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Automated Pronunciation Digital System Using Pls-Mga

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ABSTRACT

Language proficiency plays a crucial role in ensuring that communication is accurate, clear, and easily understandable with the support of automated pronunciation digital system. The problem addressed by this study is the lack of an efficient and accurate automated system for assessing and enhancing pronunciation skills, which affects language learners' ability to communicate effectively and confidently. The purpose of this empirical study is to investigate the effects of interface quality (IQ), system quality (SQ), and perceived usefulness (PU) on students' satisfaction (SS) using an automated pronunciation scoring system to enhance their pronunciation learning. The intent of this study is to examine three factors affecting the students' satisfaction using this automated pronunciation scoring system. This study used a sample frame of 232 non-native learners learning Chinese from two universities in Malaysia. The relationships were tested through the partial least squares structural equation modelling method. The results revealed that IQ has no significant impact on SS. However, for both SQ and PU, there are positive significant relationships. Besides, learning levels could have effects on these relationships. The partial least squares (PLS) technique was used to examine the direct relationship and PLS-MGA was used to demonstrate the effect of learning levels, with the diploma and degree students. These relationships are further explained in this article.

1. Introduction

The use of an automated pronunciation scoring digital system in improving non-native learners' pronunciation can be handy. However, satisfaction with the user is affected by factors such as interface quality, system quality, and perceived usefulness. On top of this, learning levels could have effects on these relationships. Hence, this ought to be studied.

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The use of any automated pronunciation scoring digital system is required to bring about satisfaction to the users. However, user satisfaction is always affected by factors such as interface quality, system quality, and perceived usefulness.

Assessing learners' satisfaction with the recommended system for learning is essential. There are many determinants of satisfaction levels. For example, interface quality, system quality, perceived usefulness, etc. Studies have shown that all these factors are having effects on the satisfaction of use.

There is a need to examine user satisfaction with the intention of recommending any system to support learning [1]. The experience of using any of the systems that bring about satisfaction will drive the users to continue using it in the betterment of their pronunciation [2, 21].

Interface quality and perceived usefulness are two characteristics which are related to satisfaction. Relationships between interface quality and perceived usefulness on satisfaction have been noticed. Evaluation of interface quality is certainly affecting user satisfaction [3].

The system quality and perceived usefulness have significant impacts on satisfaction. Perceived System quality affects satisfaction level. Students need to be confident that the system quality is adhered to what they want, and they might find assistance as well as support for their learning.

Perceived usefulness is a commonly studied variable. So, perceived usefulness adds value to the satisfaction of use and brings about loyalty in use. Therefore, the critical factors that affect perceived usefulness related to satisfaction have to be explored. The determinants of perceived usefulness have to be studied. The perceived usefulness is the silver bullet to ascertaining user data available for all online recommendation systems [3]. Thus, perceived usefulness is very essential to satisfying the user's experience.

Demographic background such as levels of learning might affect the perception of the instructional technological tool recommended in the classroom. Teaching pronunciation to students of different levels might have an impact on satisfaction levels. Degree students normally have lesser contact hours in learning as compared to diploma students. They will hence have different expectations and acceptance levels pertaining to the use of the automatic pronunciation scoring system in enhancing their pronunciation learning. So, there is a potential difference in perceptions of their satisfaction levels with the use of digital systems. This effect is verified in this study.

The existing research on automated pronunciation assessment systems often lacks a comprehensive integration of advanced techniques, such as Partial Least Squares-Multiple Group Analysis (PLS-MGA), to accurately evaluate and provide targeted feedback on pronunciation. This study aims to bridge this gap by proposing an innovative Automated Pronunciation Digital System utilizing PLS-MGA, thereby contributing to more precise and personalized language learning tools for improved pronunciation proficiency.

In sum, the conceptual framework of this study is depicted in Figure 1. There are four hypotheses in this study. The following hypotheses are as follow:

1. Interface quality has a positive significant effect on students' satisfaction.
2. System quality has a positive significant effect on students' satisfaction.
3. Perceived usefulness has a positive significant effect on students' satisfaction.
4. There will be significant differing perceptions between the Diploma and Degree students on the application of this model.

