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The Acceptance of Braille Self-Learning Device

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***Abstract*— The blind and visually impaired individuals are the citizens that exists in any society. Their blindness and visual impairment prevent them from using computers, operating digital devices, learning educational software, and restricting them from gaining certain knowledges. One of the most proven techniques for people with visual impairments to gain knowledge is to become proficient in Braille. Braille is represented by six dots arranged in a 3x2 matrix and can be read receptively only by the sense of touch. The common way of learning Braille is one-to-one technique between students and teachers. They use bulky devices which is inconvenient, not portable and costly. In fact, learning Braille always requires teachers to be present. People with visual impairments need special tools or tutorials to master the Braille language. This research introduces Braille Fingers Puller (BFP) self-learning device which is autonomous, low-cost, user-friendly, and portable with self-learn and self-test functions. Prior to the current device development, a Braille Finger Puller acceptance model is proposed based on seven factors that influence the BFP behavioral pattern which are perceived usefulness, perceived ease of use, performance, satisfaction, emotion, attitude, and comfort. The Braille Fingers Puller is tested with the blind association and finding shows that all factors except comfort factor have high score toward the intention to use BFP. Further improvement of the self-learning device is suggested in order to make it more comfortable for the visually impaired person to use.**

***Keywords*— braille; braille fingers puller; blinds and visually impaired; acceptance model.**

I. INTRODUCTION

Braille is a reading and writing system used by the blind and visually impaired persons to gain knowledge. Master in Braille code brings sight to visually impaired people and plays an essential role in their lives. In today's digital era, blind and visually impaired individuals have a great deal of highly effective selections for communication. Latest technology has enabled them to be part of the knowledgeable society by enabling them to grasp the contents of any website or book [1].

The learning duration for the blind and visually impaired students to achieve the learning objectives are more than the normal sighted students. This is even worse when the teaching professionals are still unequipped with a suitable pedagogical methods or tools to teach the blinds and visually impaired students in learning Braille. There have been plethora of strategies, approaches, methods and techniques used in the teaching and learning Braille. A study by [2] focused on development of a system rearrangement that translate the Quran verses to Braille symbols by which new vibrations were included.

Another technique for learning Braille is using a combination of the deep and hand-crafted descriptor was suggested in order to understand patterns from the handwritten figures [3]. In terms of language learning using Braille, a study by [4] has shown several strategies of assisting learning *Jawi Braille* through dictation, listening and speaking, drill, memorizing, demonstrations and lectures activities. Correspondingly,[5] advocate an automatic multi-lingual script recognition system by which the system is capable to categorize documented descriptions into several international languages such as Arabic, Devanagari, Hebrew, Thai, Greek, Cyrillic, and Korean.

Most of the visually impaired students are keen to have a special tool in helping them to cope well and swiftness in learning the Braille language. Apart from that, teaching students with vision impairment takes tremendous effort as it is proven that to be more challenging [6].

This study has modified perceived outcome model [7]. The model was built on Technology Acceptance Model (TAM) [8], Unified Theory of Acceptance and Use of Technology (UTAUT) [9], and the concept of usability for human-system interaction [10]. However, this study does not include the efficiency and effectiveness of Braille Fingers Puller (BFP) in the predicting model. This is because the unit of analysis is visually impaired persons who may have some difficulties in using BFP device during the first few times.

The researchers who dealt with Information Systems (IS) have been put forth their efforts on building and test running the IS models from the mid-eighties. This was done in order to statistically forecast users' behavioral pattern of usage towards the system. The technology acceptance model (TAM) was chosen to be one of the prominent models. This model which was suggested by Davis has since been made as a benchmark for the expansion of the system by other researchers.

In total, TAM has been empirically proven to predict about 40% of system usage. Therefore, this study includes eight variables such as perceived usefulness, perceived ease of use, emotions, attitude, comfort, performance, satisfaction and perceived results into the development of BFP device. Based on these eight variables, an evaluation instrument was developed to assess the acceptability of BFP devices.

