Original Research Paper

Teledentistry: students' intention to adopt based on the Unified Theory of Acceptance and Use of Technology construct

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Abstract

Background: Teledentistry facilitates treatment planning, patient monitoring and education in dentistry by enhancing the access to and outcomes in oral health. This study aimed to assess the undergraduate students' use and acceptance of teledentistry services using a tool based on the UTAUT model. **Methods:** The implementation of teledentistry into the curriculum of 241 undergraduate students receiving training for teleconsultation was evaluated. The students' behavioral intention to adopt teledentistry was measured with questions based on the Unified Theory of Acceptance and Use of Technology (UTAUT) constructs, such as performance expectancy, effort expectancy, social influence, facilitating conditions, and trust. **Results:** A total of 105 students completed the UTAUT model questionnaire. The valid hypotheses considered the following constructs: performance expectancy (H1), social influence (H3) and trust (H5) showed positive impacts, whereas effort expectancy (H2) had a non-significant negative influence and facilitating conditions (H4) had no significance. Therefore, performance expectancy, social influence and trust had an impact on the students' behavioral intention to use teledentistry. **Discussion:** The constructs performance expectancy, social influence and trust impacted the behavioral intention of undergraduate students in using teledentistry, meaning that these factors must be considered during the implementation of this telehealth service.

Keywords: Teledentistry, technology acceptance model, telehealth, dental education, digital dentistry

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INTRODUCTION

Expectations and attitudes in contemporary society place a predominant emphasis on modern techniques of health communication.[1] The introduction of digital technologies for education and patient monitoring is well received by patients and aids professionals in providing guidance while reducing clinical time, thereby lowering overall costs for both patients and professionals.[2,3]

Teledentistry provides a viable option for remote screening, diagnosis, consultation, treatment planning, and guidance in the field of dentistry, thereby being valuable for patient monitoring and education.[4-8] Furthermore, expectations are that in the next two decades teledentistry will evolve into an essential tool benefiting patients by offering enhanced and continuous interconnection among clinical professionals. This will provide direct and secure access to the patients' needs, which improves the oral health outcomes.[4,9,10] This technology has proven to be a valuable communication tool for professionals to address their patients' concerns.[11]

Thus, the incorporation of teledentistry practice into undergraduate education is highly relevant.

However, the non-implementation of technology may be related to the health professionals' resistance to its use due to intrinsic and extrinsic factors.[12] As the non-acceptance of technology may be related to individual or organizational cultural aspects, it is necessary to better manage and clarify the implementation process. Additionally, the mistaken perception that teledentistry is limited to virtual video calls suggests that non-users do not fully understand its various applications in dentistry.[13] There is a need for more evidence in evaluating the practice of teledentistry,[2,4] as well as its behavioral intention[15,16] in order to reduce barriers dental professionals encounter when using this technology.[12,17] So, the behavioral intention refers to the individual's conscious plan or willingness to use a technology in the near future.[15,16]

In this regard, the Unified Theory of Acceptance and Use of Technology (UTAUT) proves to be a comprehensive tool for institutions and organizations that need to assess the success of implementing new technologies and identify potential barriers to their acceptance and use.[18,19] It also contributes to the understanding of acceptance factors in order to take more effective intervention actions, such as training and infrastructure, targeted at users who are less inclined to accept and use new systems and tools.[20,21]

The use of the UTAUT model to predict behavioral intentions has been investigated in various healthcare services[22-25] as it can facilitate better management of implementation processes in both education and clinical practice.[4,25]

Therefore, it is necessary to conduct an investigation into the factors influencing the acceptance of teledentistry innovation among professionals in this field in order to fill this gap in the literature. Thus, the objective of this study is to assess the acceptance and use of teledentistry among undergraduate students through a survey tool developed from the UTAUT model.

METHODS

Study Context

This is a retrospective epidemiological study conducted, with support from the Telehealth and Teledentistry Center (FOUSP-SAITE), at the University of Sao Paulo, School of Dentistry. The study used data collected during the implementation of a teledentistry activity held from July 2020 to October 2021. The activity has been implemented during the COVID-19 pandemic as a result of the temporary suspension of the baby and toddler clinic. The main objective of the activity was to maintain the links with the families of the babies being monitored, thus reinforcing preventive guidelines on the babies' oral health while teaching and allowing undergraduate students of teledentistry to apply them in clinical care. This activity included telemonitoring, teleorientation and telescreening for patients, as they are recognized as important strategies for oral health prevention policies and service demand optimization. The inclusion of this activity in the undergraduate curriculum enabled the assessment of the undergraduate students' perceptions regarding the use of teledentistry in their practice.