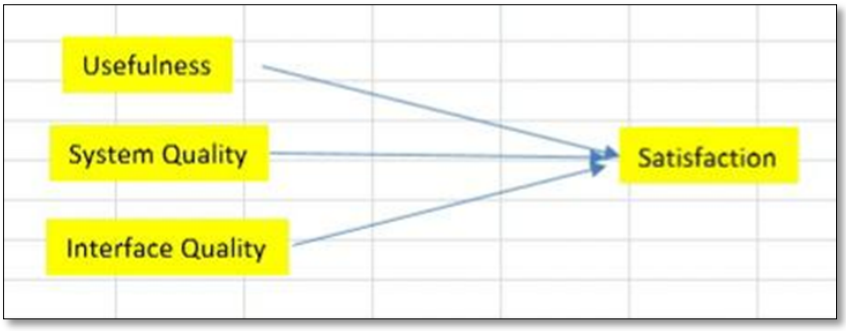


Fig.1: Conceptual framework

2. Methodology

This study was conducted in two universities in Malaysia. They were UiTM and UMT. Students at these universities were selected as their instructors were involved in this joint collaborative research project. There were 232 students in total. The students involved were non-native learners learning Chinese as a foreign language. They were diploma and degree students. The demographic information of these students is shown in Table 4.

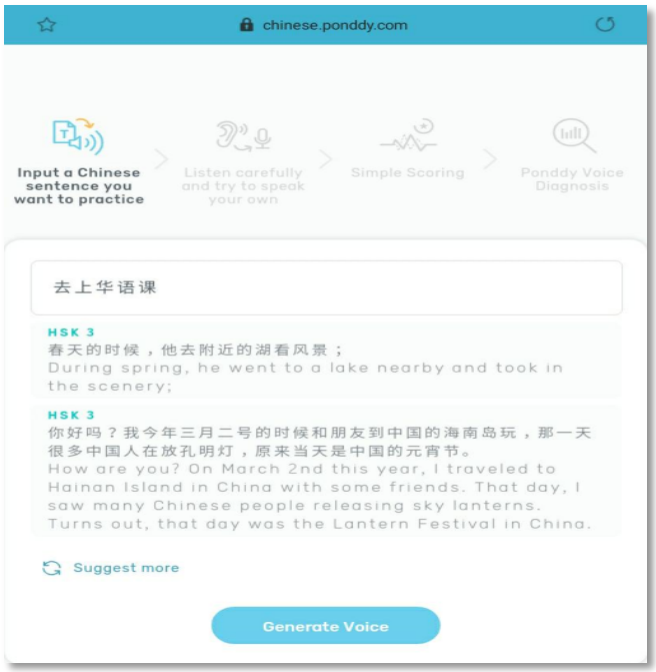
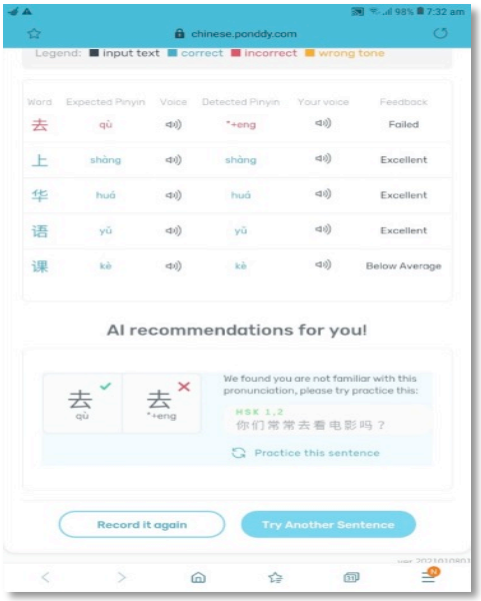
The students were taught on how to use the automated pronunciation scoring system to improve their pronunciation. This system can be accessed at https://chinese.ponddy.com/voice-widget/. This system was developed by Chinese Ponddy, an American-based artificial intelligence application company.