The objective of this paper is to measure the acceptance level of the developed Braille self-learning device known as Braille Fingers Puller among the blind and visually impaired people. The research paper is divided into four main sections: Section II explains the materials and methods, Section III the results and discussion and follows by conclusion in Section IV.

II. Materials and Methods

This section explains the development of Braille Fingers Puller Acceptance model; illustrates and describes the Braille Fingers Puller device; and testing procedures.

A. Developing Braille Fingers Puller Acceptance model

After conducting an observation of the experiment on the users to acquire the user requirements, the BFP Acceptance model is developed specifically for visually impaired users as shown in Fig. 1. This BFP Acceptance Model is adapted from the perceived outcome model as cited in the introductory section. Nonetheless, due to the respondents of this study are novice users who would experience some difficulties in using the BFP devise in the earlier stage, the efficiency and effectiveness items of BFP in the predicting model are discarded and excluded.

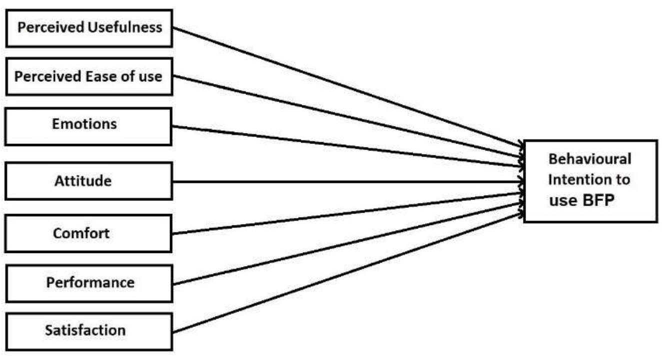

Fig. 1 Braille Fingers Puller Acceptance model

The original TAM model fits this research because it measures the acceptance of technology in higher institution. Flexibility is the advantageous side of the original TAM as alteration can be made to suit the aim of the research [11]. Based on the features of this technology, TAM also helps determine how users are developing attitudes towards mobile learning technology services.

TAM is one of the popular models of Information System Acceptance which focuses on the user-perceived usefulness and perceived ease of use of Information System in ascertaining users' intention to adopt the Information System [12]. A systematical review is done using TAM in relation to Mobile learning research done from various perceptions. An extensive analysis of 87 research articles from 2006 to 2018 has been studied. It has been found that most studies in TAM on M-learning focused on extending the TAM with external variables.

The formulation of a new theory of technology acceptance, UTAUT which covers not only user intention, but also their behavior evidenced the lacking aspect in the previous models. This theory with the introduction of the moderators is providing more effective guidance in understanding the determinants of acceptance in technology. Technically, UTAUT takes into consideration the commonalities across the eight (8) models as the basis of a new formulation model [9]. The related eight (8) models are TRA, TPB/DTPB, TAMlTAM2, C-TAM-TPB, MM, MPCU, IDT and SCT. The commonalities divided into three (3) categories, i.e. significant, non- significant after some time and significant only under mandatory condition.

The researchers discovered that it will be too complicated to establish a common model which considers all the factors involved in TAM models as many of the same factors have been defined and labeled differently depending on the application. However, the expansion of TAM initial model could consider additional beliefs that may adversely affect technological acceptance [13]. Furthermore, the original TAM model which includes perceived usefulness, perceived ease of use, attitudes towards usage, behavioral intention to use and actual system use seems to be positively represented in understanding the conceptual issues regarding the use of ICT.

The two variables of TAM model, namely perceived usefulness (PU) and ease of use (PEU) have their relevancy in behavioral intention of the use and acceptance of new technology. Performance is the degree to which an individual believes that using the system will help him or her to attain gains in job presentation [9]. Other scales of acceptance towards the device usage are emotions which measure the feelings when interacting toward using the BFP; attitude when using the BFP includes the beliefs and opinions; comfort is associated with the physical experience while learning; and satisfaction is a pleasant feeling when using the learning device that lead to behavioral intention to use BFP.

