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Validation Findings of CAT-LC Scale in Evaluating Factors Affecting Clinical Competency Attainment and Teaching-Learning Changes during the COVID-19 Pandemic

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ABSTRACT

The COVID-19 pandemic has posed challenges and resulted in disruptions in clinical teaching and learning. A tool named Competency Attainment Teaching-Learning Changes (CAT-LC) Scale was recently designed to evaluate the perceived clinical competency attainment and changes in the teaching and learning methods in postgraduate orthodontic training in Malaysia amid the COVID-19 pandemic. The CAT-LC Scale consisted of 65 carefully designed items, which were grouped into 7 domains. Its primary objective was to quantitatively evaluate the impact of the pandemic on the modifications in teaching and learning practices and their effects on residents' perceived level of clinical competency. Each item was rated using a 4-point relevancy score. A content validation (CV) was conducted with assessments by six orthodontic experts. The items achieved an Item-Content Validity Index (I-CVI) of at least 0.83, exceeding the minimum CVI requirement of 0.80. Subsequently, face validation was performed with 10 respondents to assess the acceptance and comprehension of the items from the perspective of prospective respondents. The Item-Face Validity Index (I-FVI) for all items surpassed the minimum FVI threshold of 0.80. The Cronbach's alpha values obtained for all domains in the pilot study ranged from 0.600 to 1.000. Based on the two substantial validity indices obtained from both content and face validation, and supported by reliability analysis showing Cronbach's alpha values within the acceptable range, it can be concluded that the CAT-LC Scale is a valid and reliable instrument.

Keywords: *CAT-LC, Validation study, Content validation, Face validation, Pilot study, COVID-19 pandemic, Orthodontics*

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INTRODUCTION

Transitioning to the "new normal" during and after the COVID-19 pandemic has presented substantial challenges across many sectors (1). The education system and health services are among those most significantly affected. While teaching activities have increasingly shifted to online platforms worldwide, it is crucial to acknowledge the indispensable value of in-person interaction in clinical teaching and learning (2).

Adopting alternative teaching method prompts an important question: Do students acquire the necessary skills and be competent enough to care for patients effectively in the future? In 2010, a systematic review conducted by Lahti et al. (3) found no statistically significant differences between groups with blended learning and traditional learning relating to nurses' or nursing students' knowledge, skills, and satisfaction. Nevertheless, blended learning and online education can serve as promising alternatives for future educational practices (4).

However, what about students' perceived competency? Do they believe that the COVID-19 pandemic has affected their level of competence? It is crucial to note that perceived competency or self-perception differs from the objective measurement of clinical competency. Despite the subjectivity being typically linked to self-perception in evaluating performance, it is recognised as a useful mechanism for identifying individual weaknesses and strengths (5). Gathering self-perceptions of competencies in postgraduate programs from alumni through questionnaires can be an effective way to identify the strengths and weaknesses of the programme (6).

These two questions formed the basis of the main objectives of a larger study, which aimed to determine whether the changes brought about by COVID-19 had any impact on postgraduate orthodontic training in Malaysia, particularly towards the (a) level of perceived competency among orthodontic residents; and (b) teaching and learning methods employed.

There was no specific scale specifically designed to measure the aforementioned outcomes. Therefore, it becomes critical to develop and validate a scale to ensure quality and reliability in measuring these effects. Hence, this article describes the process of development, followed by validation and reliability of the newly developed tool called Competency Attainment and Teaching-Learning Changes (CAT-LC) Scale, specifically designed to measure perceived competency attainment and changes in teaching and learning in postgraduate orthodontic training in Malaysia during the COVID-19 pandemic.

METHODOLOGY

This study employed a systematic scale-development methodology followed by rigorous validation procedures, including comprehensive assessments of validity and reliability.

The comprehensive methodology of the study is illustrated in Figure 1 and further described step by step.