The procedure of use is shown in Table 1. Students received the texts in Chinese which were to be tested by their instructors, e.g., qu shang Huayu ke, 去上华语课. They did not have to log in to the system. No registration was required for use as well. They just have to copy and paste the Chinese texts in the system and followed the procedures as shown in Table 1, they would receive feedback on the accuracy of their pronunciation. The snapshots of use were depicted in Table 1.

Students accessed the system for a semester in improving their pronunciation by using the phrases and sentences recommended by their instructors. At the end of the semester, these students were asked to answer an online questionnaire. Questionnaires can be used to rate users' satisfaction and are one of the most effective ways to gather users' opinions about the systems. The questionnaire used in this study is adapted based on System Usability Questionnaire (SUQ) developed by IBM to evaluate the system usability. Moreover, this questionnaire consists of 23 questions (adapted from IBM system usability satisfaction) [4]. This questionnaire is adapted for use as it serves the purpose of this study beside with its reliability index of .8242 and validity of this questionnaire. Each question is rated from one to five and the Likert-scale ranges from "strongly disagree" to "strongly agree" and a "neutral" option is present.

The questionnaire is categorized into four key factors: system usefulness (questions 1 to 8), system quality (questions 9 to 17), interface quality (questions 18 to 20), and satisfaction (questions 21 to 23). The contents of the questionnaire are shown in Table 2. The PLS-SEM approach is a viable research method to determine the impact of various aspects affecting satisfaction. Hence, PLS-SEM is employed for data analysis in this study.

Table 1
Procedures of use

Process	Note	Snapshot
1 Key in sentences for self testing. Eg. Qu shang huayu ke 去上华语课	Generate voice for testing	
2 Simple scoring is given Eg 75% Eg Qu 去	Incorrect pronunciation is highlighted and detected in red.	

The difference between a diploma and degree students is studied in this study. Therefore, PLS-MGA is the most common type of analysis used to address differences between groups of respondents [5]. MGA (multigroup analysis) is often used to explore differences across groups defined by group variables. Heterogeneity across groups in MGA occurs if there are significant differences across at least two groups.

Table 2
Contents of the questionnaire [4]

Constructs	**Items**
Perceived Usefulness, PU	1. I am satisfied with how easy it is to use this system 2. It is simple to use this system 3. I can effectively evaluate my pronunciation using this system 4. I am able to obtain feedback on the accuracy of my pronunciation quickly using this system 5. I am able to detect where my mistakes are in my pronunciation using this system 6. I feel comfortable using this system 7. It is easy to learn to use this system 8. I believe I am able to improve my pronunciation using this system
System Quality, SQ	9. The system gives messages that clearly tell me how to follow the instructions. 10. The system gives messages that clearly tell me how to fix problems I faced. 11. I discover easily each time a mistake is done using this system. 12. The information (such as online help, on-screen messages, and other documentation) provided in this system is clear 13. It is easy to follow the instructions given by the system 14. The instructions given in this system is easy to understand 15. The instructions given are effective in helping me to complete the tasks of doing self-automated pronunciation scoring 16. The organization of instructions on the system screens is clear 17. The organization of instructions on the system screens is easy to follow
Interface Quality, IQ	18. The interface of this system is pleasant 19. I like using the interface of this system 20. This system has all the functions I expect it to have
Students' Satisfaction, SS	21. I am satisfied with the system as it is easy to use 22. I am satisfied with the system as it can help me to improve my pronunciation 23. As a whole, I am satisfied with this system

3. Results

3.1 Common method bias

Table 3 shows the full collinearity testing of the 4 constructs in this study. The purpose is to eliminate common method bias in this study. As stated by Kock [6], VAF values that are less than 5 are acceptable. This is a preliminary step of PLS-SEM analysis.