B. Braille Fingers Puller (BFP)

The BFP device as shown in Fig. 2 is designed specifically for the blind and visually impaired people who are braille beginners or have never had exposure to Braille. The Braille Finger Puller comprises of six rings fixed on a square flat panel box. Individuals with visual impairments need to wear this on their three fingers (index, middle and ring) for both left and right hands until their knuckles (distal phalanx) as illustrated in Fig. 3. Then, the users utter any alphabets or letters, which they desire using the smartphone which has a voice to text application that is connected via Bluetooth module in the device.

This device is also a self-test product for users to practice BFP independently where it is compulsory for them to press the exact rings that indicates the alphabets or letters required by Braille code. Then a smartphone produces a sound as an output through its audio speaker the alphabets or letters that the users have pressed and transferred.

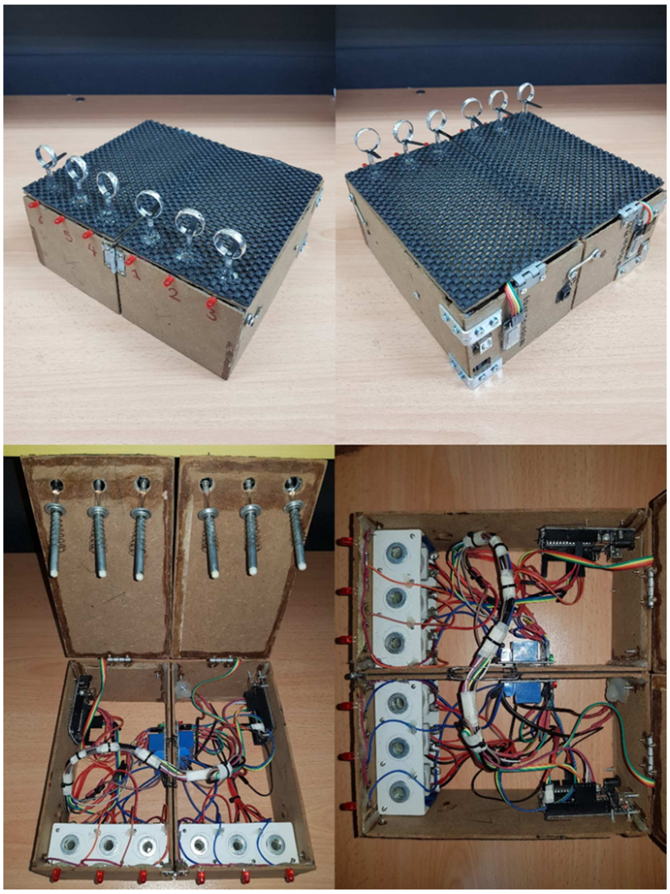

Fig. 2 Braille Fingers Puller (BFP)

Fig. 3 Fingers position in rings

Braille Fingers Puller will use the applications provided by Android applications which are usually purchased through Google Play store and smartphones acts an input method for the users. The existing smartphone software which help blind and visually impaired users can sometimes hinder them from completing some tasks. The Android smartphone operating system contains two applications for voice recognition AMR_Voice and BlueAct-voice effect as shown in Fig. 4 and Fig. 5 which function in providing feedback for rings that users can interact with via smartphones through Android system.