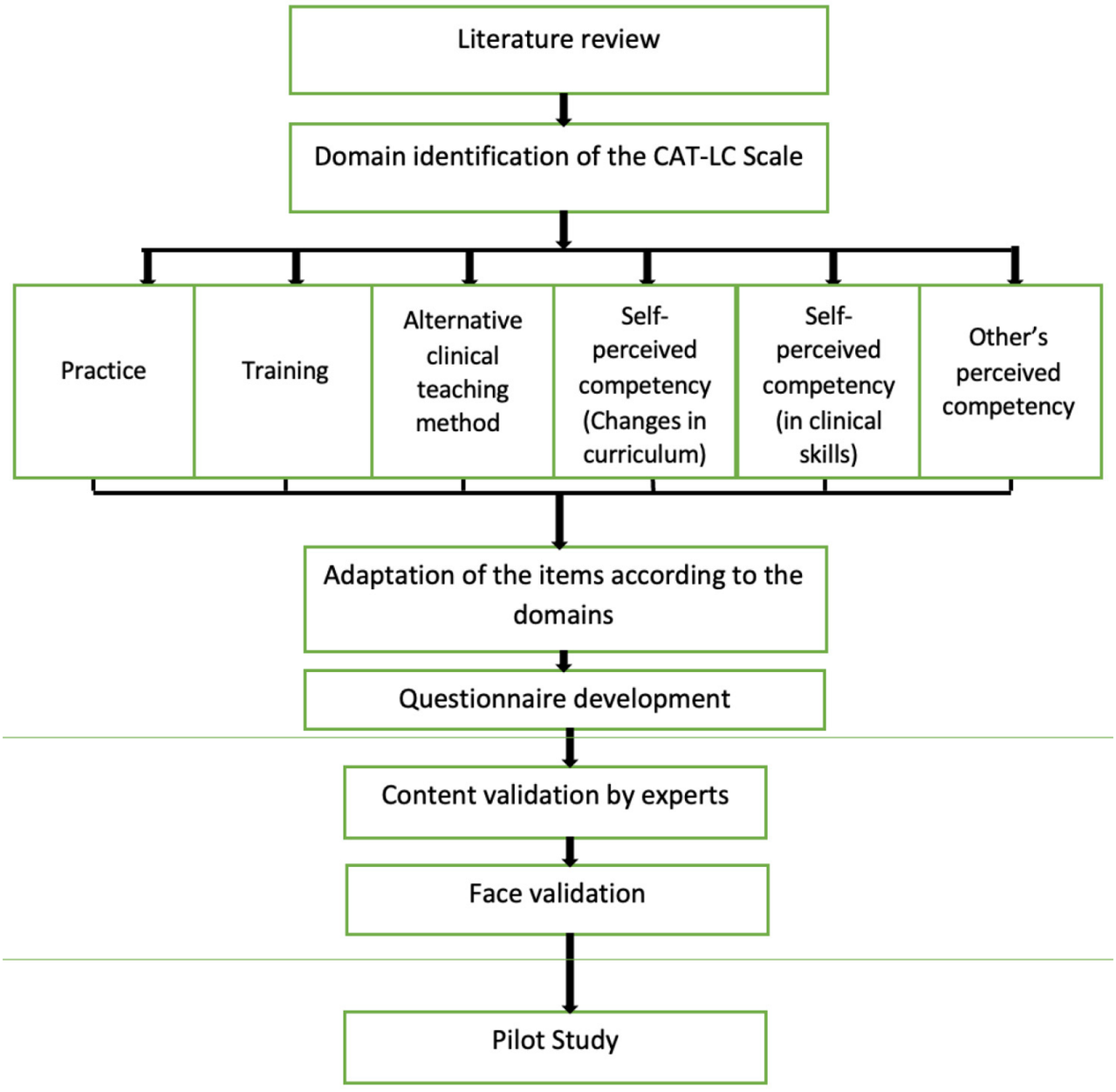

Figure 1: Flowchart of the CAT-LC Scale development, validation, and reliability process.

Step 1: Literature Review

Firstly, to develop the scale, a comprehensive literature review was conducted to ensure that all relevant literature was thoroughly examined. A structured search was performed in electronic bibliographic databases, including PubMed, ScienceDirect, Scopus, and Google Scholar, to identify pertinent peer-reviewed studies. Search terms focused on the effects of the COVID-19 pandemic on postgraduate clinical training, changes in teaching and learning methods, self-perceived competency, and alternative teaching and learning approaches. All retrieved articles were screened for eligibility. After removing duplicates 305 articles remained. Of these, 236 articles were excluded as irrelevant due to factors such as not being written in English or published over 25 years ago. An additional 29 articles were excluded because their outcome measures were not applicable to this study despite their relevance to COVID-19, including those focusing on emotional well-being and infection control.

