

USABILITY OF FREE SOFTWARE USED FOR VISUALIZATION  
AND MEASUREMENT OF DIGITAL ORTHODONTIC MODELS

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**Abstract**

The aim of this study was to evaluate the usability of the free software available that allow visualization and measurement of orthodontic digital models. 80 graduate students of orthodontics were asked to perform pre-defined tasks in a digital model through 3D Viewer<sup>®</sup> and 3D-Tool<sup>®</sup> software. The success in accomplishing the tasks and the time spent were recorded. To end, each participant answered a questionnaire to express their satisfaction regarding the software. There were no statistically significant difference between the software when compared to the accomplishment rates of tasks and the time spent by participants on each one. The software were evaluated as "slightly satisfactory" in several criteria. There is scope for optimization of orthodontic software by manufacturers since lack of their interface usability can discourage orthodontists' adherence to new resources that could provide benefits to their daily routine, even if they are freely available.

**Keywords:** Dental Models. Orthodontics. Technology. User-Computer Interface.

**1. Introduction**

Digital resources can be observed in the orthodontic diagnostic and planning stages, where digital models tend to gradually replace plaster models, and bring with them benefits regarding its storage, automation of procedures and ease of sharing (Horton et al. 2010; Aragón et al. 2016; Rossini et al. 2016). Digital models can be produced by scanning dento-alveolar structures. This scan generates a digital file that needs specific software for visualization and that, for the most part, can be exported in STL (Standard Triangle Language) format. However, these programs generate significant costs for orthodontists (Camardella and Vilella 2015; Burhardt et al. 2016; Colombo et al. 2018). On the other hand, there are free software available on the Internet that allow the visualization of digital orthodontic models since they are provided in STL format. Although STL is not yet standard format among software used in the study of orthodontic models, it allows users to overcome the cost barrier, identified as a main factor of non-adherence to digital resources by professionals (Zande et al. 2013; Matthews et al. 2016; Park and Laslovich 2016; Jacox et al. 2019). In this way, orthodontists need only worry about what software satisfies their workflow.

Many factors may influence software use satisfaction, efficacy and efficiency: the number of actions necessary to achieve a goal (Bauer et al. 2018); previous experience with a software (Seifert et al. 2017);

receiving prior education or training and affinity with technology (Weinerth et al. 2014); provision of feedback by the software (Wozney et al. 2016); consistency between buttons/icons and actions (Joe et al. 2015); user-friendly interface with readable fonts (O'Malley et al. 2014); presence of fewer options in software interface (Grindrod et al. 2014); compatibility with operating system (Asarbaksh and Sandards 2013); chance to correct errors made during software use without losing what has already been done (O'Malley et al. 2014); perception of practical utility of a software (Simblett et al. 2018).

Usability is the attribute that evaluates how easy to use the software is, containing three dimensions: efficacy, efficiency and satisfaction of use (ISO 2018). To employ new technologies in daily work could represent a barrier for professionals, weighed as a factor of choice against the possibility of not using them (Burzynski et al. 2018; Livas et al. 2019). Few studies (Westerlund et al. 2015; Wan Hassan et al. 2016; Felter et al. 2018) have evaluated the usability of software related to digital models in Orthodontics and, mostly, they do not consider professional use satisfaction. Thus, the aim of the present study is to fill this gap in literature, by means of an evaluation of the usability of two free softwares.

## 2. Material and Methods

This is a cross-sectional and qualitative study in which 80 orthodontic graduate students from five educational institutions were invited to perform three tasks in a unique digital model using two different softwares. Subsequently, participants were invited to respond to a scaled questionnaire, based upon ISONORM 9241 (ISO 2018), expressing their satisfaction with the experience in each.

In the present study, only those participants who had previous contact with model analysis content were included. Those who did not, or those who had prior experience with three-dimensional orthodontic digital models, were excluded. In addition, for each variable we performed a sample size calculation based on data collected in a pilot test. A study power of 80%, 95% confidence interval and significance level of 5% were considered. The highest value obtained was used.

