

A Likert Scale Versus a Visual Analogue Scale and the Participant Response: A cross Sectional Study

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Abstract

This study aims to assess whether the VAS responses are as reliable as the Likert responses from the perspective of dental students. The preference of each scale and the influence of gender and level of education on the preferred format were also assessed.

This causal comparative quantitative study was conducted at the College of Dentistry (COD) at King Saud bin Abdulaziz University for Health Sciences (KSAU-HS) using a non-probability convenient sampling technique with all second, third and fourth year male and female dental students. The survey instrument used was the well-established course evaluation at KSAU-HS. The questionnaire was distributed at two different times to the same respondents with the different measurement scales. Participants who completed both formats of the survey were included. NCSS software (Version 20) © was used for data entry and analysis

Of the 244 participants invited to participate, 127 responded to both surveys yielding a response rate of ~52%. Comparing the Likert and the scroll bar responses, the equivalence threshold criterion (a minimum of 0.7 lower band of the 95% confidence interval for ICC) was met for all the scale/item scores, except for four of the 16 items. The estimated ICCs for the rest of the items ranged between 0.67 and 0.84. The measurement equivalence criteria was preserved for the overall ICC (0.854, 95% CI 0.793 – 0.897). The males were 2.9 times more likely to prefer Likert type responses than the females.

There was no conclusive evidence that either the VAS or the Likert scale was superior. However, when choosing a response scale type, it is important to consider the study objective and the context, including the type of study population, the construct being assessed during the development or modification of instruments and the study design.

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Introduction

Scales are widely used to evaluate subjective dimensions in questionnaires¹⁹⁻²²⁻²⁴⁻³⁰. The Likert scale and the Visual Analogue Scale (VAS) are two popular methods used by researchers for psychosocial measurements.

The Likert scale, introduced by Renin Likert in 1932¹⁸, is currently still the most popular response format used³. A typical Likert scale is a

5-7 point (category) scale that is frequently used in survey questionnaires where participants indicate their level of agreement or disagreement with a given statement¹⁸. Likert scales make the respondent specify his or her experience by selecting one graduated category from the category options, however, there are different opinions about the optimal number of response alternatives⁸. Although it is easier and simple to use³ and understand for the researcher and the respondent, particularly children, and the coding and interpretation are easy, it has some inherent limitations. One limitations is that the artificial descriptive categories are not sufficient to capture a continuous phenomenon¹⁴. The categories cannot be assumed to be equally spaced⁶.

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Problems inherent in the way respondents use the Likert scale are a tendency to rate an item too high or too low. The central tendency bias towards the neutral point to avoid an extreme response choice to escape from the outlying responses²¹ and proximity, which occurs when a respondent scores items that are close together similarly¹. In addition, the respondents are inclined to select the neutral or middle response categories or to provide extreme responses¹⁻¹⁰. These response styles will lead to a biased response, which prevent the respondents' true characteristics or traits from being obtained. Too many response categories may lead to difficulties in choosing and too few may not provide enough choice or sensitivity, forcing the respondent to choose an answer that does not represent the person's true intent²⁸. Finally, the total score from a multi-item Likert scale may be the result of many different combinations of ratings, which leads to a loss of information about the scale items.

Regardless of all the factors mentioned above, the classical reason behind the complexity of measuring social traits using any of the tools available, including Likert scales, can usually be traced back to statistical difficulties²³. For instance, although many researchers regard the Likert scale as an ordinal scale where the responses are ranked, the distances between each category or point on the scale remain immeasurable and are not necessarily equal, even if the numbers assigned to those categories are. The use of summed scores may lead to incorrect conclusions, such as response styles. The fact that they produce ordinal measurement data with an ambiguous number of response categories, prevent the accurate identification of the respondents' latent traits, and also adversely affect the use of statistical analysis methods and the subsequent results².