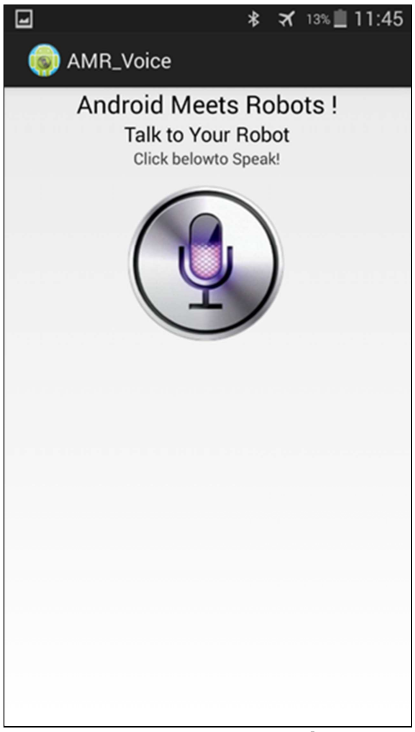

Fig. 4 Voice recognition AMR Voice application interface

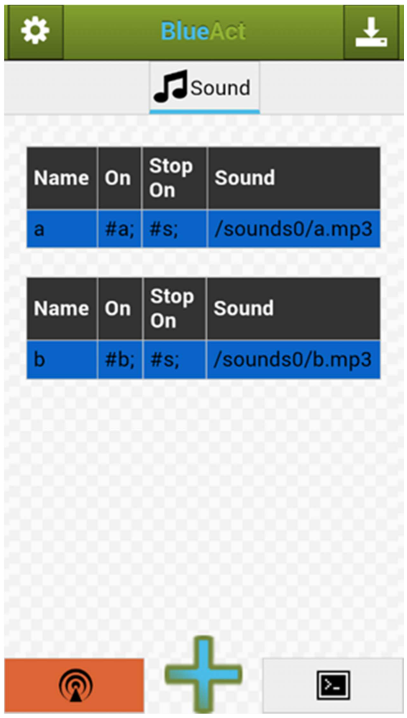

Fig. 5 BlueAct-voice effect application interface

BFP uses Android applications that are normally uploaded/bought through the Google Play store. Voice to text applications is be used for the sake of learning Braille by saying the alphabets or letters to the smartphone. The role of the smartphones as an input method for the users and it transforms the voice to a movement by Braille Fingers Puller making the symbol of that letter which was spoken by the user.

Braille Fingers Puller uses the BlueAct-voice effect application to articulate the entered Braille code for the users in order to make sure what the alphabet or letter the users typed is correct by listening to the application producing out that letter.

The accumulating tools needed to complete the project are Arduino-Uno, Bluetooth modules (HC-05), Six 12-volt Solenoids Electromagnets, Six 5-volt Relay modules, 12-volt AC adapter, Wiring, Rings and Smart Mobile phone.

C. Testing

This section explains the sample, testing procedure, the instrument used and data analysis.

1) Sample: the potential users of the BFP are selected as a sample in this study. They are among the visually impaired and blind people. In total, there are 66 of them who were then segmented into two different vision impairment classification. Out of 66 users, 16 were segmented into “low vision” classification while the other large portion (50 users) were classified as “blind”, including night blindness or tunnel vision. The survey collection lasted a total of 10 days at the Malaysian Association for the Blind (MAB). In this research, there were two types of instruments used which were questionnaires and observation.

2) Testing procedure: Users are given the opportunity to use the device for 10 to 15 minutes. After they are familiar with the device, they are required to answer the questionnaire

*3) Questionnaires: t*he questionnaires items are adapted from TAM and earlier studies and developed from the constructs and items of the UTAUT research model which involving the visually impaired and blind feedback on the usage of BFP.

A questionnaire testing session was carried out to find the users’ reaction towards the BFP and it was designed to suit the users’ understanding level. The questionnaires consisted of 44 questions using Likert Scale. The instruction of usage was done before the exposure to the device in order to find the results of their perceptions about the device. The blind and visually impaired people were asked for questions on how they felt about reading the exercise and how they perceived the Braille language through the BFP device. Based on the questions answered by the users, the results would provide insight to researchers in guiding the respondents on what they really want during Braille training and what really motivates them as well.

The questionnaire functions as the main tool to measure the acceptance of Braille Fingers Puller. The questionnaire comprised of eight scales: Perceived Usefulness (PU), Perceived Ease of Use (PEU), Comfort (C), Attitude (A), Emotions €, Performance (P), Satisfaction (S) and Acceptance (A) within total 44 items as shown in Table I.