The present study was approved by a local Research Ethics Committee. Study participants, as well as educational institutions, consented to participate in this research.

### Software selection

Software selection was based upon an electronic literature research in which 71 papers discussing linear measurements in digital models with at least one software were found, totaling 17 different software. We aimed to select only those which were freely available and that read STL universal format, finishing with two software selected: A - 3D Viewer<sup>®</sup> (3Shape, Copenhagen, Denmark) and B - 3D-Tool<sup>®</sup> (GmbH & Co. KG, Weinheim, Deutschland).

### Description of tasks requested from participants

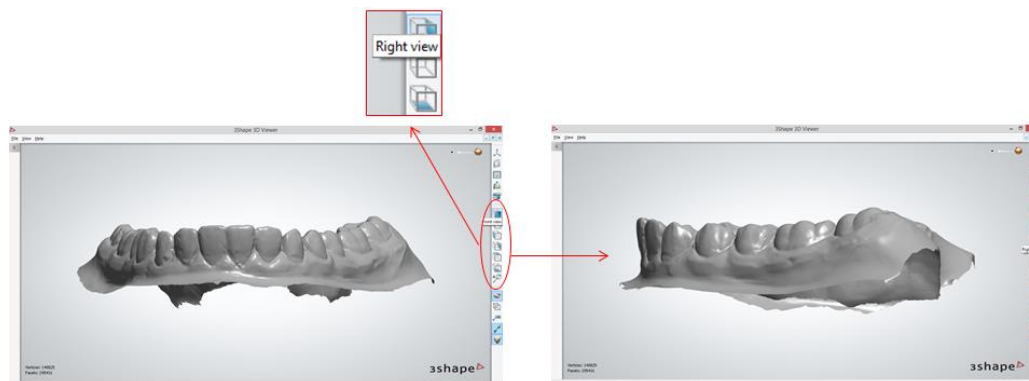
Three tasks were devised, reflecting common orthodontic practices. They were: manipulation of a model in lateral view (task 1 - figures 1 and 2); tool identification for linear measurement (task 2 - figure 3); and measurement of the mesio-distal diameter of teeth, from first molar to first molar (task 3 - figure 4). No previous instruction was given to participants in tasks 1 and 2. A time limit of 30 seconds was established for tasks 1 and 2 whereas, in task 3, there was no time limit. All the tasks started with a digital model opened in the initial screen of each software. The success rates, as well as the times spent in each task, were noted.

### Data analysis

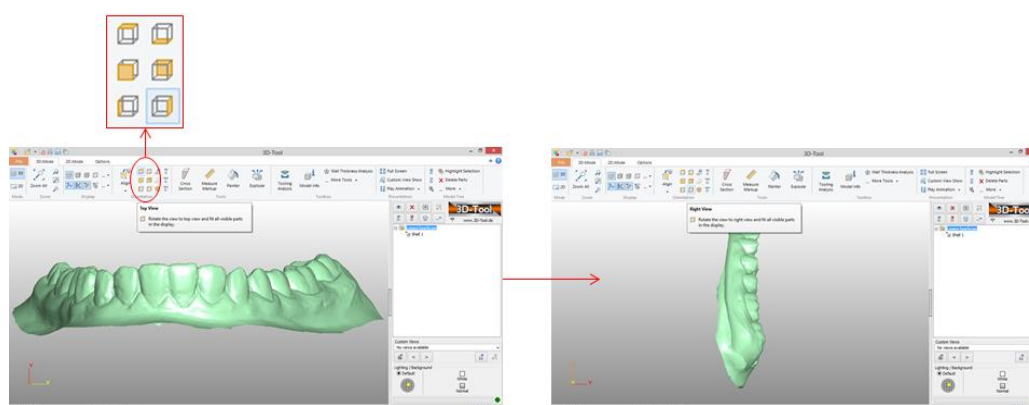
Participants' profiles were described in terms of gender, age, number of hours spent on computer *per week* and number of orthodontic patients attended monthly. Collected data were tabulated in Microsoft Excel and analyzed through SPSS program (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0, Armonk, NY: IBM Corp.). Success rates in accomplishing the tasks were compared between Software A and Software B groups using McNemar test; and times spent in each task were compared by *t test*. Statistical analysis considered a level of significance equal to 5%, a study power equal to 80% and 95%

confidence interval. A Kolmogorov-Smirnov test was also performed to evaluate the normality distribution of samples.