Alternatives to using a Likert scale are the use of a continuous line, track bar or VAS. This is typically presented as a horizontal line, anchored with two verbal descriptors at the extremes, and the respondents indicate their perceived status by placing a mark on the horizontal line at their chosen point²⁹. They have been developed to obtain measurements with more variability.

These scales offer a number of advantages over the Likert scales with regard to psychometric properties and are easy to

implement online¹⁷. They are easy to understand, administer, and score, especially when the VAS is implemented with a computer²⁹⁻³¹. VAS may provide interval-level measurements eligible for more statistical operations. The line continuum of a VAS enables the rater to make more fine-grained responses without the constraints of direct quantitative terms²⁹. The measurements are variable, which theoretically enhances their reliability⁴.

Despite the advantages of the VAS, researchers have not always reported positive results. Participants seem to experience difficulties to complete the scale, preferring to grade their responses closer to the edge of the line⁹. Historically, the VAS has not been widely used due to the practical limitations related to scoring⁵. Firstly, the researcher measured the distance from the mark to the origin of the line with a ruler, and transcribed the distance for data-entry. This was not only time consuming, but the process was prone to error¹². However, due to the recent advancements in technological capabilities, these limitations are negated by modern survey software and the location of the mouse click can be recorded with no extra effort by the researcher. Other criticisms included personal preferences⁷⁻⁹⁻¹¹, and elderly participants reported that the VAS required more time to respond to compared to the Likert scale¹⁵. Although these criticisms have been identified in literature, the documented benefits of the VAS scale outweigh the potential problems. Additional researcher training on the use of the VAS protocol can eliminate the potential problems.

Research comparing both scales in various fields of study, ranging from the psychosocial sciences to health sciences, had different results, dependent on the type of research done⁹⁻¹³⁻¹⁴⁻¹⁷. Some studies found that VAS users, with a scroll bar or slider tend to give slightly different responses compared to Likert users, though others reported no difference.

It is evident that there is a lack of consensus on which method is the most appropriate, which is also a problem for surveys to evaluate a course and satisfaction are considered. Different criteria led to different conclusions about the relative merits of the methods, and each method has its advocates.

This study aimed to assess whether the VAS responses are as reliable as the Likert responses from the perspective of dental

students. In addition, the preference of each scale and the influence of gender and level of education on the preferred format were assessed.

Materials and methods

This causal comparative quantitative study was conducted at the College of Dentistry (COD) at King Saud bin Abdulaziz University for Health Sciences (KSAU-HS). A non-probability convenient sampling technique was used with all second, third and fourth year male and female dental students. Participants who completed both formats of the survey were included.

A sample size of 128 participants with 2 observations per participant achieved 80% power to detect an intraclass correlation of 0.400 under the alternative hypothesis when the intraclass correlation under the null hypothesis is 0.200, using an F-test with a significance level of 0.05. The sample size calculation was done using PASS software 2020²⁰.

		n(%)
Gender	Male	65(51.2)
	Female	62(48.8)
Level	D1	46(36.2)
	D2	37(29.1)
	D3	44(34.6)

Table 1. Respondents Demographic Data.

The questionnaire used in the study was the well-established course evaluation survey instrument that is distributed annually to the students at KSAU-HS (Appendix: Table 1). The instrument is based on a traditional 5-point Likert scale of agreement with three sub constructs on help and support of learning, resources to support learning and evaluation of learning. The sub constructs contained 9, 4 and 3 positively written items respectively. The instrument was in the English language and based on a five-point scale, and each rating had a weight attached: strongly disagree (1), disagree (2), somewhat agree (3), agree (4) and strongly agree (5). The questionnaire used is provided in supplementary

table 1.

At week 10 of the first semester, all the second, third and fourth year male and female students enrolled in prosthodontics courses were requested to complete the course evaluation survey.

1. The course book was available



Figure 1. Scroll bar for item no.1.

