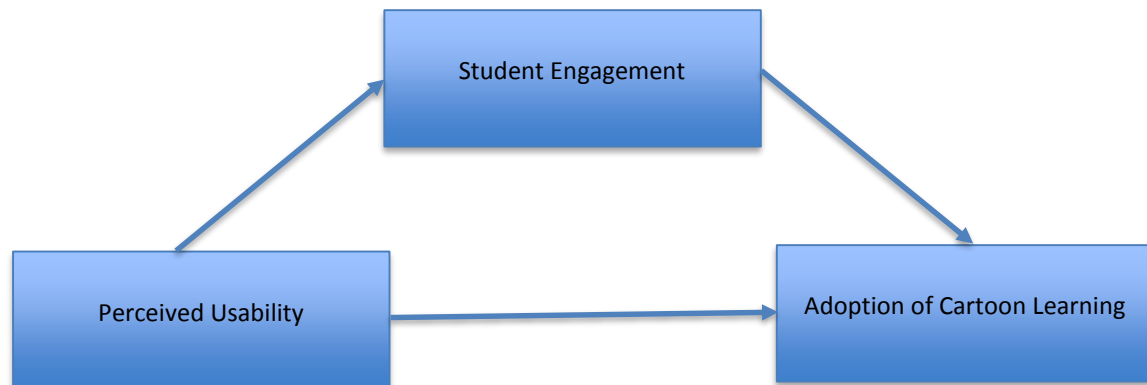
58

Figure 2. Conceptual framework

4. Research Methodology

The design of this study is a quantitative study in the form of a survey involving undergraduate students in the Faculty of Administrative Science and Policy Studies, Universiti Teknologi MARA (UiTM), who undertook research methodology subjects (ADS511, ADS651, and ADS555). It is widely recognized that SEM is a significant sample size technique. SEM scholars argued that the minimum sample size is 200 (Kline, 2011). Therefore, 250 respondents were selected for the study, and the sample is considered sufficient. The study employed a purposive sampling technique where the respondents must meet the following criteria: 1) undergraduate student, 2) has experience using SPSS software via the research courses, and 3) has been exposed to the Funky Figure note. The instructor introduced the Funky Figure note in March 2024, and it is being utilized in research courses. The research instrument is divided into four parts, namely parts A, B, C, and D. Part A contains demographic information of the respondent, part B contains four questions related to students' perception of the usability of cartoon illustration, part C contains fifteen questions related to the student engagement, part D contains three questions related to the student adoption.

The questionnaire used was modified from a questionnaire designed by Ngai et al. (2007), Davis (1989), Maroco et al. (2016), and Al-Emran and Teo (2020). A five-point Likert scale is used to identify the level of respondent agreement for each statement. Corresponding to Nunnally (1978), the tool of a study is contemplated to have satisfactory internal consistency if the value of Cronbach's alpha coefficient surpasses the value of 0.70 (α value > 0.70). Based on Cronbach's Alpha values shown in Table 1, this study fulfilled the assumption of reliability. Suggestion by Kline (2011) is pursued to verify the data's normality. The attained values for skewness and kurtosis were within ±2 and ±7, respectively (see Table 1). Therefore, the acceptable results indicate that the data were distributed normally.

Table 1. Distribution of Items in the Study Questionnaire

Variables	Items	Skewness	Kurtosis	Cronbach's Alpha Coefficient
Perceived Usability	1. Using cartoons improves my learning performance.	-1.118	0.538	0.849
	2. Using cartoons enhances my learning effectiveness.			
	3. Using cartoons gives me greater control over learning.			
	4. Cartons are helpful in my learning.			
Student Engagement	Behavioural engagement	-0.266	-0.489	0.865
	1. I pay attention in class.			
	2. I follow the rules of my institution.			
	3. I usually complete my assignments on time.			
	4. When I have doubts, I ask questions and participate in debates in the classroom.			
	5. I usually participate actively in group assignments.			
	Emotional engagement			
	6. I feel very accomplished at the institution.			
	7. I feel excited about the university work.			
	8. I like being at my learning place.			
	9. I am interested in the university/institutional work.			
	10. My classroom is an exciting place to be.			
	Cognitive engagement			
	11. When I read a book, I question myself to understand the subject.			
	12. I talk to people outside my institution about matters I learned in class.			
	13. If I need help understanding some concepts taught, I try to solve the problem by consulting with others.			
	14. I integrate the acquired knowledge in solving new problems.			
	15. I integrate subjects from different disciplines into my general knowledge.			
Adoption of Cartoon Learning	1. I will use cartoon illustration aids in the future.	-0.256	-0.611	0.871
	2. I will continue to use cartoon illustration aids in the future.			
	3. I would use cartoon illustrations in the future.			