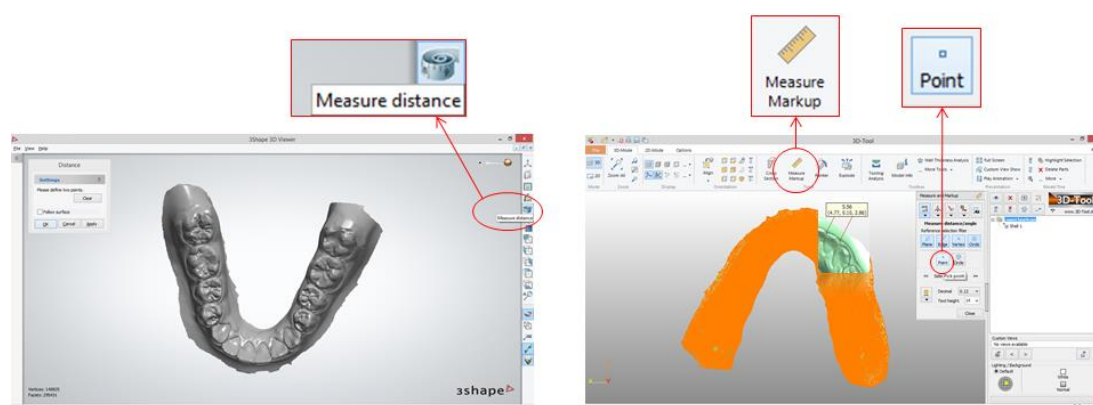
Answers obtained in questionnaires were analyzed in a quanti-qualitative way. In order to facilitate a comparative view of responses, scores from 1 to 7 were assigned to each question and mean values, as well as standard deviation, were obtained. It was also assigned a category for each score, which made it possible to describe data categorically (1 - very bad; 2 - bad; 3 - slightly bad; 4 - Neutral; 5 – slightly satisfactory; 6 - satisfactory; 7 – very satisfactory).



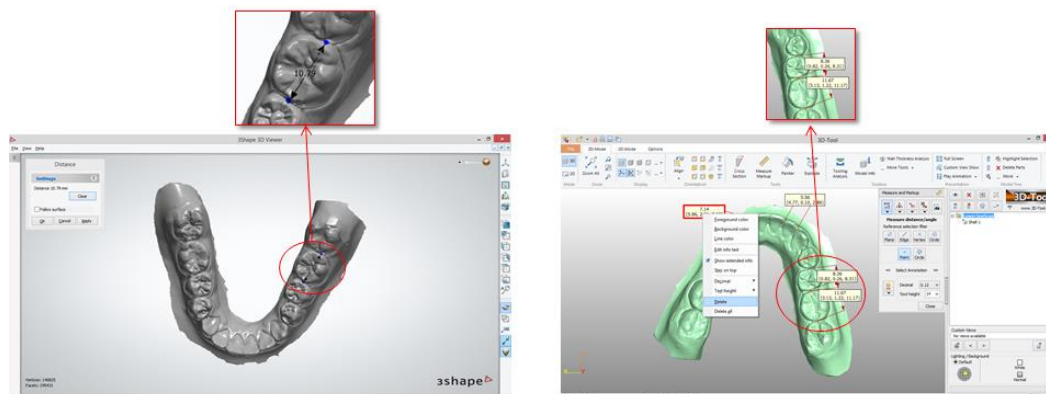
**Figure 1.** Initial view of the model (software A) and indication of the icon where participants could click to complete task 1, in addition to being able to click-hold-drag the model.