The next day, the same sample was asked to complete the second survey. The measurement scale used a scroll bar (track bar) facilitated by the use of an online survey design application (Survey Monkey) (Figure 1). The scroll bar allows for the elimination of internal points keeping only the extreme categories on both sides to orient the participant to the direction of the trait measured. In addition, a small box on the side of the scroll bar shows a numerical value from 0-100 that correlates with the position of the pointer on the scroll bar.

To link and pair the two surveys for each participant, they each chose a random identification word prior to completing the first survey (example: redpencil1). Consequently, each participant was requested to use the same word for the second survey. This additional step enabled the comparison of the results in the analysis. After being exposed to both surveys, the participants were also asked to indicate their preferred survey format.

NCSS software (Version 20) © was used for data entry and analysis. Frequency and percentage were used to describe the gender and the educational level of the student. To convert the values obtained from the 5-point Likert scale (1-5) to be comparable with the values obtained from the scroll bar (0-100), the following formula was applied to the values obtained from scroll bar:

$$\frac{(\text{Likert scale score} - \text{min})}{(\text{max} - \text{min})} \times 100$$
 where "min" is the lowest score/sum score that a scale/index can assume and "max" is the highest.

The mean and the standard deviation were used to describe the final scores obtained from both scales. The Intraclass correlation analysis (ICC) was performed to assess the reliability between the Likert scale and the scroll

bar responses. A test with a P-value < 0.05 was considered significant. The internal reliability of the Likert indices was measured using the Cronbach alpha.

Results

Of the 244 participants invited to participate, 127 responded to both surveys yielding a response rate of ~52%. Table 1 displays the demographic data of the participants. The participants were equally distributed between gender and year level.

Table 2 presents the measurement equivalence, the mean (SD) for each scale or item score for each of the two measurement scales and the estimated ICC (95% CI). Comparing the Likert and the scroll bar responses, the equivalence threshold criterion (a minimum of 0.7 lower band of the 95% confidence interval for ICC) was met for all the scale/item scores, except for four of the 16 items. The estimated ICCs for the rest of the items ranged between 0.67 and 0.84. The lower limit for the 95% CI for the item related to the course conduct was 0.22 and for the knowledge of the instructor was 0.44. The measurement equivalence criteria was preserved for the overall ICC (0.854, 95% CI 0.793 – 0.897). The equivalence threshold criterion was met for 14 of the 16 items.

The psychometric properties of the scales: Internal consistencies for all three sub-constructs differentiated by response scale are displayed in Table 3. The internal consistencies were similar for both response scales.

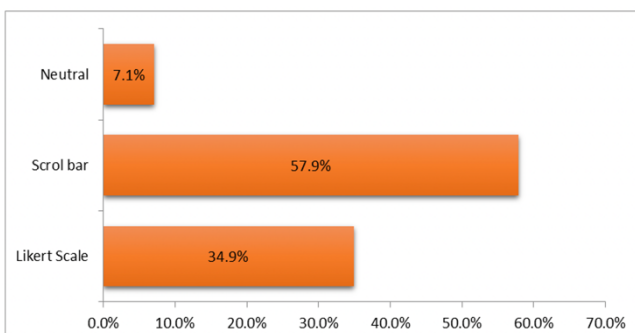


Figure 2. Respondents Preferred Survey Format.

Figure 2 shows the distribution of the participant preferred survey. Overall, 57.9% preferred the scroll bar to the 5-point Likert scale, 34.9% preferred the 5-point Likert scale, and

7.1% were neutral. There was a general tendency towards the scroll bar for gender and year level.

A logistic regression was performed to determine the effects of gender and year of study, on the preferred type of scale of the participants. The logistic regression model was statistically significant ($\chi^2(3) = 8.922, p < .05$). The model explained 9% (Nagelkerke R^2) of the variance in the preferred survey format and correctly classified 63.8% of cases. Gender ($p=0.008$) contributed significantly to the model but the level of the students did not add to the model. The odds of selecting a Likert scale, as the preferred survey format is 2.9 times greater for the males. The males were 2.9 times more likely to prefer Likert type responses than the females.