Ethical Considerations

The study was approved by the Research Ethics Committee of the University of São Paulo School of Dentistry according to protocol number 4749508 and carried out in compliance with resolution number 466/12 of the Brazilian National Health Council.

Study sample

For the study, 241 undergraduate students were trained and equipped to conduct teledentistry, which included telemonitoring, telescreening and teleorientation. For telemonitoring and teleorientation in early childhood, students worked in pairs and were supervised by 34 preceptors, including six faculty members, one postdoctoral researcher, and 27 postgraduate students. They were also supported by a technological support team and a dedicated telehealth platform.

The platform complies with the Health Insurance Portability and Accountability Act (HIPAA), as well as with the Brazilian Data Protection General Law. It was chosen for its capacity to enable secure and efficient patient monitoring, incorporation of advanced technologies such as network connectivity for data security, data integrity, immutability, integration with existing systems, video recording retrieval, and health record personalization.

Validation of Unified Theory of Acceptance and Use of Technology (UTAUT) Model

To assess the impact of implementation and the perception of undergraduate students regarding the

use of teledentistry, a questionnaire based on the Unified Theory of Acceptance and Use of Technology (UTAUT) model, as presented by Venkatesh (2003),[12] was applied. The survey instrument (i.e. the questionnaire) used items empirically validated in the literature which were translated into and adapted to Brazilian Portuguese language. The translation process was conducted by a bilingual researcher, who independently translated the items into Portuguese. The comprehension of the items was verified by a panel of subject experts, including faculty members with expertise in digital health, telehealth, and psychometrics. Their comments focused mainly on the clarity of wording, cultural adaptation of certain terms, and alignment with the Brazilian academic context. After considering these comments, minor revisions were made to improve comprehensibility without altering the theoretical constructs.

Subsequently, the revised version was piloted with a small sample of undergraduate dental students to test readability and comprehension, as recommended by the literature.[12,25] The feedback confirmed the adequacy of the instrument, and the final version was then applied in the main study. The questionnaire evaluated the behavioral intention of students to use teledentistry based on five key UTAUT variables: performance expectancy; effort expectancy; social influence; facilitating conditions; and trust. Furthermore, the study tested six hypotheses based on the UTAUT model in order to evaluate the relationship between these variables and the behavioral intention of students to use teledentistry.

Previous studies have demonstrated that BI (behavioral intention) is a reliable representation of actual behavior.[25] Moderating effects of age, gender and experience were not tested in this study. Based on the UTAUT model, this study aimed to test six hypotheses as follows:

- **H1:** Performance expectancy (PE) is positively associated with BI of dental students to use teledentistry.
- **H2:** Effort expectancy (EE) is positively associated with BI of dental students to use teledentistry.
- **H3**: Social influence (SI) is positively associated with BI of dental students to use teledentistry.
- **H4:** Facilitating conditions (FC) are positively associated with BI of dental students to use teledentistry.
- **H5:** Trust (T) is positively associated with BI of dental students to use teledentistry.
- **H6:** The proposed UTAUT model predicts the BI of students to use teledentistry.

Details of data collection

The questionnaire was sent to undergraduate students who conducted telemonitoring at two different times through the Google Forms platform. They answered the questionnaire after completing telemonitoring with the parents of pediatric patients. This allowed for analyzing the acceptance and intention to use the technology in question. Only students with experience in teledentistry practice were eligible.