Table 3
Four constructs in this study

Interface Quality	**Satisfaction**	**System Quality**	**Usefulness**
3.439	3.625	4.227	4.890

3.2 Demographic background

Table 4 shows the demographic information in this study. There are 156- diploma students and 94-degree students involved in this study.

Table 4
Demographic information

	Number of respondents	Year of study	Background
Diploma	156	3rd and 4th semester of study	Diploma in Business Administration
Degree	94	1st, 2nd and 3rd semester of study	Degree in Business studies
Total	250		

3.3 Descriptive analysis

Table 5 depicts the descriptive findings of this study. The mean values and standard deviation values of the complete data, degree data, and diploma data are shown. Items SQ13, SQ15, SQ16, and SQ17 were deleted due to cross-loading issues.

3.4 Measurement Model

The examination of the measurement model in this study includes reflective metrics. Loadings greater than .50 show that the construct accounts for more than half of the variation in the indicator. Reliability ratings of .70–.95 are considered "acceptable to good". [8] Construct reliability (CR) ratings of .70–.95 are considered appropriate [9]. The items' average variance extracted (AVE) linked with a specific construct is used to measure convergent validity. The AVE must be .500 or greater to be considered acceptable [10], accounting for (more than) 50% of the variation in its components on average.

As shown in Table 6, all the loadings, AVE and CR are in acceptable ranges. Hence, the measurement model is suitable for hypothesis testing in the next section.

Table 7 shows the discriminant validity values of all four constructs. Discriminant validity is the final stage. [11] that demonstrates how empirically different a concept is from others. In PLS-SEM, discriminant validity is determined by examining the heterotrait–monotrait ratio of correlations. If the route model includes variables defined as conceptually and extremely similar, a value of .900 is proposed as a threshold. In PLS-SEM, the heterotrait–monotrait ratio criterion is a novel requirement for assessing discriminant validity that outperforms the Fornell–Larcker criterion and cross-loading assessments. [8] As stated by Franke & Sarstedt [12], the values should be below .9. Therefore, the findings are considered acceptable for hypotheses testing in the next subsection.

3.5 Measurement invariance

Measurement invariance is conducted for MGA assessment. The findings in Table 8 shown that full measurement invariance has been established. Therefore, hypothesis testing in comparing diplomas and degrees can be done.

3.6 Hypotheses testing

There are four hypotheses in this study. They are:

1. Interface quality (IS) has a positive significant effect on students' satisfaction (SS).
2. System quality (SQ) has a positive significant effect on students' satisfaction.
3. Perceived usefulness (PU) has a positive significant effect on students' satisfaction.
4. Diploma and degree students will have different perceptions of the application of this model.

Table 5
Descriptive analysis

Constructs/Indicators	Complete		Degree		Diploma	
	Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation
Perceived Usefulness (PU)						
U1. I am satisfied with how easy it is to use this system.	3.444	1.107	3.381	1.052	3.480	1.140
U2. It is simple to use this system.	3.457	1.332	3.476	1.375	3.446	1.311
U3. I can effectively evaluate my pronunciation using this system.	3.483	1.199	3.476	1.217	3.486	1.192
U4. I am able to obtain feedback on the accuracy of my pronunciation quickly using this system.	3.483	1.217	3.476	1.256	3.486	1.198
U5. I am able to detect where are my mistakes in my pronunciation using this system.	3.487	1.259	3.488	1.294	3.486	1.243
U6. I feel comfortable using this system.	3.539	1.173	3.536	1.217	3.541	1.151
U7. It is easy to learn to use this system.	3.810	1.150	3.798	1.149	3.818	1.155
U8. I believe I am able to improve my pronunciation using this system.	3.569	1.171	3.500	1.156	3.608	1.182
System Quality (SQ)						
SQ09. The system gives messages that clearly tell me how to follow the instructions.	3.047	1.008	3.048	0.981	3.047	1.026
SQ10. The system gives messages that clearly tell me how to fix problems I faced.	3.022	1.008	2.976	0.994	3.047	1.019
SQ11. I discover easily each time a mistake is done using this system.	3.284	1.018	3.333	1.057	3.257	0.997
SQ12. The information (such as online help, on-screen messages, and other documentation) provided in this system is clear.	3.216	1.063	3.214	1.109	3.216	1.040
SQ14. The instructions given in this system is easy to understand.	3.254	1.109	3.321	1.055	3.216	1.140
Interface Quality (IQ)						
IQ18. The interface of this system is pleasant.	3.310	1.173	3.262	1.163	3.338	1.181
IQ19. I like using the interface of this system.	3.358	1.119	3.405	1.183	3.331	1.084
IQ20. This system has all the functions I expect it to have.	3.569	1.359	3.679	1.355	3.507	1.363
Students' Satisfaction (SS)						
S21. I am satisfied with the system as it is easy to use.	3.509	0.980	3.524	0.988	3.500	0.979
S22. I am satisfied with the system as it can help me to improve my pronunciation.	3.142	1.144	3.143	1.184	3.142	1.125
S23. As a whole, I am satisfied with this system.	3.591	1.249	3.607	1.290	3.581	1.229