Discussion

The focus of the current study was to evaluate whether the changes in the scale type may change the participant responses. It follows the principal concern about the response methods, that the participant may respond differently to items when the question and response options are displayed differently. The difference in the response patterns could theoretically stem from the type of response options. In addition, participants could find it inconvenient to scroll and pick a response type to move to the next question quickly. For this reason, we examined the hypothesis that the type of response option, Likert response or scroll bar, can alter the participants' response pattern. In this study, the two versions showed a considerable overlap as indicated by the high ICC values between the scales. The internal reliability, mean, and SD did not differ much between the response scale versions. This finding is in line with literature reporting moderate to strong correlations between the VAS and Likert scales¹⁴⁻²⁵⁻²⁶.

However, all the Likert-scaled items resulted in a slightly lower mean satisfaction than did the scroll bar-scaled items, which is contrary to¹⁴⁻²⁷. The Likert scale and VAS Cronbach alpha reliability coefficients were identical and comparable to literature¹⁶.

The equality of the mean and SD suggests similar distributional properties of both response scale versions. The finding of equal SDs contrasts with previous research that found

a lower SD when implementing the VAS¹⁷. Possible explanations for this finding could be the difference between the assessed constructs and the difference in design. The present study investigated both response scales in a within-participant design, with the previous studies implementing between-participants designs.

In addition, there was a general tendency to choose the scroll bar as the preferred survey format. This is in contrast to studies where some respondents, for example children, preferred the Likert scale²⁵. Another study also reported the preference for a Likert scale, claiming that it better represented their participants' opinions and was easier and simpler to use⁷⁻¹¹. In contrast, Voutilainen et al.(23) compared the Likert scale and VAS to analyze patient satisfaction, and the results indicated that the VAS was less vulnerable, less confusing, and the response time was 28% less than the questionnaire using a Likert scale. They concluded that the VAS better characterized patient satisfaction because it presented fewer confounding factors for the examiner²⁷.

Although these criticisms have been identified in literature, the benefits of the VAS scaling outweigh the potential problems, and researcher training related to the use of the VAS protocol can eliminate the potential scaling problems. However, choosing a scale that is preferred by and more appealing to the participants may increase their willingness to participate in the survey. The scroll bar is only practical when using online digital surveys.

The strengths of the current study includes investigating both response scales in a within-participants design, previous studies implemented between-participants designs. The present study provided evidence of equal measurement when implementing the VAS compared to the Likert scale in a within-participants design. Additional research should be conducted to investigate other variables and establish the validity of VAS. Examining the impact of the length of the scale, including longer questionnaires, is also a possible direction for future studies. It should be noted, however, that the results with regard to external criteria only included the level of education and gender. This renders the interpretation of the results more difficult and presents several possible explanations.

Several limitations were identified in this

study. The main limitation was the generalizability of the results because the sample was non-random, comprising only the students. In addition, the study used a convenient sampling strategy. Another limitation is the scope of the study, with the findings attributed to the instrument that was used, the course evaluation survey. It is likely that the other survey types would yield similar results, which should be evaluated. In the study, the participant responses to a very short survey were examined. Most surveys are much longer. We did not measure the time taken to respond to the surveys. Future studies should examine what effect prolonged survey engagement has on the different scale type responses. It is important to note that the present study focus on course evaluation surveys. It is reasonable to constrain the implications of our results to the use of similar types of survey questions. To assess the course evaluation, the two scales can be used interchangeably to produce reliable results. An additional study investigating other aspects of instrument-related confounding factors and the effect this has on survey results is recommended.

Conclusions

Within the limits of this study, the Likert and VAS are both acceptable response scale options. There was no conclusive evidence that either the VAS or the Likert scale was superior. However, when choosing a response scale type, it is important to consider the study objective and the context, including the type of study population, the construct being assessed during the development or modification of instruments and the study design. Additional research should examine other personality measurements and validation criteria to examine possible moderator effects.