Statistical Procedures

The use of partial least squares structural equation modeling (PLS-SEM) has advanced significantly due to the introduction of new discriminant validity and overall model fit metrics.[27,28] As a result, many researchers have been encouraged to use PLS-SEM in their studies.[29-32] The estimates presented in this article were based on the PLS-SEM approach and Smart PLS v.3 software. The statistical analysis follows the recommendations and structural model assessment,[28,33] whose approach is usually reported in the literature.[29,34] The measurement model examination suggests that all factor loading values should be significant and greater than 0.707, indicating that the corresponding latent variable can explain over 50 percent of the variance in a single indicator.[27] The composite reliability (CR) values should be higher than 0.7 and Cronbach's alpha values above 0.6 and 0.7 for exploratory and confirmatory research, respectively.[27]

Convergent validity evaluates whether the indicators belong to one latent variable measuring the same construct.[28] The literature suggests that the average variance extraction (AVE) value should be above 0.5.[33] The Fornell and Larcker's approach recommends that the AVE value from each construct should be higher than the squared inter-construct correlation to evaluate discriminant validity.[35] Recent literature suggests using the hetero-trait mono-trait ratio (HTMT) approach to assess discriminant validity in PLS-SEM models.[28,33] The correlation values in the HTMT approach should be below 0.9 for structural models with very similar constructs and lower than 0.85 when the constructs are conceptually more distinct.[33] The structural model assessment suggests using the root mean square residual (RMSR) value to assess the approximate fit and obtain empirical evidence for the proposed theory.[33] RMSR values below 0.08 indicate a satisfactory fit for the model.[28]

RESULTS

A total of 105 completed the questionnaire, corresponding to an estimated margin of error of 7%. This sample size can be considered adequate for exploratory analyses of technology acceptance, as supported by similar studies in dental education that employed convenience sampling and voluntary participation.[25] The statistical analysis was divided into steps.

The results were evaluated based on measurement models. One can observe in Table 1 that in relation to the loading approach, the results were higher than 0.70, as recommended in the literature.[36] As for AVE, the values remained stable as they did not exceed 0.7, which was a satisfactory behavior (i.e. above 0.5).[37] CR above 0.80 indicates a substantial reliability score,[38] whereas Cronbach's alpha requires values above 0.800, although factor FC was lower, that is, 0.637, which refers to the perceived availability of resources and support for the use of technology.

Because the study was conducted during the pandemic, students were isolated at home, often living in cities and states different from their registered addresses and facing unstable socioeconomic conditions. Therefore, these demographic data were not included in the results to minimize potential confounding factors. These circumstances may have been reflected in the assessment of the Facilitating Conditions (FC) construct.

The Fornell-Larcker criterion (Table 2) was used to describe the discriminant validity of the factors, in which the square root of parameter AVE (central diagonal in the table) is used to compare the correlations between the factors (i.e. values out of the central diagonal).[35]

Table 1: The factor loading of the constructs.

Item	Effort Expectancy	Performance Expectancy	Social Influence	Facilitating Conditions	Trust	Behavior Intention
EE1	0.874***					
EE2	0.891***					
EE3	0.848***					
EE4	0.851***					
PE1		0.850***				
PE2		0.840***				
PE3		0.874***				
PE4		0.872***				
SI1			0.962***			
SI2			0.961***			
SI3			Removed			
FC1				0.750***		
FC2				Removed		
FC3				0.935***		
FC4				Removed		
TR1					0.904***	
TR2					0.912***	
TR3					0.893***	
TR4					Removed	
TR5					0.720***	
BI1						0.932***
BI2						0.923***
BI3						0.901***
AVE	0.750	0.738	0.925	0.719	0.742	0.845
CR	0.923	0.919	0.961	0.835	0.919	0.942
Cronbach's alpha	0.893	0.882	0.919	0.637	0.880	0.908

Table 2: Fornell-Larcker criterion – Discriminant Validity.

Construct	BI	EE	FC	PE	SI	TR
Behavioral Intention (BI)	0.919					
Effort expectancy (EE)	0.304	0.866				
Facilitating Conditions (FC)	0.296	0.588	0.848			
Performance expectancy (PE)	0.771	0.404	0.351	0.859		
Social Influence (SI)	0.602	0.252	0.263	0.505	0.962	
Trust (T)	0.600	0.568	0.386	0.617	0.458	0.861

Table 3: Hetero-Trait Mono-Trait Ratio – Discriminant Validity.