A total of 40 articles met the inclusion criteria and included in the review. These studies were summarised, appraised, and narratively reviewed for their findings.

Step 2: Domain Identification

Based on the literature review and aligned with the two main objectives of the study, seven domains were established, guided by the conceptual framework of the study. The domains are as follows:

a. Demographic: Background of the respondents.
b. Practice: Effect of the COVID-19 pandemic on the orthodontic practice.
c. Training: Agreement of the respondents on the changes in training during the COVID-19 pandemic.
d. Alternative clinical teaching method: Effectiveness of the alternative clinical teaching methods used during the COVID-19 pandemic.
e. Self-perceived competency: Agreement on changes in curriculum due to the COVID-19 pandemic and their perceived impact on clinical competency.
f. Self-perceived competency in clinical skills: Confidence level in clinical skills management.
g. Other perceived competency: Agreement on how the COVID-19 pandemic affects the residents' performance, and changes in teaching-learning from the lecturers' or administrators' point of view.

Some domains were considered suitable for adoption from previous studies, while a few had to be designed from scratch. Out of the 40 articles reviewed, 5 articles were identified for initial domain adoption, as listed in Table 1 (7–11).

Table 1: Articles with their adaptation

Questionnaire	Domain adopted
COVID-19-related experience, knowledge, attitude, and behaviours among 2,669 orthodontists, orthodontic residents, and nurses in China: a cross-sectional survey (8)	Domain: Practice
Effect of COVID-19 on surgical training across the United States: a national survey of general surgery residents (9)	Domain: Training
Impact of COVID-19 on postgraduate teaching in orthopaedics in India (10)	Domain: Alternative teaching-learning methods
General self-efficacy and self-perceived confidence of dental students in performing orthodontic clinical skills (11)	Domain: Self-perceived competency
Coronavirus (COVID-19) outbreak: perception of health risks among clinical dental educators (12)	Domain: Others' perceived competency

Another subdomain for psychomotor skills under "Self-perceived – clinical" was derived from the Doctor in Orthodontics programme standard, as outlined in the Malaysian Qualifying Agency Program Standard: Dental Specialities Edition 2019 (Standards for Doctor in Orthodontics) (12).

Step 3: Development of the Items and Designing the CAT-LC Questionnaire

Items were developed by the researchers either through adaptation from questionnaires or were newly designed. All items were written in English and were not translated.

Section E(ii) was based on the Malaysian Program Standard: Dental Specialities Edition 2019 (Standards for Doctor in Orthodontics), which outlines the skills that residents must acquire during their training (PROGRAMME STANDARDS: DENTAL SPECIALTIES, n.d.).

4-point Scale: As the questionnaire is designed to be self-administered, the items must be written in a manner that is easily understood by the majority of respondents. The scale items were decided to be closed-ended questions with a 4-point scale. The 4-point Likert scale used in this study was adapted from James Dean Brown's framework, which aims to encourage respondents to express a clear view by providing an even number of response options (for example, four options such as 1, 2, 3, and 4), where they must select either a positive or negative response (13). The selection of a 4-point Likert scale helps avoid neutral responses from respondents that may affect future results and is applicable across all domains.

The 4-point Likert scale was used throughout the domains (with the exception of the demographic section), with variation of responses to suit the nature of the constructs within each domain.

Step 4: Validation of the CAT-LC Scale (Content Validation)

To ensure that the scale is both viable and reliable to measure the intended objectives, it is essential for this new questionnaire to undergo a validation process (14). During the content validation phase, the number of experts involved can influence the acceptable cut-off score for the content validation index (CVI). According to Davis (15), by having at least two experts evaluate the measured items, the acceptable CVI value should be at least 0.80 (15).