Structural Equation Modeling (SEM) analysis was carried out in this study using the Analysis of Moment Structure (AMOS) programme. SEM can be used to analyse research models with several independent (exogenous) and dependent (endogenous) variables, as well as moderating or intervening variables. The researcher used a two-step modeling approach. First is testing a measurement model where the relationship (loading value) between the indicator and the (latent) construct is tested, and second is where a structural model of the relationship between the constructs is tested. Descriptive analysis was used to analyse the demographic frequency and percentage of participants, while SEM was conducted to examine the relationships between the variables. In SEM, several fitness indices describe the model's fit, as obtained from the statistics. To determine the model fit, the value for Comparative Fit Index (CFI), Goodness Fit Index (GFI), and Tucker Lewis Index (TLI) is expected to be ≥ 0.90. The values scale from 0.00 (poor fit) to 1.00 (perfect fit) (Hair et al., 2010). The Root Mean Square Error of Approximation (RMSEA) explains the residual found in the model. The size of the expected RMSEA value ≤ 0.05. A value of RMSEA ≤ 0.05 indicates a close fit, whereas if the value is in the range of 0.05<RMSEA≤0.08, the model can still be assumed as a good fit (Hair et al., 2010). The value of chi-square ($\chi 2/df$) ≤3 It is considered acceptable (Hair et al., 2010).

5. Results

5.1 Demographic Profile

Out of 250 respondents, valid data from 203 respondents were obtained with a return rate of 81.2%. Based on Table 2, many respondents were female (n=135, 66.5%), and the rest were male respondents (n=68, 33.5%). Then, there were 146 respondents (71.9%) aged 21 and above, while 57 respondents   (28.1%) aged less than 21. Next, all respondents were bachelor's degree students (n=203, 100%). Finally, in terms of Cumulative Grade Point Average (CGPA), many of them achieved a CGPA of 3.00-3.49 (n=155, 76.4%), followed by 3.50 and above (n=34, 16.7%), and <3.00 (n=14, 6.9%).

Table 2. Demographic Profile

No.	Profile	Frequency (n)	Percentage (%)
1	**Gender**		
	Male	68	33.5
	Female	135	66.5
2	**Age**		
	Less than 21	57	28.1
	21 and above	146	71.9
3	**Program level**		
	Diploma	0	0
	Bachelor's degree	203	100
4	**CGPA**		
	<3.00	14	6.9
	3.00-3.49	155	76.4
	3.50 and above	34	16.7

5.2 Confirmatory Factor Analysis (CFA)

In SEM, several fitness indices describe the model's fit obtained from the data. To determine the model fit, the value for Comparative Fit Index (CFI), Goodness Fit Index (GFI), and Tucker Lewis Index (TLI) is expected to be ≥ 0.90. The values range from 0.00 (poor fit) to 1.00 (perfect fit) (Hair et al., 2010). The Root Mean Square Error of Approximation (RMSEA) explains the residual found in the model. The size of the expected RMSEA value ≤ 0.05. A value of RMSEA ≤ 0.05 indicates a close fit, whereas if the value is in the range of $0.05 < RMSEA ≤ 0.08$, the model can still be accepted as a good fit (Hair et al., 2010). The value of chi-square (χ^2/df) ≤3 It is considered acceptable (Hair et al., 2010). For this study, various indicators of the confirmatory model were acceptable (χ^2/df = 2.198, $p < 0.001$, GFI = 0.911, TLI = 0.910, CFI =0.900, and RMSEA = 0.045). Figure 3 shows the basic model using confirmatory factor analysis (CFA).
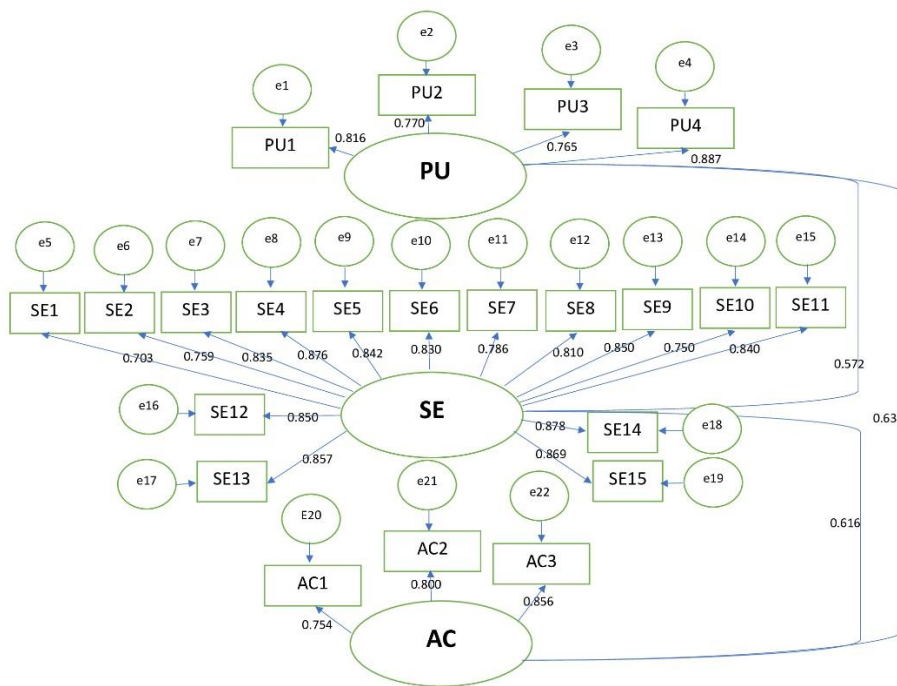