Item SQ13, SQ15, SQ16, SQ17 were deleted due to cross loading.

Table 6
Assessment results of the measurement model

Constructs/ Indicators	Loading			CR			AVE		
	Complete	Degree	Diploma	Complete	Degree	Diploma	Complete	Degree	Diploma
Perceived Usefulness (PU)				0.980	0.980	0.979	0.857	0.862	0.855
U1	0.883	0.882	0.887						
U2	0.912	0.923	0.906						
U3	0.939	0.943	0.936						
U4	0.960	0.966	0.956						
U5	0.959	0.967	0.954						
U6	0.951	0.955	0.949						
U7	0.976	0.975	0.977						
U8	0.816	0.804	0.823						
System Quality (SQ)				0.952	0.950	0.953	0.797	0.790	0.803
SQ09	0.920	0.914	0.923						
SQ10	0.860	0.842	0.871						
SQ11	0.880	0.873	0.886						
SQ12	0.909	0.916	0.906						
SQ14	0.894	0.898	0.893						
Interface Quality (IQ)				0.922	0.924	0.922	0.798	0.803	0.798
IQ18	0.883	0.894	0.879						
IQ19	0.885	0.876	0.891						
IQ20	0.912	0.918	0.910						
Students' Satisfaction (SS)				0.945	0.944	0.946	0.852	0.848	0.855
S21	0.883	0.870	0.890						
S22	0.954	0.957	0.952						
S23	0.932	0.934	0.931						

Item SQ13, SQ15, SQ16, SQ17 were deleted due to cross loading.
Note: See Table 2 for the names of the indicators

Table 7
Discriminant validity (HTMT.90 criterion)

Constructs	Complete				Degree				Diploma			
	IQ	PU	SQ	SS	IQ	PU	SQ	SS	IQ	PU	SQ	SS
IQ												
PU	0.860				0.878				0.849			
SQ	0.892	0.853			0.891	0.843			0.891	0.858		
SS	0.782	0.870	0.844		0.802	0.886	0.833		0.770	0.860	0.850	

Table 8
Measurement invariance

Constructs	Configural invariance	Compositional invariance		Partial measurement invariance established	Equal mean value		Equal variance		Full measurement invariance established
		C = 1	95% CIs		Differences	95% CIs	Differences	95% CIs	
IQ	Yes	1.000	[0.999; 1.000]	Yes	0.052	[-0.262; 0.259]	0.043	[-0.325; 0.267]	Yes
PU	Yes	1.000	[1.000; 1.000]	Yes	-0.022	[-0.269; 0.264]	0.039	[-0.329; 0.272]	Yes
SQ	Yes	1.000	[0.999; 1.000]	Yes	0.027	[-0.269; 0.258]	-0.023	[-0.371; 0.334]	Yes
SS	Yes	1.000	[1.000; 1.000]	Yes	0.017	[-0.279; 0.265]	0.060	[-0.432; 0.386]	Yes