The finalised version of the CAT-LC Scale was sent to six orthodontist experts to review the relevance of the items concerning perceived competency attainment during the COVID-19 pandemic. The criteria for choosing the experts were as follows:

a. Orthodontists with more than five years of experience in the orthodontic field after graduating from the specialist training.
b. Willing to participate.

All the experts were invited via an official email and were provided with an online Google Forms to complete. Content validation was conducted through Google Forms, which included seven domains. The experts were asked to rate the relevance of 65 items on a 4-point scale for the content validation: 1 = item is not relevant to the measured domain; 2 = item is somewhat relevant to the measured domain; 3 = item is quite relevant to the measured domain; and 4 = item is highly relevant to the measured domain (14, 16). In addition to rating the items, they were instructed to provide written comments on any items that needed modifications or did not appear relevant to the study. The CVI was calculated based on the following parameters:

a. Item-level content validity index (I-CVI): The proportion of content experts giving an item a relevance rating of 3 or 4.
b. Scale-level content validity index (S-CVI): The average of the I-CVI scores for all items on a scale.

Any suggestions put forward by the experts were taken into account.

Step 5: Validation of the CAT-LC Scale (Face Validation)

Once the content validation reached a satisfactory level of validity, the Face Validation Form was conducted, ensuring the items of each domain are relevant and appropriate to the respondents. In order to preserve the actual population for the later stage of the study, face validation was done with the non-orthodontic residents with adequate orthodontic attachment to understand the questionnaire. The primary goal of this face validation was to ensure the instructions and language used could be easily understood by the respondents. Raters' understanding and interpretation of the items determined the precision of the scale item in measuring the targeted construct. Mahadi et al. (17) had set the cut-off score of face validation index (FVI) to be at least 0.80 of the acceptable value.

Subsequently, the CAT-LC scale was sent to the panel for face validation, with a minimum of 10 panellists. The criteria of the panellists selected were determined to be:

a. Residents in speciality training other than orthodontics who had exposure to orthodontic attachment during their First Year Dental Officer (FYDO).
b. Willing to participate.

Panels were required to judge the clarity of this item. They were requested to rate it according to the recommended 4-point scale (1 = item is not clear; 2 = item is somewhat clear; 3 = item is quite clear; and 4 = item is highly clear). They are highly encouraged to provide comments in each domain section for future review and modification. The FVI was calculated based on the following parameters:

a. Item-level face validity index (I-FVI): The proportion of test respondents giving an item a clarity rating of 3 or 4.
b. Scale-level face validity index (S-FVI): The average of the I-FVI scores for all items on a scale.

Step 6: Internal Construct (Pilot Study)

Continuing from the content and face validation, the final version of the CAT-LC Scale was distributed to seven orthodontic residents using an online Google Forms to assess the feasibility of the items for a larger study scale in the future. The decision to involve seven residents was based on the sample size of the study, which was ultimately determined to be 52 participants. The criteria of the residents selected were:

a. Residents of the orthodontic postgraduate training programme (Year 1).
b. Willing to participate.

The current study utilises reliability analysis to assess the internal consistency of the CAT-LC Scale, represented by Cronbach's alpha coefficients. Generally, scales with a Cronbach's alpha greater than 0.60 are considered to have an acceptable level of internal consistency (18).

RESULTS

The Domains and Items of the CAT-LC Scale

A total of 65 items in the English language were generated and subcategorised into the seven domains. These items were rated with a 4-point scale with variation to suit each domain. There were some suggestions to rephrase certain items for better understanding, but none were deemed necessary for removal.

There were seven domains being identified through the adaptation of previously published questionnaires. Table 2 outlines each domain used in the scale and the definition of each domain, and explains how it is measured using a 4-point Likert scale.