Figure 3. CFA Model
Note: PU, perceived usability; SE, student engagement; AC, adoption of cartoon learning

5.3 Convergent and Discriminant Validity

Cronbach's Alpha's, Convergent Validity, and Composite Reliability measure the value validity and reliability of the study. To identify the convergent validity, the researchers need to ensure that the Composite Reliability (CR) value is ≥ 0.60 and the Average of Variance Extracted (AVE) values are ≥ 0.05 (Hair et al., 2010). Table 3 describes the Factor Loading, Average Variance Extracted (AVE), Composite Reliability (CR), and Cronbach's alpha (CA) for the study variables. Based on Table 3, the factor loading for each study item was more than

62

0.60, and AVE, CR, and Cronbach's Alpha values were within the acceptable range (Hair et al., 2010). The study then assesses the discriminant validity by looking at the diagonal value. According to Fornell and Larcker (1981), a diagonal value is said to have discriminant validity when it is ≥ 0.85. From Table 4, the discriminant validity is achieved as the values were more than 0.85.

Table 3. Value of Factor Loading, Average Variance Extracted (AVE), Composite Reliability (CR), and Cronbach Alpha

Variable	Items	Item Loadings	Average Variance Extracted (AVE) (≥ 0.50)	Composite Reliability (CR) (≥ 0.60)	Cronbach's Alpha α (≥ 0.70)
Perceived Usability	PU1	0.816	0.647	0.892	0.849
	PU2	0.770			
	PU3	0.765			
	PU4	0.887			
Student Engagement	SE1	0.703	0.662	0.890	0.865
	SE2	0.759			
	SE3	0.835			
	SE4	0.876			
	SE5	0.842			
	SE6	0.830			
	SE7	0.786			
	SE8	0.810			
	SE9	0.850			
	SE10	0.750			
	SE11	0.840			
	SE12	0.850			
	SE13	0.857			
	SE14	0.878			
	SE15	0.869			
Adoption of Cartoon Learning	AC1	0.754	0.684	0.875	0.871
	AC2	0.800			
	AC3	0.856			

Table 4. Discrimination Validity

No.		1	2	3
1	Perceived Usability	**0.804**		
2	Student Engagement	0.572	**0.813**	
3	Adoption of Cartoon Learning	0.634	0.616	**0.827**

Note: Values in the diagonal show the square root of AVE

5.4 Structural Model Analyses

The results of the direct path show that there was a significant and positive relationship between perceived usability (β =0.599, p<0.001) and student engagement (β =0.523, p<0.001) towards the adoption of cartoon learning. Thus, H1 was accepted. Next, there is a significant influence of perceived usability on student engagement (β =0.610, p<0.001). Thus, H2 was accepted.