Table 9
Results of hypothesis testing

Hypothesis	Path	Full				Degree				Diploma			
		Beta	SE	T value	Result	Beta	SE	T value	Result	Beta	SE	T value	Result
H1	IQ -> SS	-0.037	0.056	0.672	NS	-0.036	0.101	0.357	NS	-0.041	0.070	0.590	NS
H2	PU -> SS	0.574	0.054	10.559	S	0.649	0.092	7.037	S	0.528	0.071	7.472	S
H3	SQ -> SS	0.347	0.078	4.424	S	0.278	0.130	2.143	S	0.393	0.100	3.930	S

Table 10
Result of R2, and f2

	Full			Degree			Diploma		
	F2	Q2	R2	F2	Q2	R2	F2	Q2	R2
IQ	0.001			0.001			0.002		
PU	0.324			0.420			0.271		
SQ	0.115			0.082			0.140		
SS		0.605	0.724		0.489	0.739		0.606	0.718

As shown in Table 9, H1 is rejected (p value>.0000). For both H2 and H3, they are accepted. Therefore, hypothesis 4 is partially rejected as the diploma and degree students did not show different perceptions on the application of this model for the relationship of IQ to SS as the t value is below 1.96 but with significant differences of relationships between PU to SS and SQ to SS with t values above 1.96.

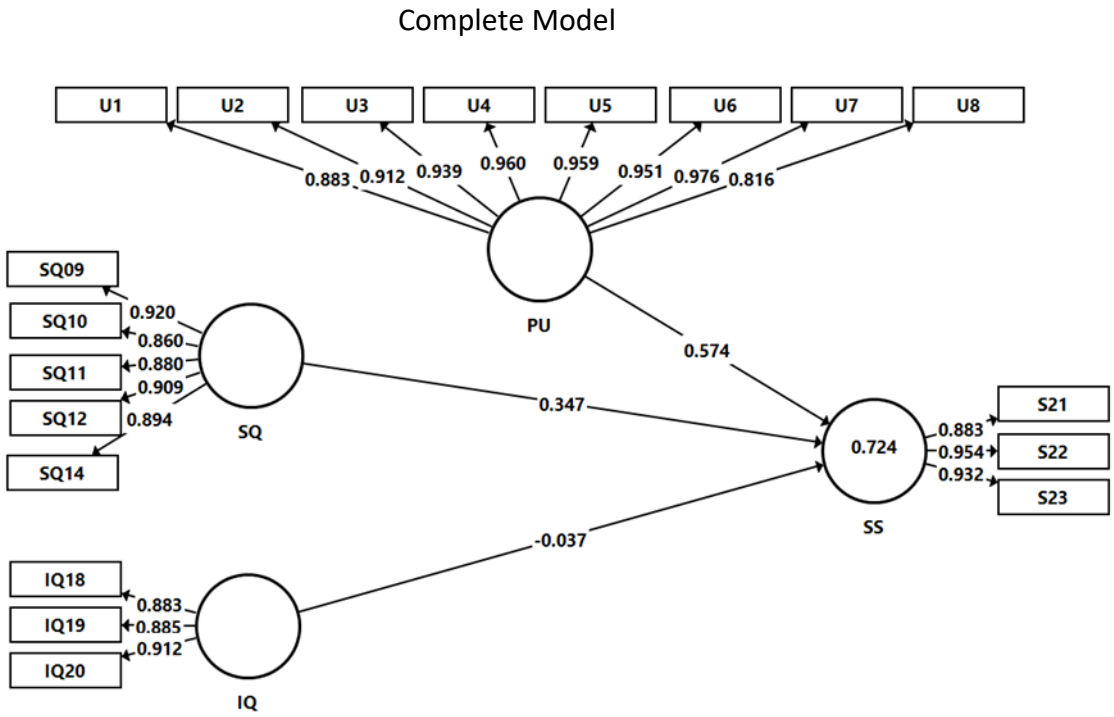


Fig. 2. Complete model

3.7 Structural Model

Researchers Ringle *et al*., [13] recommend the inclusion of measures like R2, f2, Q2, model fit, and statistical significance to assess the structural model. For a given endogenous component, Q2 values larger than zero indicate a reasonable degree of prediction accuracy [13,14]. To test for statistical significance, Hair *et al*., [8] recommend a minimum t-value of 1.65 at $p < .05$. The structural model was estimated using the consistent PLS bootstrapping option with 5,000 subsamples in this investigation.