Declaration of Interest

The authors report no conflict of interest.

	Likert	VAS
Help, support and learning	0.88	0.88
Resources to support learning	0.79	0.77
Evaluation of learning	0.73	0.75

Table 3. The Cronbach alpha of the Evaluation scales by response format.

Comparison	Likert	Scroll bar	ICC	Confidence interval
The conduct of the course were consistent with the course outline	78.15 (22.68)	80.63 (19.05)	0.457	0.220 - 0.622
Instructors were committed	76.47 (24.64)	81.64 (21.93)	0.718	0.593 - 0.805
Instructor(s) had thorough knowledge of the course content	83.40 (23.98)	88.03 (18.11)	0.615	0.448 - 0.731
Instructor(s) were available to help me during office hours	69.33 (25.51)	74.39 (25.89)	0.788	0.693 - 0.854
Instructor(s) were enthusiastic about what they were teaching	78.57 (23.54)	80.65 (21.63)	0.754	0.647 - 0.829
Instructor(s) cared about my progress and were helpful	69.96 (26.56)	70.74 (28.48)	0.764	0.660 - 0.836
Course materials were up to date and useful	74.79 (25.32)	78.30 (22.74)	0.785	0.691 - 0.850
Resources I needed in this course were available when I needed them	76.05 (23.56)	81.24 (23.35)	0.776	0.673 - 0.846
Effective use was made of technology to support my learning.	66.60 (28.79)	70.40 (26.86)	0.818	0.738 - 0.873
I was encouraged to ask questions and develop my own ideas.	74.58 (24.57)	73.87 (26.19)	0.735	0.619 - 0.816
I was inspired to do my best work	73.32 (27.18)	74.05 (27.69)	0.767	0.665 - 0.838
The things I had to do in this course ,activities, assignments, laboratories, were helpful for developing the knowledge and skills the course was intended to teach	74.16 (24.12)	77.62 (21.39)	0.672	0.529 - 0.771
The amount of work I had to do in this course was reasonable for the credit hours allocated	61.97 (29.80)	67.09 (27.18)	0.840	0.766 - 0.890
I was informed of my assignments' and tests' results in this course within reasonable time	71.22 (27.16)	78.68 (24.91)	0.787	0.672 - 0.858
Grading of my tests and assignments in this course was fair and reasonable	64.71 (28.82)	72.09 (28.04)	0.788	0.678 - 0.858
The links between this course and other courses in my total program were made clear to me	73.74 (24.97)	80.73 (21.33)	0.672	0.518 - 0.775
Overall score	72.93 (17.93)	76.81(18.09)	0.852	0.777 - 0.901

Table 2. Intraclass Correlation Coefficient (ICC) analysis between Likert scale and scrollbar responses.

Q #	Question Text	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	The conduct of the course and the things I was asked to do were consistent with the course outline					
2	My instructor(s) were fully committed to the delivery of the course ,E.g. Classes started on time, instructor was always present, material well prepared, etc					
3	My instructor(s) had thorough knowledge of the course content.					
4	My instructor(s) were available to help me during office hours.					
5	My instructor(s) were enthusiastic about what they were teaching					
6	My instructor(s) cared about my progress and were helpful to me.					
7	Course materials were up to date and useful (texts, handouts, references etc.)					
8	The resources I needed in this course were available when I needed them (textbooks, library, computers etc.)					
9	In this course effective use was made of technology to support my learning.					
10	I was encouraged to ask questions and develop my own ideas.					
11	I was inspired to do my best work.					
12	The things I had to do in this course ,class activities, assignments, laboratories, were helpful for developing the knowledge and skills the course was intended to teach					
13	The amount of work I had to do in this course was reasonable for the credit hours allocated.					
14	I was informed of my assignments' and tests' results in this course within reasonable time.					
15	Grading of my tests and assignments in this course was fair and reasonable.					
16	The links between this course and other courses in my total program were made clear to me.					

Suppl Table 1: Course Evaluation Survey.

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