Construct	BI	EE	FC	PE	SI
Behavioral Intention (BI)					
Effort expectancy (EE)	0.314				
Facilitating Conditions (FC)	0.361	0.735			
Performance expectancy (PE)	0.859	0.437	0.441		
Social Influence (SI)	0.659	0.286	0.310	0.560	
Trust (TR)	0.672	0.635	0.489	0.699	0.508

One can observe that the central diagonal values are greater than the other ones, meaning that the square root of parameter AVE is greater in magnitude than the correlations between factors. In this way, the discriminant validity could be obtained for each one.[33]

Table 3 shows the hetero-trait mono-trait ratio (HTMT) approach, which is another method to assess the discriminant validity. Because values close to 1 (one) indicate low discriminant validity, it is necessary to use a threshold for comparison.[39] Some authors suggest a threshold value of 0.85,[40] whereas others 0.90.[41] One can observe in Table 3 a satisfactory result considering a more conservative comparison (i.e. 0.85). In this sense, only constructs PE and BI had values above the threshold (see Figure 1).

Table 4 shows the relationships between the model constructs. Three parameters were used to test whether the standardized path coefficients between the constructs were statistically significant in our hypotheses (i.e. H1, H2, H3, H4, H5 and H6). One can observe that H1 ($p < 0.01$ and coefficient = 0.562), H3 ($p < 0.01$ and coefficient = 0.252) and H5 ($p < 0.05$ and coefficient = 0.190) are valid because they have significant positive influence. On the other hand, H2 ($p = 0.126$ and coefficient = 0.107) has negative influence and H4 ($p = 0.766$ and coefficient = 0.022) has no influence, but not significantly enough.

In Table 5, one can observe that all the values of R^2 exceeded 0.20, which is in accordance with previous studies.[42]

DISCUSSION

The need to use information and communication technologies (ICT) in healthcare and educational institutions has become important to improve performance and clinical practice. However, such investments can be expensive and require an effective implementation process to increase the service performance.[43] Therefore, it is important to understand the acceptance and ease of use when implementing emerging technologies, as in the case of teledentistry.[44]

It is worth highlighting that professionals and decision-makers may resist the use of these technologies. If individuals who are offered a given technology do not want to use it in their work, this will not result in greater efficiency in the final

outcome.[43] In the present study, it is evident that performance expectancy impacted the intention to use teledentistry. Therefore, if students believe they can perform well when using teledentistry, then its accessibility and use will increase.

According to other authors,[45,46] performance expectancy has also been identified as a critical and significant factor in the intention to use telemedicine. Moreover, studies using the UTAUT model also suggest that performance expectancy is the most important determinant of intention to use a technology.[45,47] Performance expectancy is also influenced by trust, which in turn is directly affected by social environment and users´ experiences.

In this context, individuals tend to be more concerned about the safety and reliability of health services.[48,49] An important aspect in the introduction of teaching and clinical practices was the

Figure 1: Relationship between the model constructs

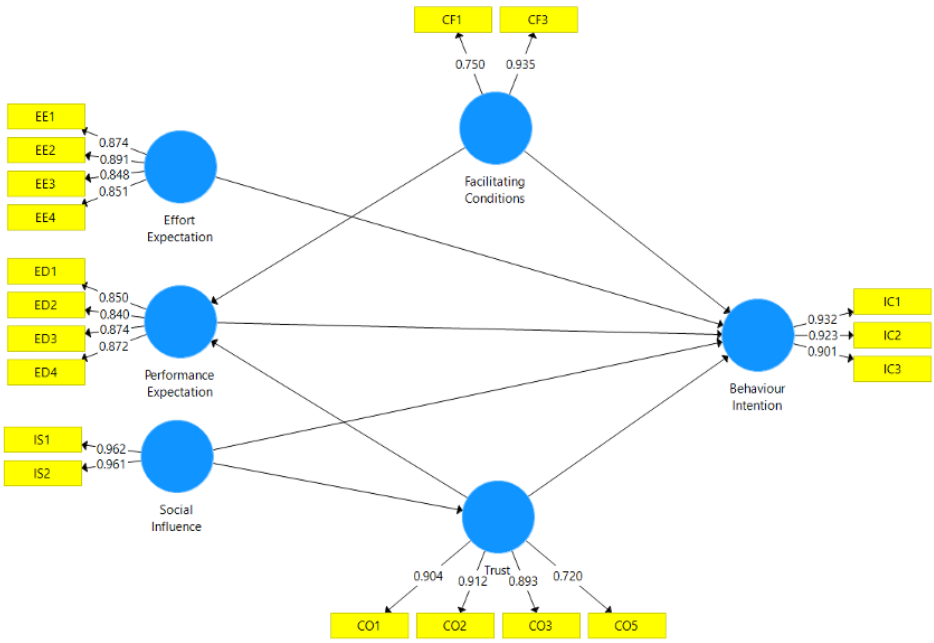

Table 4: Relationship between the model constructs.