**Figure 2.** Initial view of the model (software B) and indication of icons where participants could click to complete task 1, in addition to click-hold-drag model.



**Figure 3.** View of software A and B immediately after tool selection to perform measurements (note the arrow pointing to a second bottom-click required in software B in order to remove the distortion caused in the model by the first click).



**Figure 4.** Marking of points for measuring linear distance in softwares A and B (note the presentation of the points marked in the model image and the button to "clean" marked points allowing to mark new ones).

### 3. Results

109 graduate students in Orthodontics were invited to this research. Of these, 29 refused to participate ( $n = 80$ ). Participants were between 22 and 48 years of age (mean 28.7; standard deviation 6.2), 14 men (17.5%) and 66 women (82.5%). Regarding time of computer *per week*, responses ranged from zero (43, or 54% of participants) to forty hours (1 participant; mean 5.1, standard deviation 8.2). Among those who did it for at least one hour *per week*, an average of 1 (+ -2) software were reported. Participants also reported how many orthodontic patient attendances they performed monthly. Responses ranged from zero (27, or 34% of participants) to five hundred (53, or 66% of participants), with a mean and standard deviation of 52 +- 91 monthly patients.

Table 1 and table 2 show the results obtained, in terms of efficacy (completeness of tasks) and efficiency (times spent in each tasks) for both groups (Software A and Software B). In Task 3, which consisted in measuring mesio-distal diameter of teeth, all participants could complete the task, once instructions were given.

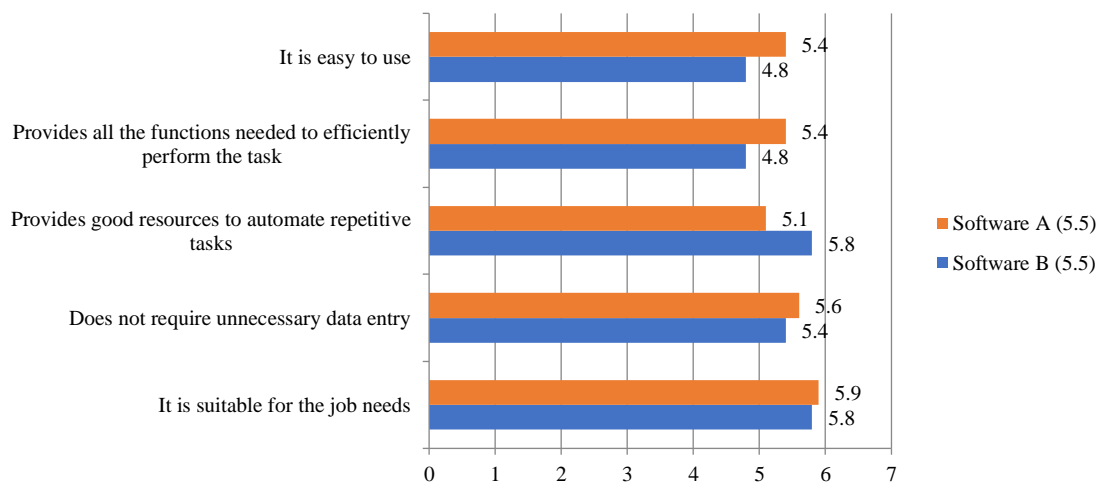
Questionnaires answers are presented graphically (Figures 5-11). Bars refer to average scores obtained in each question (maximum value = 7). The average score of each group precedes the software names.