Table 10 shows the PLS prediction findings. As stated by Shmueli *et al*., [9], the q square values are > .35 and with large predictive relevance. Therefore, these models were with high predictive relevance.

Figures 3 and 4 show the structural models of this study for both degree and diploma students.

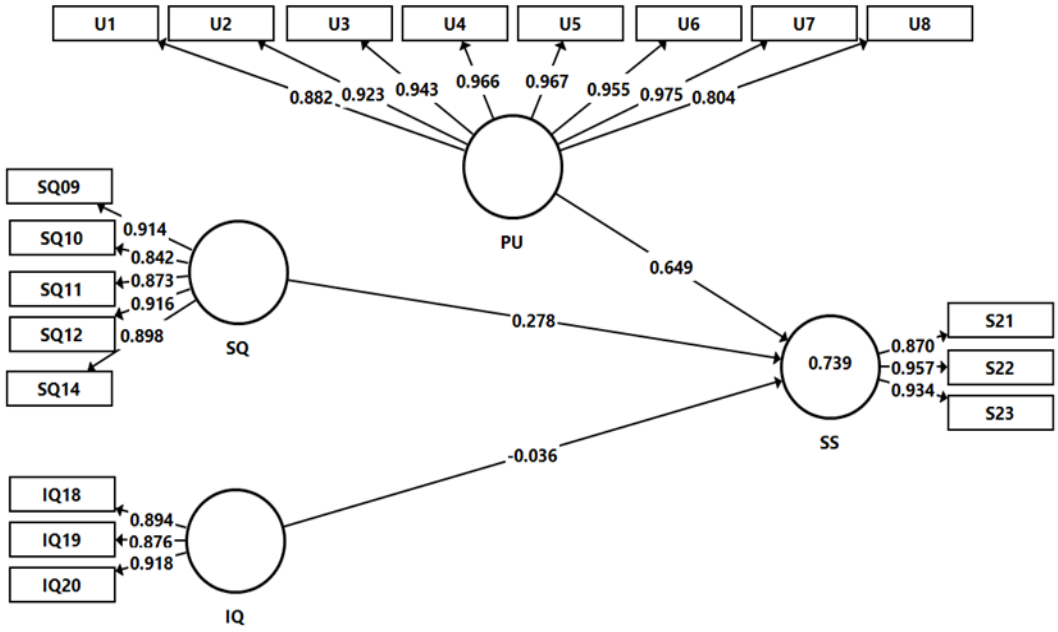


Fig. 3. Structural model for degree students

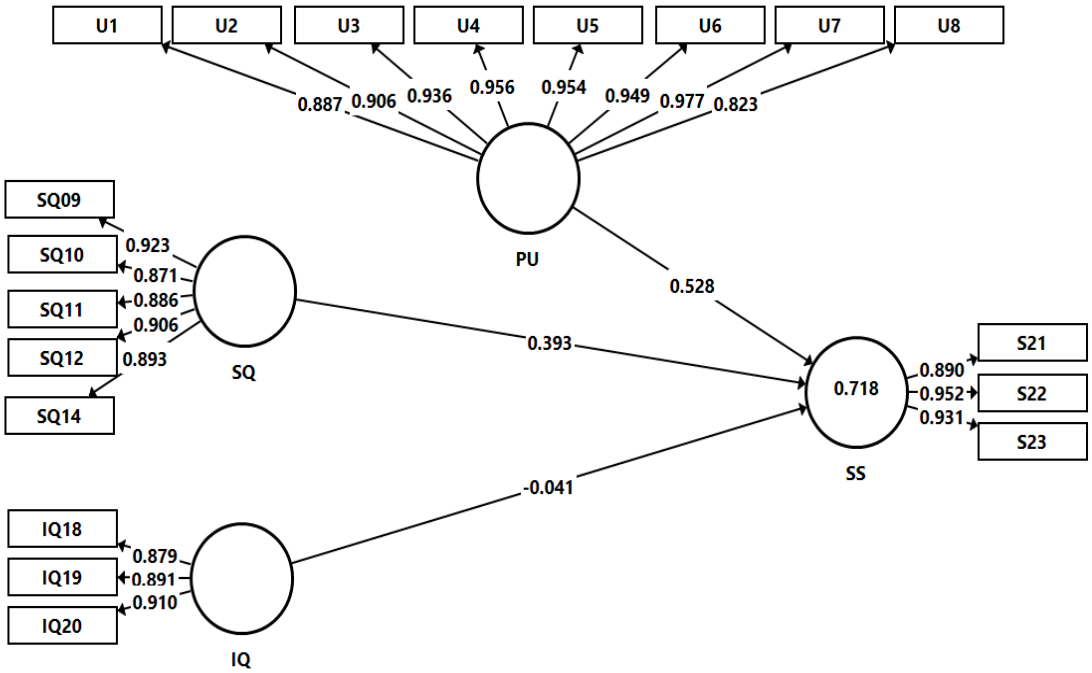


Fig. 4. Structural model for diploma students

4. Discussions and Conclusions

This research has validated the influences of three variables on the students' satisfaction with the use of an automated pronunciation scoring digital system to enhance their pronunciation learning. The study confirmed that both system quality and perceived usefulness have positive significant effects on students' satisfaction. However, the effect of interface quality on students' satisfaction hasn't been affirmed in this study significantly. This study did not show different

perceptions between diploma and degree students on this satisfaction model. Therefore, for future research, the effect of interface quality on students' satisfaction and the effect on learning levels can be further explored and confirmed. These findings are in line with [15], where results also show that system quality and perceived usefulness have significant impacts on satisfaction.

This study has focused on the study of three factors that affect students' satisfaction with the use of the automated pronunciation scoring digital system to enhance their pronunciation learning. They are other factors that contribute to the influence of satisfaction dimensions which can be further explored and studied in future research [16]. Good systems and beneficial systems that support learning have to go through the lens of the students in which more vital factors are to be studied.