TABLE I
FACTORS NAME AND NUMBER OF ITEMS

Factor name	**Number of Items**
Perceived Usefulness	4
Perceived Ease of use	6
Emotions	5
Attitude	5
Comfort	8
Performance	5
Satisfaction	6
behavioral intention to use	5
Total number of items	**44**

The questionnaire is constructed based on TAM and UTAUT models. The items are developed and selected from both models. The researcher decided to employ a five-point Likert scale rating, ranging from ‘strongly agree’ to ‘strongly disagree’ in order to maximize information availability, without overexciting the participants’ discrimination ability.

4) Data analysis: the collected data from the questionnaires are then interpreted statistically whereby every single question was analyzed through a descriptive statistic. The normality and multicollinearity of the data are also tested to confirm the data are suitable for further analyses. To verify the reliability of the items and factors, the Cronbach Alpha coefficients are used. Based on the reliability test, some unreliable items are deleted. The level of acceptance is measured based on the mean of each factor, and finally the relationship between all variables are analyzed using Pearson correlation analysis.

III. RESULTS AND DISCUSSION

To better understand the results of the test, the sample was further categorized into 14 different groups, according to socio-demographic variables such as age: “under 30 years old”, “between 30-60 years old” and “above 60 years old” and gender: “male” and “female”.

The basis of the categorization was established from the analytical discussion which considered the best and relevant way to address the test group’s information. However, the results of the study cannot be generalized as they are not statistically significant due to the relatively small and overlapping sample size.

A. Normality

Normality is the third step for screening data. The normality test is a precondition before any inferential statistics are performed. Thus, data normality is the most critical factor in the parametric analysis [14, 15]. Correlation test can only be done if data is normally distributed. There are two methods to test the normality of variables which are observed by graph or trough skewness and kurtosis value [15].

In this study, the researcher used Skewness and Kurtosis approaches compared with [16] Statistics to test the normality. However, the data were considered normally distributed and appropriate for parametric analysis as shown in Table I. Based on [15], skewness and kurtosis must not be more than ±2, and if exceeded, the data will be eliminated. However, the constructs shown in Table II are less than ±2.

TABLE II
NORMALITY TEST STATISTICS OF THE VARIABLES

Constructs	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
Perceived Usefulness	-.503	.297	-.005	.586
Perceived Ease of Use	-.414	.297	.086	.586
Emotion	-.411	.297	-.614	.586
Attitude	.497	.297	.124	.586
Comfort	-.226	.297	-.334	.586
Performance	-.919	.297	.626	.586
Satisfaction	.431	.297	-.647	.586
Behavioural Intention to Accept Braille	.042	.297	.062	.586

B. Multicollinearity

Multicollinearity test is one of the requirements before the analysis of correlation techniques being implemented. This test aims to identify whether there is a high association between two or more independent variables [17]. There are two methods that can be used to identify multicollinearity which are Pearson-Product Moment analysis and Variance Inflation Factor (VIF) values.

According to Hair [17], a high correlation will affect the coefficient position and will reduce the predictive power of a variable. A usual cut off threshold for multicollinearity is a tolerance value of 0.10, which correlates with a VIF value of 10. The results show that the tolerance value obtained is generally above the cut-off threshold, while the VIF value is less than 10 as recommended by [17]. It is a proved that multicollinearity problems do not exist as shown in Table III.

TABLE III
MULTICOLLINEARITY TEST STATISTICS OF THE VARIABLES

Independent variable	Tolerance	VIF
Perceived Usefulness	.349	2.864
Perceived Ease of Use	.545	1.835
Emotion	.452	2.213
Attitude	.692	1.445
Comfort	.660	1.515
Performance	.326	3.065
Satisfaction	.388	2.575

C. Reliability

Reliability analysis is used to assess the stability and consistency of measurement tools. According to [16], the nearer the reliability coefficient gets to 1.0, it is considered as great. In general, reliability coefficient scores below than 0.60 are considered as poor, those in the range of 0.70 are considered as acceptable and those more than 0.80 are considered as good. In this study, the internal consistency reliability was measured by Cronbach's alpha value. Hence, all constructs variables proposed in this study were tested to ensure they are in the same construct and therefore would be highly correlated [18]. They are four items deleted (PEU4, PEU5, C3, BI5). The internal consistency results are presented in Table IV. All constructs show a high value of Cronbach Alpha which is between 0.65 to 0.89.