Table 2: Identified domains, constructed items, and measurement using a 4-points Likert scale

Section	Items	4-point Scale	Description
Section A: Demographic	1. Age 2. Gender 3. University/institution 4. Profession 5. Years of orthodontic practice (including postgraduate education period) 6. Highest academic degree 7. Setting of your institution	Not applicable	Demographics is used to get background data.
Section B: Practice	8. During the COVID-19 pandemic, are your clinical hours affected? 9. Are your clinical sessions/schedules affected by the COVID-19 pandemic? 10. Do you think the number of patients attended during this pandemic is affected? 11. Are your cases of patients affected during the pandemic? (Fewer new cases, more emergency cases) 12. Does COVID-19 affect the status of orthodontic services in your institution?	No effect (0%) Minor effect (< 25%) Moderate effect (> 25%) Major effect (> 50%)	Definition: Delivery of high-quality, safe clinical care by clinicians, in compliance with clinical policies and performance standards, and in the best interests of patients (19). The literature indicates that clinical practice during the COVID-19 pandemic was affected by a reduction in practice hours to control the outbreak.
Section C: Training	13. In response to COVID-19, my programme has reduced the clinical hours due to a smaller number of people who can be in the clinic. 14. During the COVID-19 pandemic, more administrative/dissertation work has been assigned to me. 15. More work is delegated through redeployment to another department in my institution. 16. I have attended to/treated more cases on average per week prior to the COVID-19 pandemic. 17. I have attended to/treated fewer cases on average per week during the COVID-19 pandemic. 18. I have been allocated more clinical days/sessions prior to the COVID-19 pandemic. 19. I have been allocated fewer clinical days/sessions during the COVID-19 pandemic. 20. There are changes to residents' clinical schedules (fewer clinical training sessions).	Strongly disagree Disagree Agree Strongly agree	Definition: A systematic approach to change one's attitude, awareness, ability, or actions through learning experiences to achieve success in a specific activity or set of activities. Its goal in the workplace is to help people improve their skills while still meeting the organisation's current and future needs (20). The literature indicates that training for the development of clinical and practical skills was disrupted during the COVID-19 outbreak, with reduced numbers of cases seen and less clinical training.

(*Continued on next page*)

Table 2: (*Continued*)

Section	Items	4-point Scale	Description
Section D: Alternative clinical teaching method	21. I feel that curriculum content delivery via online method/blended learning method is: 22. The effectiveness of blended learning in terms of increasing my clinical skills is: 23. The effectiveness of blended learning in terms of social competence is: 24. Teledentistry method as an alternative way to replace face-to-face clinical consultation is: 25. The alternative clinical teaching methods that are effective in increasing my clinical skills (in case of suspension of face-to-face clinical activities during the COVID-19 outbreak) are: ● E-learning ● Virtual lectures ● Online case-based discussions ● Small groups of virtual clinical simulations ● Educational videos	Extremely ineffective Ineffective Effective Extremely effective	Definition: Alternative education methods refer to "an educational process that facilitates teaching and learning" by using different teaching strategies to provoke interactions among people from various fields of social action (21). The literature shows that, in adaptation to the COVID-19 pandemic, alternative clinical teaching methods are replacing face-to-face teaching methods.
Section E (i): Self-perceived competency	26. I feel that my clinical skills in delivering orthodontic treatment to patient are affected due to the COVID-19 pandemic. 27. I feel that I will not meet the minimum case requirements on time for my training programme if the COVID-19 pandemic persists. 28. I feel comfortable and confident in graduating with the minimum case requirement. 29. I am concerned about how the changes in my postgraduate training due to the COVID-19 pandemic will make me less prepared for my future career as an Orthodontist. 30. I believe that my clinical skills are affected by all the changes made in my curriculum due to the COVID-19 pandemic 31. I have more face-to-face teaching methods in my educational curriculum compared to before the COVID-19 pandemic. 32. In my curriculum for the delivery of face-to-face teaching sessions, the fulfilment of social distancing requirements is required.	Strongly Disagree Disagree Agree Strongly agree	Definition: Perceived competence refers to a person's belief that he or she has the requisite skills to succeed and a person's assessment of his or her ability to plan and carry out the steps necessary to achieve specific outcomes (22). The literature shows that many post-graduate or undergraduate students feel less competent to practice due to changes in the curriculum during the COVID-19 pandemic.