**Table 1.** Completeness of tasks (efficacy) by the participants.

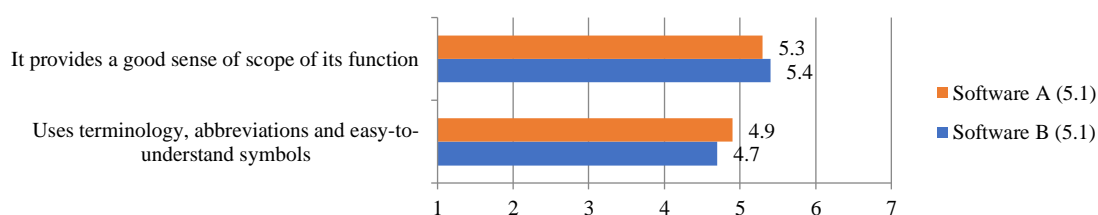
	Software A		Software B		p value
	Yes	No	Yes	No	
Task 1	80%	20%	86.3%	13.7%	0.345
Task 2	52.5%	47.5%	33.8%	66.2%	0.163
Task 3	100%	0	100%	0	-

**Table 2.** Mean value and standard deviation for time spent (s) in tasks and teeth measurements (mm).

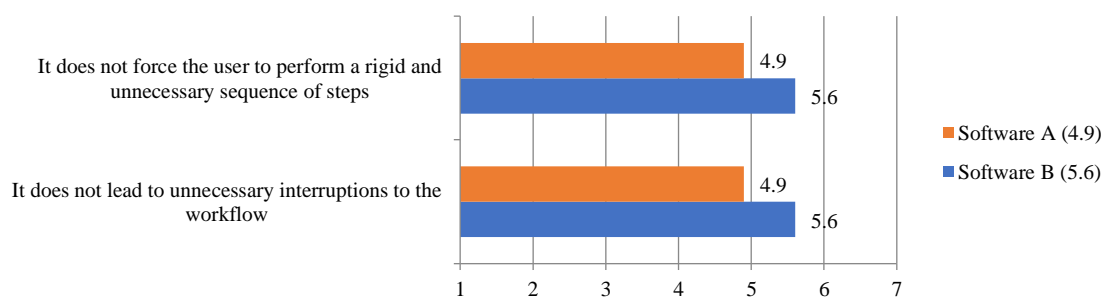
	Software A	Software B	p value
Time spent for task 1	17.7 (9.4)	15.9 (9.4)	0.191
Time spent for task 2	22.8 (9.7)	25.7 (7.5)	0.252
Time spent for task 3	112 (39)	108 (48)	0.553
Min. and max. values	66 e 249	50 e 257	-
Dental measures (first molar to first molar diameters)	89.21 (5.3)	86.8 (9.5)	0.798
Min. and max. values	72.8-110.3	75.2-120.3	-



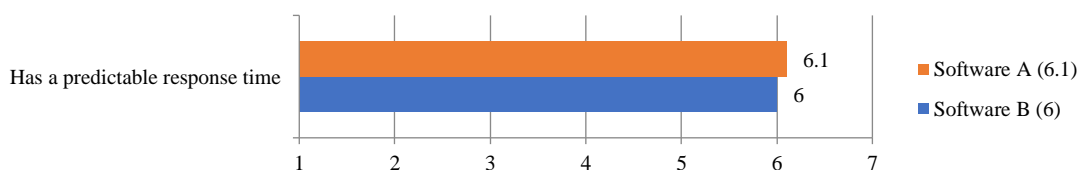
**Figure 5.** First group of questions: adequacy to the task.



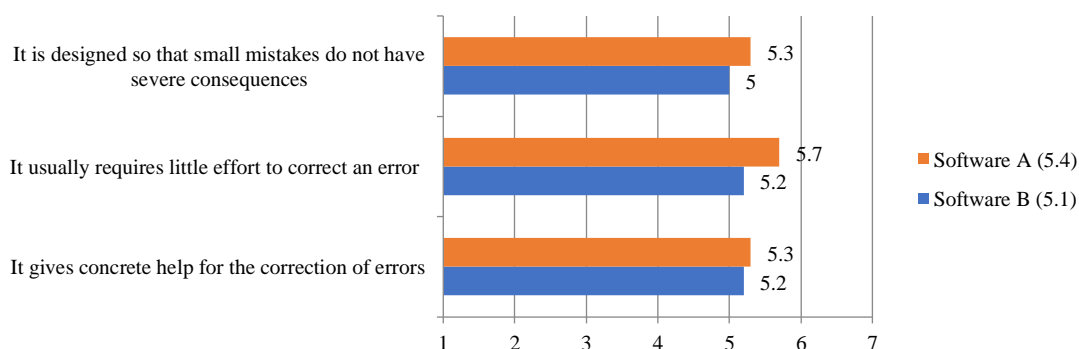
**Figure 6.** Second group of questions: self-description.