The use of PLS-MGA provides insights into the differences in effects between the constructs under investigation across groups. For future studies, various aspects of grouping features such as different locations, institutions, etc. can be investigated. The effect between groups is essential to understand how various factors affect satisfaction by employing PLS-MGA [17].

In this study, we developed and evaluated an Automated Pronunciation Digital System using Partial Least Squares-Multiple Group Analysis (PLS-MGA) as a novel approach for enhancing language learners' pronunciation skills. Our findings revealed that the integration of PLS-MGA significantly improved the accuracy of pronunciation assessment compared to traditional methods by using AI enhanced pronunciation assessment system [18-22]. The system's ability to identify subtle nuances in pronunciation, adapt to individual learning styles, and provide personalized feedback was a noteworthy advancement.

The use of the automated pronunciation scoring digital system is highly linked to the satisfaction of use. In order to enhance the use, the findings have implied that ample attention should be given to the aspects of interface quality, system quality, and perceived usefulness. Instructors have to play an active role in ensuring that the users are comfortable and familiar with the interaction with the system. The developer of the system is also required to make sure that the interface provided is in line with the technological knowledge as well as other features that ease the use of the system, such as system requirements, language support, technical issues, etc. Continuance satisfaction will bring about continuing use [19,20].

In conclusion, the study on satisfaction has to come to ensure the consistent use of an automated pronunciation scoring digital system to support pronunciation learning. By integrating user feedback and refining the system's algorithms, we can create a more effective and user-friendly pronunciation learning tool.

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