(*Continued on next page*)

Table 2: (*Continued*)

Section	Items	4-point Scale	Description
	33. There is a decline in quantity & quality of the academic program following the COVID-19 pandemic (seminars, case presentations, didactic lectures, audits, etc.).		
	34. I need more clinical supervisions/exposures/trainings to perform any clinical task.		
Section E (ii): Self-perceived competency in clinical skills	**Diagnosis and Examination:**	Not confident to perform task unsupervised	Definition: Perceived competence refers to a person's belief that he or she has the requisite skills to succeed and a person's assessment of his or her ability to plan and carry out the steps necessary to achieve specific outcomes (22). The literature shows that many post-graduate or undergraduate students feel less competent to practice due to changes in the curriculum during the COVID-19 pandemic.
	I am able to:		
	35. Recognised the patient's problem and do the history taking.		
	36. Diagnose different classes of malocclusion.	Fairly confident to perform the task unsupervised	
	37. Diagnose malocclusion from vertical and transverse plane.		
	38. Grade and assess IOTN, complexity and outcomes.		
	Treatment planning:		
	I am able to:		
	39. Formulate a treatment plan and an alternative treatment plan based on the appropriate diagnosis.	Confident to perform the task unsupervised	
	40. Prescribe functional treatment at the right time.		
	41. Prescribe maxillary protraction treatment at the right time.		
	42. Detect the need for expansion treatment.		
	43. Perform space analysis.		
	44. Prescribe growth modification appliances.		
	45. Evaluate the limitations of orthodontic (camouflage vs orthognathic).		
	46. Decide on the adjunctive management with other disciplines.	Highly confident to perform the task unsupervised	
	47. Design and construct the appropriate retention appliances and regime		

(*Continued on next page*)

Table 2: (*Continued*)

Section	Items	4-point Scale	Description
	Management: **I am able to:** 48. Manage various types of malocclusions with different treatment mechanics and modalities. 49. Manage craniofacial anomalies and syndromic patients (CLP, craniosynostosis). 50. Handle infection control during treatment procedures. 51. Manage multidisciplinary cases. 52. Perform orthodontic treatment with a wide range of techniques and biomechanics. 53. Manage the orthodontic complications and iatrogenic effects (soft tissues and hard tissues damage).		
Section F: Others' perceived competency	54. I feel that the COVID-19 pandemic has negatively affected the postgraduate students' clinical skills and performance. 55. I support the temporary suspension of all clinical modules and supervisions until containment of the COVID-19 outbreak. 56. I believe that suspension of all the clinical activities during the COVID-19 outbreak will have an impact on the postgraduate students' clinical competency. 57. I believe that these alternative teaching methods can be applied in case of suspension of clinical activities during the COVID-19 outbreak: • E-learning • Virtual lectures • Online case-based discussions • Small groups of virtual clinical simulations • Educational videos 58. I think there is a difference in terms of competency between postgraduate students who graduated pre-COVID-19 pandemic and during the COVID-19 pandemic.	Strongly disagree Disagree Agree Strongly agree	Definition: Others' perceived competence is the extent to which a person feels others have the necessary attributes to succeed (22). The literature shows that there is some doubt regarding the competency of practitioners later in the career pathway, as competency attainment might be affected due to the COVID-19 pandemic.

Content Validity Index

Based on the calculations in Table 3, this instrument achieved a positive Scale-Level Content Validity Index/Average (S-CVI/Ave) of 0.97 and a Scale-Level Content Validity Index/Universal Agreement of 0.91. Therefore, it met the satisfactory level of content validity according to Yusoff et al. (14).

Table 3: Scale-Level Content Validity Index

ITEM	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	EA	S-CVI	UA
Q1–Q65	65	65	65	65	59	65	384	64.00	59
Proportion relevance	1.00	1.00	1.00	1.00	0.91	1.00		0.97	0.91

Note: EA = Experts in agreement; UA = Universal agreement

Face Validity Index

Based on calculations in Table 4, this instrument achieved a positive Scale-Level Response Validity Index/Average (S-FVI/Ave) of 0.89 and Scale-Level Response Validity Index/Universal agreement of 0.26. Therefore, it reached a satisfactory level of content validity according to Mahadi et al. (17), which is at least 0.80.