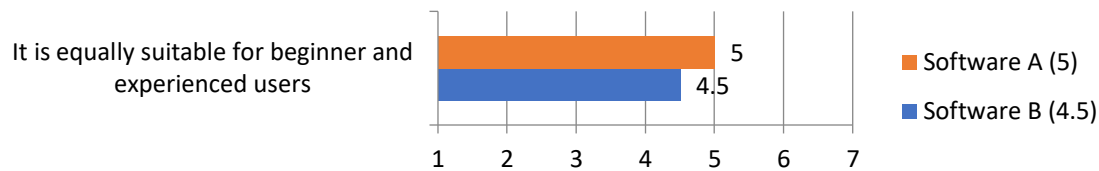
**Figure 7.** Third group of issues: controllability.



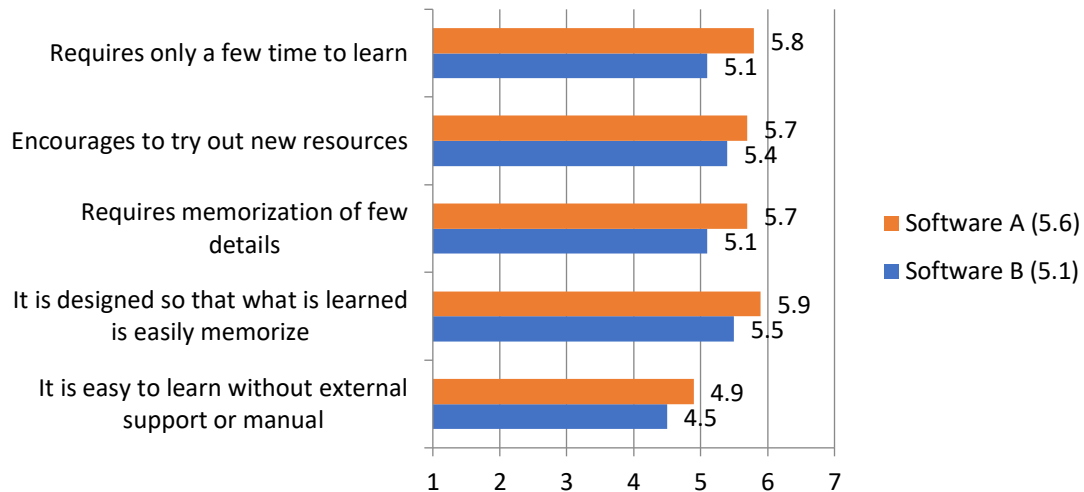
**Figure 8.** Fourth group of questions: compliance with user expectations.



**Figure 9.** Fifth group of questions: errors tolerance.



**Figure 10.** Sixth group of questions: support for individualization.



**Figure 11.** Seventh group of questions: appropriateness to learning.

#### 4. Discussion

Software A (3D Viewer<sup>®</sup>) and B (3D-Tool<sup>®</sup>) were evaluated for their usability. Efficacy, which referred to the ability of participants to complete three pre-selected tasks, was tested with most participants achieving desired results in both softwares, except for Task 2 in Software B. The ability to click-and-drag a model would be more intuitive than the other options to accomplish this task (Westerlund et al. 2015), however, difficulties were observed. The first difficulty was in relation to the mousepad, which was also observed in a usability test carried out by Joe et al. (2015). Handling it was relatively difficult for some users, so that small movements could cause undesired turns in model position. In addition, in software A, the clicking-and-dragging model should be done with the mousepad's right button. Also, it became evident that some participants did not relate buttons / icons / texts to their actions, since both software were evaluated as "slightly satisfactory" in understanding their interfaces. Westerlund et al. (2015) compared four softwares for usability and also reported difficulties for their participants to locate desired functionalities due to this discrepancy. This also illustrates that there is a divergence between what a button represents and what its action generates. This creates confusion during its use (Richardson et al. 2017).