Table 5. Results of Direct Path

Path	Estimate *β*	S.E.	C.R.	*p*
Perceived Usability to Adoption of Cartoon Learning	0.599	0.008	43.214	***
Perceived Usability to Student Engagement	0.610	0.072	3.286	***
Student Engagement in the Adoption of Cartoon Learning	0.523	0.007	35.701	***

Hayes' mediation method was used to test the mediating effect. According to process V3.1, the 95% confidence interval of the mediating effect was estimated by extracting 5,000 bootstrap samples. Bootstrapping has been documented as one of the effective methods for testing the mediating effect (Hayes, 2009). The results are shown in Table 6. Perceived usability → student engagement → adoption of cartoon learning, the mediating effect is 0.017, 95% confidence interval is [0.519, 0.337], excluding 0, and the mediating effect is significant. Therefore, H3 is accepted. Since perceived usability no longer influences the adoption of cartoon learning, it is proven that the mediation effect of student engagement is fully mediated. In other words, the independent variable cannot directly affect the dependent variable without through the mediator variable.

Table 6. Results of the Mediation Model

Effect	Path	*β*	*p*	95% Confidence Interval	
				Upper Limit	Lower Limit
Direct effect	Perceived Usability to Adoption of Cartoon Learning	0.027	0.543		
	Perceived Usability to Student Engagement	0.136	**		
	Student Engagement in the Adoption of Cartoon Learning	0.127	**		
Indirect effect	Perceived Usability to Student Engagement to Adoption of Cartoon Learning	0.017	**	0.519	0.337

6. Discussion

The study's first objective was to examine the usability of the cartoon illustration known as Funky Figure as a teaching aid for learning Statistical Package for the Social Sciences (SPSS). The study first revealed a direct relationship between perceived usability and the adoption of cartoon learning (i.e., non-mediated model). Information consists of two categories: information in the form of numbers and information presented in text, images, and graphics. Based on research, the majority of information processed by the human brain comes from visual information (Bromage et al., 2022; Martzoukou, 2020). This shows that information in visual form is the leading supporter in the presentation of information. Cartoons can help to improve memory (Martzoukou, 2020). It helps visualize complex data and information, especially for information with lengthy text, essential pictures, and critical numerical data (da Silva Caixeta et al., 2021; Dinghan & Yue, 202). In addition, due to the

64

presentation of information supported by creativity and accurate illustrations, cartoon illustrations become interesting and easy to remember (Abdinejad et al., 2021).

The second objective of this study relates with the indirect influence of student engagement towards the perceived usability of a cartoon illustration and student adoption. The study has revealed that student engagement fully mediates the relationship between perceived usability and the adoption of cartoon learning. Abdinejad et al. (2021) found that cartoon animation greatly benefits educators and students. Using cartoon animation has made it easier for educators to create exciting and effective teaching techniques while the students enjoy learning. Using cartoons in learning research statistics can make it easier for students to understand what is being taught and encourages students to be enthusiastic about learning (Martzoukou, 2020). Therefore, the researcher suggests that the research methodology educators use cartoon animation in their teaching. Entertainment must be present in teaching and learning to motivate students to stay focused during the learning session. This is because exciting colors, humor, and symbols can attract students' attention (Unsworth, 2020). The cartoon helps to clarify the message so that it is not too verbalistic and overcomes limitations of space, time, energy, and sensory power. Cartoons provide the same stimulus, equalize the experience, and give rise to the same perception (Knapp et al., 2022).

The implication of this study is that lecturer training and skills in managing creative teaching aids are necessary. Lecturers play an important role in trying to gain knowledge about using effective teaching aids to help their teaching and learning process. Lecturers also need to discipline themselves through individual self-learning or in groups through training resources on the website. Some lecturers do not want to know about digital-based learning patterns and want to avoid trying something new in their teaching. This perception should be changed by changing the mentality, so it is not tied to the old teaching notch. The universities and faculties play an important role in changing the attitude of lecturers. This finding can also provide a meaningful contribution of knowledge to universities by providing training and further education to improve competencies and lecturer career development.

The lecturers can also be more creative by mastering various skills to achieve teaching and learning outcomes and, at the same time, developing students' creativity. There are many available free tools to create comics. These include Comica, Cartoon Comic Strip, Comic Book Creator – Comic Maker, and Comic and Meme Creator. The tendency of lecturers to carry out innovation is significant in producing innovative teaching and learning patterns, thus producing quality and innovative graduates. Lecturers' commitment to innovation is significant, and previous studies have found that four factors influence the tendency of lecturers to carry out innovation. These include personality, organisational culture, leadership style, and lecturer motivation. A more active role in providing a series of workshops and courses oriented toward knowledge and skills related to the academic field of lecturers' needs to be done. Infrastructure and facilities need to be well-prepared and sufficient to meet the needs of existing university lecturers. This will catalyse lecturers' readiness to master knowledge that aligns with the current industry's needs.