TABLE IV
RESULT OF INTERNAL CONSISTENCY RELIABILITY

Measurement	No. of items	No. of item deleted	No. of item after deleted	Cronbach Coefficient Alpha Value
Perceived Usefulness	4	0	4	.89
Perceived Ease of Use	6	2	4	.65
Emotion	5	0	5	.87
Attitude	5	0	5	.77
Comfort	8	1	7	.77
Performance	5	0	5	.82
Satisfaction	6	0	6	.77
Behavioural Intention	5	1	4	.67

D. Descriptive Analysis

Based on the first aim of the study, the data are analyzed to obtain information regarding the level of the variables which are (perceived usefulness, perceived ease of use, emotion, attitude, comfort, performance, satisfaction and behavioral intention) to accept Braille among visually impaired students and teachers. Each variable score was obtained by calculation the mean score for each of the questionnaire's items.

Table V depicts the descriptive statistics of each variable in this study. Descriptive analysis can give an overview to the researchers about respondents' pattern based on average values, standard deviations, and variants [19]. This study involves seven independent variables and one dependent variable to be analyzed. The descriptive statistical test results indicate the mean values of all variables are in the range of 2.77 to 4.35 and have a positive value.

Conversely, the findings of the standard deviation analysis show that the highest variable is the performance (0.557) and the lowest variable is the Behavioral Intention (0.281). The lowest score is 2.00 while the highest score is 5.00. The total number of scores, frequencies, and percentages of each variable are presented in Table V. The classification of min score is based on [14] recommendation. They are value level for low (1.00-2.33), medium (2.34-3.66) and high (3.67-5.00).

TABLE V
DESCRIPTIVE STATISTIC

Constructs	Minimum	Maximum	Mean	Std.Dev.
Perceived Usefulness	3.00	5.00	4.29	.507
Perceived Ease of Use	3.17	4.67	4.06	.325
Emotion	3.20	5.00	4.35	.412
Attitude	3.60	5.00	4.24	.344
Comfort	2.00	3.63	2.77	.350
Performance	2.40	5.00	3.96	.557
Satisfaction	2.67	4.67	3.84	.519
Behavioural Intention to Accept Braille	3.40	4.80	4.14	.281

E. Test on Relationship

A correlational analysis was analyzed to explain the relationships among all variables in this study. Correlation is used to determine relationship and strength between them. The researcher used the Pearson correlation test to find the correlation coefficient among the variables. Correlation tests can also help researchers identify the direction and strength of the relationship. Correlation coefficient (r) has intervals between +1.00 and -1.00 [20], [21].

The hypotheses development was focused on the correlational aspect of the constructs and matched the second objective of the study which was to analyze the connection between perceived usefulness and behavioral intention. The rules of thumb for correlation coefficient size are based on [21] with the r-value 0.50 to 1.0 (strong); 0.30 to .49 (moderate) .10 to .29 (weak).

Based on Table VI, results Pearson correlation analysis showed six factors namely perceived usefulness, emotion, attitude, comfort, performance, and satisfaction have significant association towards behavioral intention to accept Braille at p>.05 level. Thus, hypotheses H1, H3, H4, H5, and H6 were accepted. Based on the correlation analysis, the relation between perceived usefulness and behavioral intention to accept showed a significantly positive relationship with moderate coefficient value (r = .473; p <.01). Emotion related–significantly to behavioral intention to accept with moderate level and positive relationships (r = .363; p <.01), and attitude also showed the same finding that correlated significantly at moderate level toward behavioral intention to accept with coefficient value (r = .3.49; p <.01). Meanwhile, comfort connected at a moderate level and negative correlation with behavioral intention to accept (r = -.352; p <.01). In addition, performance related significantly to behavioral intention to accept is a moderate level and positive correlation (r = .361; p <.01). Satisfaction also showed the same result which is significantly positive relationship toward behavioral intention to accept with coefficient value (r = .425; p <.01). However, perceived ease of use is not importantly correlated with behavioral intention to accept (r = .243; p >.05).