Path	Coefficient	Standard Deviation	T-values	P-values	Results
EE-> BI	-0.107	0.070	1.529	0.126	Negative
FC-> BI	0.022	0.075	0.297	0.766	Negative
FC-> PE	0.133	0.075	1.764	0.078*	Positive
PE-> BI	0.562	0.075	7.519	0.000***	Positive
SI -> BI	0.252	0.071	3.548	0.000***	Positive
SI -> Trust	0.458	0.095	4.847	0.000***	Positive
Trust -> BI	0.190	0.076	2.487	0.013**	Positive
Trust -> PE	0.566	0.078	7.289	0.000***	Positive
Notes: *significant at 10%, **significant at 5%, ***significant at 1%					

Table 5: Model Assessment (R^2).

	R^2	R^2 adjusted
Model		
Behavioral Intention (BI)	0.801	0.791
Performance Expectancy (PE)	0.498	0.489
Trust (T)	0.258	0.251

incorporation of the concepts and foundations of this emerging field of knowledge into the curriculum. It is noteworthy that both in theoretical classes and in simulations and clinical activities, the established protocols were carefully planned to comply with the general data protection law in force in Brazil. Telemedicine security refers to the condition of being protected against risks and dangers, whereas reliability refers to the trust patients place in telemedicine technology, healthcare professionals and quality of care.[49]

As a result, the construct trust was strongly affected by the students' social influence. Social influence is also considered a subjective aspect and refers to the degree to which an individual perceives that others in their environment believe in or use such technology.[47,49,50]

Social influence can be understood as a social support and has been shown to be an important factor in the acceptance of telemedicine.[51] Several researchers have confirmed the positive effect of social influence on behavioral intention, with the surrounding environment being a significant factor in influencing one's behavior and potentially changing one's lifestyle.[34,51] Thus, it may be challenging to measure this factor when the technology is innovative and not well known.

Therefore, the present study validates how the opinions of persons considered important to the students can influence their behavior and use of teledentistry, a finding aligned with studies on marketing, management and education.[25,52,53] Such assessments are crucial to understand how culture and the academic environment can encourage students to promote the technology themselves.[52,53] In contrast to previous studies reporting that effort expectancy had no significant effect on the intention of use,[43,54,55] it was demonstrated that students´ engagement and the perceived importance of technology can be more related to a favorable usage behavior.

An important factor to be considered is that many professionals are resistant to the use of new technology. This resistance occurs at the beginning of the change and is generated by fear of the unknown and insecurity due to the rupture of previous stability.[56]. However, several medical schools adapted to the pandemic by implementing training programs in telemedicine.[57] In times of change, such as during the COVID-19 pandemic, it is important to understand that resistance to change results from the analysis of individual behaviors and motivations,[58] and the barriers that, if not identified, can be a limiting factor for improvements in practice,[12,17] especially regarding new clinical practices,[56] as in the case of teledentistry.

Therefore, the introduction of teledentistry into the undergraduate curriculum is important because this is an opportune moment to demonstrate all the benefits of its use, especially regarding clinical outcomes. Also, precautions and risks and how to avoid them can be addressed so that future professionals can be engaged with this emerging technology.

As a limitation of this study, it is worth noting that telemedicine and teledentistry have been emerging technologies during the pandemic,[57] and the study participants were students with little professional experience and influenced by professors and academic circles. It is recommended that future research be conducted with different target audiences, in addition to comparative analyses between groups that have not yet been exposed to teledentistry, and groups that have already been exposed to the technological intervention.

It can be concluded that the constructs performance expectancy, social influence and trust all impacted the behavioral intention of students in using teledentistry. Therefore, these factors should be considered during the implementation of this telehealth service by institutions.

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