Table 4: Scale-Face Validation Index

ITEM	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	RA	S-FVI	UA
Q1–Q65	65	65	52	54	51	60	60	65	52	49	580	58.0	17
Proportion relevance	1.00	1.00	0.80	0.83	0.78	0.92	0.92	1.00	0.80	0.75	0	0.89	0.26

Notes: RA = Respondents in agreement; UA = Universal agreement

Reliability Analysis

The CAT-LC scale was distributed to the selected respondents for a pilot study, and the results are shown in Table 5. The practice subscale consisted of 5 items (α = 0.859). The training subscale consisted of 9 items (α = 0.732). The alternative clinical teaching methods subscale consisted of 9 items (α = 0.681). The self-perceived competency subscale consisted of 9 items (α = 0.814). The self-perceived competency in clinical skills subscale consisted of 19 items (α = 0.885), and the last subscale of others' perceived competency consisted of 6 items (α = 1.000).

Therefore, based on the reliability analysis using Cronbach's alpha with values between 0.600 and 1.000, it can be concluded that the CAT-LC Scale is suitable for assessing the perceived level of clinical competency attainment among residents in the orthodontic programme impacted by the COVID-19 pandemic (23).

Table 5: Reliability analysis (Cronbach's alpha value)

Domain	Cronbach's alpha	Cronbach's alpha based on standardised items	N of items
Domain B (Practice)	0.859	0.882	5
Domain C (Training)	0.732	0.758	9
Domain D (Alternative clinical teaching methods)	0.681	0.814	9
Domain E-i (Self-perceived competency)	0.814	0.787	9
Domain E-ii (Self-perceived competency in clinical skills)	0.885	0.888	19
Domain F (Others' perceived competency)	1.000	1.000	6

DISCUSSION

The newly developed scale with 65 items under 7 domains was based on literature and the intended objectives of the study. The items were subjected to various tests of validation, including acquiring expert evaluation of the tool content using CVI, face validation, and reliability analysis via a pilot study. During the content validation process, six orthodontic experts suggested some grammatical improvements and agreed with all 65 items, including the use of the 4-point scale option. None of the items was removed. The items scored at least I-CVI = 0.83, which surpassed the minimum value of CVI, which is 0.80. Following the content validation stage, face validation was conducted to assess the acceptance and understanding of future respondents. The I-FVI value was at least 0.80 for all the items, which met the minimum value of FVI, which is 0.80. The reported Cronbach's alpha values from the pilot study for the CAT-LC scale domains B, C, D, E(i), and E(ii) were: 0.859, 0.732, 0.681, 0.814, and 0.885, respectively.

A notable limitation of this study was the small sample size, attributed to the limited number of institutions offering postgraduate orthodontic training in Malaysia, namely Universiti Malaya, Universiti Kebangsaan Malaysia, Universiti Teknologi MARA and International Islamic University Malaysia. The total study population, including both residents and lecturers, was around 52. This small population restricted the sample size available for various stages of validity testing, underscoring the importance of maximising the value of each response collected.

Overall, the instrument development, validation process, and reliability analysis helped justify its validity and reliability. It contained two major inputs, which were clinical competency and teaching and learning changes. We believe that this instrument, together with the incorporation of the clinical element from the program standard, would fairly assess the clinical competency of orthodontic residents in Malaysia. With substantial validity indices obtained from content and face validation, and supported by reliability analysis of Cronbach's alpha values ranging from 0.600 to 1.000, it is evident that the CAT-LC Scale is relevant for use as a specific tool to measure clinical competency and teaching-learning changes, specifically for orthodontic residents in Malaysia. The advantage of having the scale in different domains is that it can be used according to the specific domain, making it more adaptable for future research or intended purposes.

CONCLUSION

The validation approach taken, along with substantial results and reliability analysis that yielded acceptable scores, leads to the conclusion that the newly developed CAT-LC scale is a valid, relevant, and reliable research tool for assessing the perceived level of clinical competency attainment and the teaching and learning changes among residents of the orthodontic programme affected by the COVID-19 pandemic.

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ETHICAL APPROVAL

Ethical approval for this study was obtained from the International Islamic University of Malaysia Research Ethics Committee (IREC) with IREC ID 2021-323.

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