7. Conclusion

The study aimed to examine the usability of the cartoon illustration known as Funky Figure as a teaching aid for learning Statistical Package for the Social Sciences (SPSS) and the indirect influence of student engagement towards the perceived usability of a cartoon illustration and student adoption. Based on the findings, educators need to utilize cartoon illustrations as one alternative to the existing teaching materials. The use of animation by educators not only attracts students to continue actively learning in class, but students also will be more focused and better understand the content of the subjects learned (Martzoukou, 2020). Based on the discussion, students respond to a positive perception towards the use of interactive cartoons in the teaching and learning process in the 21st century. Therefore, cartoon illustrations must be usable and can be applied to all subjects to produce highly knowledgeable students.

Lecturers must integrate the latest methods to diversify instead of relying on conventional teaching methods or solely on 'chalk and talk.' A paradigm shift is required by applying an interactive approach among educators in higher learning institutions. Innovative teaching methods are not just about using the most advanced technology in the classroom or keeping up with the latest educational trends; they also include using new teaching strategies that are more student-focused (Unsworth, 2020; Knapp et al., 2022). This encourages students to proactively participate and interact with their classmates and the educator during the lesson. Unlike traditional teaching, which focuses primarily on how much knowledge can be conveyed to the students, innovative teaching methods dig deeper into what students take away from what the educators teach in lectures. However, this study has several limitations. The study data were collected cross-sectionally and analysed based on the correlation between three measured variables. This study also only examines the involvement of undergraduate students from public universities in Malaysia. Further research needs to expand the range of respondents by adding other variables such as attitude, perceived ease of use, university support, or lecturer behaviour.

References

Abdinejad, M., Talaie, B., Qorbani, H. S., & Dalili, S. (2021). Student perceptions using augmented reality and 3D visualization technologies in chemistry education. *Journal of Science Education and Technology, 30*, 87-96. https://doi.org/10.1007/s10956-020-09880-2

Abdulrahaman, M. D., Faruk, N., Oloyede, A. A., Surajudeen-Bakinde, N. T., Olawoyin, L. A., Mejabi, O. V., Imam-Fulani, Y.O., Fahm, A.O., & Azeez, A. L. (2020). Multimedia tools in the teaching and learning processes: A systematic review. *Heliyon, 6*(11). https://doi.org/10.1016/j.heliyon.2020.e05312

Akpan, B. (2020). Classical and operant conditioning—Ivan Pavlov; Burrhus Skinner. In Ben Akpan & Teresa J. Kennedy (Eds.), *Science education in theory and practice: An introductory guide to learning theory*, (pp. 71–84). https://doi.org/10.1007/978-3-030-43620-9

Alam, A. (2022). Employing adaptive learning and intelligent tutoring robots for virtual classrooms and smart campuses: Reforming education in the age of artificial intelligence. In Rabindra Nath Shaw, Sanjoy Das, Vincenzo Piuri & Monica Bianchini (Eds.), *Advanced Computing and Intelligent Technologies: Proceedings of ICACIT 2022* (pp. 395–406). Springer Nature Singapore. https://doi.org/10.1007/978-981-19-2980-9_32

Al-Emran, M., & Teo, T. Do knowledge acquisition and knowledge sharing really affect e-learning adoption? An empirical study. *Education and Information Technologies 25*, 1983–1998 (2020). https://doi.org/10.1007/s10639-019-10062-w

Alhadreti, O. (2021). Assessing academics' perceptions of blackboard usability using SUS and CSUQ: A case study during the COVID-19 pandemic. *International Journal of Human–Computer Interaction, 37*(11), 1003-1015. https://doi.org/10.1080/10447318.2020.1861766

Bromage, A., Pierce, S., Reader, T., & Compton, L. (2022). Teaching statistics to non-specialists: Challenges and strategies for success. *Journal of Further and Higher Education, 46*(1), 46-61. https://doi.org/10.1080/0309877X.2021.1879744

Carter, C. K., & Hartley, C. (2021). Are children with autism more likely to retain object names when learning from colour photographs or black-and-white cartoons? *Journal of Autism and Developmental Disorders, 51*(9), 3050–3062. https://doi.org/10.1007/s10803-020-04771-2

da Silva Caixeta, W., Malafaia, G., Doretto, L. B., Rosa, I. F., Nóbrega, R. H., & de Lima Rodrigues, A. S. (2021). Cartoon as support material in education for biodiversity conservation: The feasibility of using "the Tom and Jerry show", "Mickey Mouse Clubhouse" and "Masha and the Bear" series in elementary school. *Case Studies in Chemical and Environmental Engineering, 4*, 100123. https://doi.org/10.1016/j.cscee.2021.100123

Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information Technology. *MIS Quarterly, 13*(3), 319–340. https://doi.org/10.2307/249008

Dinghan, G., & Yue, M. (2022). The "p-hacking-is-terrific" ocean-A cartoon for teaching statistics. *Teaching Statistics, 44*(2), 68–72. https://doi.org/10.1111/test.12305

Ferreira, J. M., Acuña, S. T., Dieste, O., Vegas, S., Santos, A., Rodriguez, F., & Juristo, N. (2020). Impact of usability mechanisms: An experiment on efficiency, effectiveness, and user satisfaction. *Information and Software Technology, 117*, 106195. https://doi.org/10.1016/j.infsof.2019.106195

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research, *18*(1), 39–50. https://doi.org/10.2307/3151312

Foster, A., & Shah, M. (2020). Principles for advancing game-based learning in teacher education. *Journal of Digital Learning in Teacher Education, 36*(2), 84–95. https://doi.org/10.1080/21532974.2019.1695553

Hadamitzky, M., Lückemann, L., Pacheco-López, G., & Schedlowski, M. (2020). Pavlovian conditioning of immunological and neuroendocrine functions. *Physiological Reviews, 100*(1), 357-405. https://doi.org/10.1152/physrev.00033.2018

Hair, J. F. J., Black, W. C., Babin, B. J., & Anderson., R. E. (2010). *Multivariate data analysis: A global perspective* (7th ed.). Pearson Education.

Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs, 76*(4), 408–420. https://doi.org/10.1080/03637750903310360

Hilton, J., III. (2020). Open educational resources, student efficacy, and user perceptions: A synthesis of research published between 2015 and 2018. *Educational Technology Research and Development, 68*(3), 853–876. https://doi.org/10.1007/s11423-019-09700-4

Hiver, P., Al-Hoorie, A. H., & Mercer, S. (2020). *Student engagement in the language classroom* (Vol. 11). Multilingual Matters.

Howson, C. K., & Kingsbury, M. (2023). Curriculum change as transformational learning. *Teaching in Higher Education, 28*(8), 1847-1866. https://doi.org/10.1080/13562517.2021.1940923

Jahnke, I., & Liebscher, J. (2020). Three types of integrated course designs for using mobile technologies to support creativity in higher education. *Computers & Education, 146*, 103782. https://doi.org/10.1016/j.compedu.2019.103782

Jian, L. & Eryong, X. (2023). Dynamic Interaction between student learning behaviour and learning environment: Meta-analysis of student engagement and its influencing factors. *Behavioural Sciences, 13*(1), 59. https://doi.org/10.3390/bs13010059

Junwei, G., Ling, Y., Jinghui, Z., Lian, W., Jiao. Z., Chunxiang, W., & Xiaotang, F. (2020). Comparison of problem-based learning and traditional teaching methods in medical psychology education in China: A systematic review and meta-analysis. *PLoS One, 15*(12), e0243897. https://doi.org/10.1371/journal.pone.0243897

Kalburgi, N. K., David, A., & Muralidhar, L. B. (2023). Understanding the perceptions of students towards YouTube as a learning tool-an empirical approach. *Central European Management Journal*, 31(1), 74-83. https://ssrn.com/abstract=4327030

Kline, R. B. (2011). *Methodology in the social sciences: Principles and practice of structural equation modeling.* Guilford Press.

Knapp, P., Benhebil, N., Evans, E., & Moe-Byrne, T. (2022). The effectiveness of video animations in the education of healthcare practitioners and student practitioners: A systematic review of trials. *Perspectives on Medical Education, 11*(6), 309-315. https://doi.org/10.1007/s40037-022-00736-6

Kulas, J. T., Roji, R. G. P. P., & Smith, A. M. (2021). *IBM SPSS essentials: Managing and analyzing social sciences data*. John Wiley & Sons.