TABLE VI
CORRELATION PERSON BETWEEN VARIABLES

Measurement	1	2	3	4	5	6	7	8
Behavioural Intention	1							
Perceived Usefulness	.473 **	1						
Perceived Ease of Use	.243	.441 **	1					
Emotion	.363 **	.703 **	.351 **	1				
Attitude	.349 **	.423 **	.264 **	.489 **	1			
Comfort	-.352 **	-.510 **	-.393 **	-.311 **	-.130 **	1		
Performance	.361 **	.661 **	.656 **	.537 **	.411 **	-.471 **	1	
Satisfaction	.425 **	.627 **	.568 **	.542 **	.448 **	-.469 **	.730 **	1

Findings release that an increase in perceived usefulness, emotion, attitude, performance and satisfaction were correlated with increases in behavioral intention to accept. While the decrease in comfort was correlated with the increase in behavioral intention to accept. However, increases in perceived ease of use was not correlated with increases in behavioral intention to accept. Thus, hypotheses H1, H3, H4, H5, H6, and H7 are accepted and hypotheses H2 is denied.

F. Summary of Hypotheses Testing

Based on the correlation analysis detailed in the previous sections, Table VII summarized the results of the hypotheses testing for all variables.

TABLE VII
SUMMARY OF HYPOTHESIS TESTING

Hyp.	Hypothesis Statement	Result
H1	Perceived usefulness is significantly related on behavioural intention to accept Braille among visually impaired	Supported
H2	Perceived ease of use is significantly related on behavioural intention to accept Braille among visually impaired	Not supported
H3	Performance is significantly related on behavioural intention to accept Braille among visually impaired	Supported
H4	Satisfaction significantly related on behavioural intention to accept Braille among visually impaired	Supported
H5	Emotions is significantly related on behavioural intention to accept Braille among visually impaired	Supported
H6	Attitude is significantly related on behavioural intention to accept Braille among visually impaired	Supported
H7	Comfort is significantly related on behavioural intention to accept Braille among visually impaired	Supported

IV. CONCLUSION

The results lead to the understanding that the visually impaired people might get the greatest benefits from using the device, along with people with blind and low vision. It is observed that the assistive device did not harm the test group for the whole 30 hours cumulative time spent. Instead, it acts as a value-added entity to their life. In fact, individuals with visual impairments and those with blind and low vision may gain tremendous advantage from this assistive device. From the verbal interviews conducted, it is further observed that users appreciate the Braille Fingers Puller as it is possible for them to use the device at any time they wish, even with less knowledge about Braille Language.

The researcher has presented the operating principles and investigation results of the mobile assistive device Braille Fingers Puller. It can be concluded that the 66 participants in the ten-day test felt that they have certainly gained benefits from the device. The testing was conducted with the standard QUEST 2.0 questionnaire [22]. Understanding the acceptance of technology is salient to the productive and effective teaching and learning environment. This paper has summarized the technology acceptance theories and models, along with the factors relevant to each model and suggested that the Unified Theory of Acceptance and Use of Technology (UTAUT) model is a better choice for researchers in the area of technology use behavior. Thus, before investing limited funds for teaching and learning advancement, it is important that an institution be able to predict and account for the determinants that influence its learners' acceptance. It will be a waste of funding if students fail to accept the use of proposed technology and utilize this technology to the betterment of their learning. Students' interests and perceptions are pivotal as these might affect their interest in learning and language development. Thus, a suitable and robust model needs to be adopted in investigating students' technology acceptance.

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