Another important factor to remember is that, in the present study, none of the software had native participant's language as an option. While technology taught in orthodontic courses is analog (Shastry and Park 2014), this adaptation is not likely to be prioritized by manufacturers. In order to improve user satisfaction in orthodontics, the language needs to be considered. Facing difficulties in performing basic necessary tasks could cause stress and frustration in professionals (De Góes et al. 2015; Roman et al. 2017), reducing their motivation to use digital models, even if there is no additional workflow cost.

When software efficiency was evaluated, no significant differences were observed. For Grunheid et al. (2014), differences between 20 and 25% would be relevant. However, this parameter reinforces a similarity between software A and B (a delay of approximately 2 minutes per arc). It is worth noting that no statistically significant differences were found between measures obtained in the studied software, although, in software B, the largest measure, 120.33mm, was obtained, compared to 110.32mm in software A. It would also be possible to relate this difference to unfriendly software interfaces, once it is realised that they reduce professional chances to make mistakes while using them in order to obtain good user

satisfaction. The possibility of fixing mistakes with little effort was considered "slightly satisfactory" for both softwares, with a worse evaluation of software B.

The two software had a predictable response time; that is, as soon as participants performed an action, such as two-point marking, they instantly obtained a response, such as a tooth measurement. That was a better perceived characteristic in both softwares. When there is slow interaction within a software, a professional may believe that his or her action did not work and seek other, ineffective, ways to achieve a desired goal (Joe et al. 2015). This workflow breakdown can generate errors, preventing tasks (O'Malley et al. 2014). However, this has not happened in any software.

In evaluation of software support for individualization, neither software was considered totally satisfactory to be used by people with different levels of knowledge, a finding that corroborates several authors (Westerlund et al. 2015; Seifert et al. 2017), who also reported greater ease of use by more experienced users. Finally, software A was considered "satisfactory" in relation to the estimated time to learn how to use it. It was also considered "satisfactory" in relation to: encouragement of experimentation of its functionalities; amount of detail needed to be memorized in order to repeat a task; and ease of use in general. Meanwhile, software B was considered "slightly satisfactory", demonstrating greater satisfaction of use for software A in this group of questions.

Training software users proves to be fundamental for their use in a faster and safer way (Weinerth et al. 2014; Seifert et al. 2017). Even so, it is important to be aware that not every professional is available to overcome a new learning curve, even if the software are freely available. It is possible that a replacement of plaster models with digital models occurs only when post-graduate courses in Orthodontics begin to teach, primarily, a digital workflow. This would reduce the learning curve and generate greater awareness that this format also meets the needs of orthodontists.

In this context, it is necessary to consider that it is not always the case that what seems more technological or advanced is therefore necessary. Software can be perceived differently by different users. It is up to each professional to choose those tools that are more satisfactory within their own workflow, as well as respecting two essential criteria for using a diagnostic resource: accuracy and reliability, already proven for digital orthodontic models (Rossini et al. 2016).

## 5. Conclusions

The two software evaluated were considered slightly satisfactory for use in six of seven evaluated criteria. It is suggested that manufacturers provide adequate training to professionals, as well as optimize software interfaces in order to improve their use experience.

There is a strong need for testing software with potential users before they are released, and predicting possible problems or difficulties. Doing this could encourage orthodontists' adherence to new resources, and this would give benefits to their day to day routines, even if they are freely available.

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