Legaki, N.-Z., Xi, N., Hamari, J., Karpouzis, K., & Assimakopoulos, V. (2020). The effect of challenge-based gamification on learning: An experiment in the context of statistics education. *International Journal of Human-Computer Studies, 144*, 102496. https://doi.org/10.1016/j.ijhcs.2020.102496

Leksuwankun, S., Dangprapai, Y., & Wangsaturaka, D. (2023). Student engagement in organizing extracurricular activities: Does it matter to academic achievement? *Medical Teacher, 45*(3), 272-278. https://doi.org/10.1080/0142159X.2022.2128733

Li, S., Zheng, J., & Lajoie, S. P. (2023). The relationship between cognitive engagement and students' performance in a simulation-based training environment: An information-processing perspective. *Interactive Learning Environments, 31*(3), 1532-1545. https://doi.org/10.1080/10494820.2020.1848879

Lim, W. M., Badiozaman, I. F. A., & Leong, H. J. (2023). Unravelling the expectation-performance gaps in teacher behaviour: A student engagement perspective. *Quality in Higher Education, 29*(3), 302-322. https://doi.org/10.1080/13538322.2022.2090746

Maroco, J., Maroco, A. L., Campos, J. A. D. B., & Fredricks, J. A. (2016). University student's engagement: Development of the University Student Engagement Inventory (USEI). *Psychology: Research and Review29*(24), 1-12. https://doi.org/10.1186/s41155-016-0042-8

Martzoukou, K. (2020). "Maddie is online": An educational video cartoon series on digital literacy and resilience for children. *Journal of Research in Innovative Teaching & Learning, 15*(1), 64-82. https://doi.org/10.1108/JRIT-06-2020-0031

Mingchao, L. & Liping, L. (2023). Students' perceptions of augmented reality integrated into a mobile learning environment. *Library Hi Tech, 41*(5), 1498-1523. https://doi.org/10.1108/LHT-10-2021-0345

Ngai, E. W. T., Poon, J. K .L., & Chan, Y. H. C. (2007). Empirical examination of the adoption of WebCT using TAM. *Computers and Education, 48*(2), 250-267. https://doi.org/10.1016/j.compedu.2004.11.007

Nor Sahkkina Kadir, & Mohd Ikhwan Hadi Yaacob. (2022). The development and usability of optics kit as a teaching aid among physics trainee teachers. Journal of Physics: Conference Series (2309)1, p. 012040). https://doi.org/10.1088/1742-6596/2309/1/012040

Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). McGraw-Hill.

Oderinu, O. H., Adegbulugbe, I. C., Orenuga, O. O., & Butali, A. (2020). Comparison of students' perception of problem-based learning and traditional teaching method in a Nigerian dental school. *European Journal of Dental Education, 24*(2), 207-212. https://doi.org/10.1111/eje.12486

Olson, M. H., & Ramírez, J. J. (2020). *An introduction to theories of learning* (10th ed.). Routledge.

Pallant, J. (2020). *SPSS survival manual: A step-by-step guide to data analysis using IBM SPSS* (7th ed.). Routledge.

Pavlov, I. P. (2023). *Pavlov on the Conditional Reflex: Papers, 1903-1936*. Oxford University Press.

Peiró-Signes, Á., Trull, O., Segarra-Oña, M., & García-Díaz, J. C. (2021). Anxiety towards statistics and its relationship with students' attitudes and learning approach. *Behavioural Sciences, 11*(3), 32. https://doi.org/10.3390/bs11030032

Qian, Z., Yi, C., JingJin, T., Kim, E.L. & Gentile, D. A. (2020). Effects of prosocial cartoon models on aggressive cognitions and aggressive behaviors. *Children and Youth Services Review, 118*, 105498. https://doi.org/10.1016/j.childyouth.2020.105498

Qiao, S., Yeung, S. S.-S., Zainuddin, Z., Ng, D. T. K., & Chu, S. K. W. (2023). Examining the effects of mixed and non-digital gamification on students' learning performance, cognitive engagement, and course satisfaction. *British Journal of Educational Technology, 54*(1), 394-413. https://doi.org/10.1111/bjet.13249

Ritanjali Panigrahi, Praveen Ranjan Srivastava & Prabin Kumar Panigrahi. (2021). Effectiveness of e-learning: The mediating role of student engagement on perceived learning effectiveness. *Information Technology & People, 34*(7), 1840-1862. https://doi.org/10.1108/ITP-07-2019-0380

Schiavio, A., Biasutti, M., & Philippe, R. A. (2021). Creative pedagogies in the time of pandemic: A case study with conservatory students. *Music Education Research, 23*(2), 167-178. https://doi.org/10.1080/14613808.2021.1881054

Shafiq, M., & Parveen, K. (2023). Social media usage: Analysing its effect on academic performance and engagement of higher education students. *International Journal of Educational Development, 98*, 102738. https://doi.org/10.1016/j.ijedudev.2023.102738

Shaista Saiyad, Amrit Virk, Rajiv Mahajan & Tejinder Singh. (2020). Online teaching in medical training: Establishing good online teaching practices from cumulative experience. *International Journal of Applied And Basic Medical Research, 10*(3), 149. https://doi.org/10.4103/ijabmr.IJABMR_358_20.

Sharifah Norul Akmar Syed Zamri, Zulnaidi, H., & Leong, K. U. (2020). Postgraduate students' attitude toward statistics pre and post scenario-based learning method in a statistics course. *MOJES: Malaysian Online Journal of Educational Sciences, 8*(4), 1-8. https://juku.um.edu.my/index.php/MOJES/article/view/26393/12189

Shin, M., & Bolkan, S. (2021). Intellectually stimulating students' intrinsic motivation: The mediating influence of student engagement, self-efficacy, and student academic support. *Communication Education, 70*(2), 146-164. https://doi.org/10.1080/03634523.2020.1828959

Sica, L. S., Ponticorvo, M., & Di Fuccio, R. (2022). Creativity, learning, and technology in MOOC: The DoCENT approach between teaching and gaming. In Margherita Antona & Constantine Stephanidis (Eds), *International Conference on Human-Computer Interaction* (pp. 123-141). Springer International Publishing. https://doi.org/10.1007/978-3-031-05039-8_9

Sit, C., Srinivasan, R., Amlani, A., Muthuswamy, K., Azam, A., Monzon, L., & Poon, D. S. (2020). Attitudes and perceptions of UK medical students towards artificial intelligence and radiology: A multicentre survey. *Insights Into Imaging, 11*, 1-6. https://doi.org/10.1186/s13244-019-0830-7

Skenteridou, K., & Tsiakis, T. (2021). Using infographics for teaching: A case of geography in a Greek primary school. In Leslie Haas & Jill Tussey (Eds.) *Connecting Disciplinary Literacy and Digital Storytelling in K-12 Education* (pp. 105-126). IGI Global. https://doi.org/10.4018/978-1-7998-5770-9.ch006

Sowmia, K. R., Poonkuzhali, S., & Jeyalakshmi, J. (2023). Sentiment classification of higher education reviews to analyze students' engagement and psychology interventions using deep learning techniques. In Yu-Dong Zhang, Tomonobu Senjyu, Chakchai So-In & Amit Joshi (Eds.), *Smart Trends in Computing and Communications: Proceedings of SmartCom 2022* (pp. 257–265). Springer. https://doi.org/10.1007/978-981-16-9967-2_25

Ssemugenyi, F. (2023). Teaching and learning methods compared: A pedagogical evaluation of problem-based learning (PBL) and lecture methods in developing learners' cognitive abilities. *Cogent Education, 10*(1), 2187943. https://doi.org/10.1080/2331186X.2023.2187943

Taylor, L., Dyer, T., Al-Azzawi, M., Smith, C., Nzeako, O., & Shah, Z. (2022). Extended reality anatomy undergraduate teaching: A literature review on an alternative method of learning. *Annals of Anatomy-Anatomischer Anzeiger, 239*, 151817. https://doi.org/10.1016/j.aanat.2021.151817

70

Tuli, N., & Mantri, A. (2021). Evaluating usability of mobile-based augmented reality learning environments for early childhood. *International Journal of Human–Computer Interaction, 37*(9), 815-827. https://doi.org/10.1080/10447318.2020.1843888

Unsworth, L. (2020). A multidisciplinary perspective on animation design and use in science education. In Len Unsworth (Ed.), *Learning from animations in science education: Innovating in Semiotic and Educational Research*, (3–22). Springer. https://doi.org/10.1007/978-3-030-56047-8_1

Venn, E., Park, J., Andersen, L. P., & Hejmadi, M. (2023). How do learning technologies impact on undergraduates' emotional and cognitive engagement with their learning? *Teaching in Higher Education, 28*(4), 822-839. https://doi.org/10.1080/13562517.2020.1863349

Ya, X. & Hew, K. F. T. (2023). Intangible rewards versus tangible rewards in gamified online learning: Which promotes student intrinsic motivation, behavioral engagement, cognitive engagement, and learning performance? *British Journal of Educational Technology, 55*(1), 297-317. https://doi.org/10.1111/bjet.13361

Yi, J. & Linjia, Z. (2023). High school students' expectancy, value, and cost profiles and their relations with engagement and achievement in Math and English. *Learning and Individual Differences, 101*, 102252. https://doi.org/10.1016/j.lindif.2022.102252