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# Features to Improve Precision of Traditional Visual Analogue Scale as a Measuring Instrument

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**Abstract**

The problems of imprecision in marking the intended points and discrepancies in scores from repeat measurements had been observed in the use of traditional visual analogue scale (VAS). This paper demonstrates the usefulness of incorporating fine graduation in VAS to address these problems. Two questionnaires one with traditional VAS and the other with graduated VAS were administered to fifty students to mark the same percentage figures on the scales. The mean of measurement scores of respondents from the two questionnaires were computed and compared with the mean of 62.4cm which is the true mean if all the percentages are precisely marked on the scales. Traditional VAS indicated greater variability in scores than graduated VAS scale. The mean of scores of respondents of graduated VAS scale was closer to the actual mean and was significant at 5% level in the statistical test of equality of means to actual mean. This suggested that that graduated VAS scale might provide more precise measurement of attributes than traditional VAS.

**Keywords:** Visual analogue scale, precision, graduation, measurement.

## 1. Introduction

Literature indicated that visual analogue scale (VAS) had been adopted in many sensory evaluation studies in food science technology and pain measurement in medicine. Visual analogue scale (line scale as it was popularly called in sensory evaluation method in food science technology) was introduced because the categorical scales could not produce interval level of measurement that is required by multivariate statistical analysis. [1] VAS being a continuous line was considered to be superior to other categorical rating scales as it affords the respondents the opportunity to make independent judgments as they are not restricted to discrete categories. [2; 3]

Despite the advantages of VAS over categorical scale as a measuring instrument; the problems of imprecision in marking the intended points and discrepancies in scores from repeat measurements had been observed in its use. The disadvantage of line scale was that “it

might be harder for a panelist to be consistent because a position on a line scale is not easily remembered as a number." [3]

Up till now several studies in both food science sensory evaluation method and pain studies continued to use the visual analogue scale without addressing these problems. Most reported studies on measurement scales are basically on applicability of each scale type to the neglect of psychometric properties of the scales. [4] Studies that attempted to improve on the usefulness of VAS did not address the problem of imprecision in its administration. Among such studies include [5] that evaluated different lengths (5cm, 10cm, 15cm and 20cm) and different end phase of visual analogue scale in measuring patient's level of pains. They found that scale with 10cm length with end phase of "most incomparable pain" was found to be suitable for measuring dental pains. They did not address the issue of VAS imprecision. VAS and numerical rating scale in measuring pains were compared by [6]; he found that numerical rating scale was more accurate than VAS. The problem of imprecision in marking the intended points on VAS might have reduced its accuracy. VAS and four-grade scales were compared by [7] they found that VAS imposes additional burden and suggested that the four-grade scales may be more preferred to VAS. No attempt was made to improve on the features of VAS to enhance precision in its administration. The relative validity VAS, numerical rating scale, verbal rating scale and the face pain scale-revised was compared by [8] and found that numerical rating was found to be most responsive and be able to detect sex differences in pain intensity. The issue of precision in administration was not addressed their study; this might have been responsible for low performance of VAS.

Therefore this paper demonstrates the usefulness of incorporating fine graduation in VAS to improve precision in marking intended points and consistency of scores in repeat administrations. Fine graduation may not defeat the objective of making it a continuous scale in as much that graduated points are not indicated as predefined categories. This could be likened to graduation of measuring ruler or linen tape that does not make either of them a categorical measuring instrument.

The remaining part of this paper is arranged in four sections. Section two of this paper provides overview of the features of traditional VAS and method of its administration. Section three comprises the materials and method. Section four contains results and discussion. While section five concludes the paper

## 2. Overview of Traditional VAS

Traditional VAS (line scale) is normally a horizontal line of 15cm long with anchor points located at 1.5cm from each end of the scale, with or without middle anchor point. The left anchor normally represents the lowest score (lowest intensity) and scale magnitude increases towards the right anchor that represents the highest score (highest intensity). The middle anchor is to guide the respondent to locate the middle point of the scale. The respondent's assessment of an attribute is indicated on the scale by placing a vertical line along the scale. The score for the respondent is extracted by measuring the distance from the left anchor to the vertical line [1, 2, 9.] Figure 1 is a diagram of traditional VAS with the left anchor of "Very Low", the middle anchor of "Moderate" and the right anchor of "Very High".

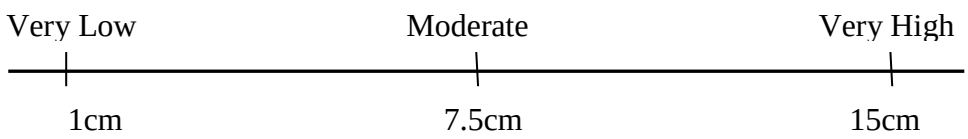


**Figure 1:** Traditional VAS

**Source:** 1

## 3. Materials and Method

Two types of questionnaire that were only differentiated by the type of line scale were used in this experiment. The first questionnaire (Option A) has traditional line scale of 10 centimeters with only two anchors: 1% and 100% as portrayed in Figure 2.

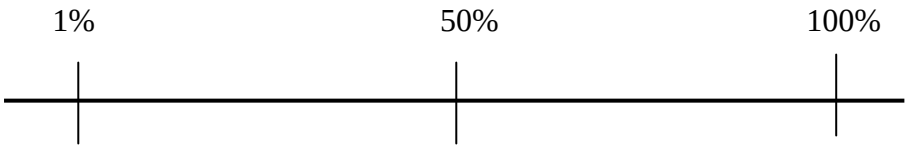


**Figure 2:** Traditional VAS in Option A Questionnaire

The second questionnaire (Option B) consists of graduated VAS of 10 centimeters long and 3 anchors points with 1% as lower anchor, 50% as middle anchor and 100% as upper anchor. In addition to the anchors the scale is graduated at 0.5cm and 1cm intervals as shown in Figure 3.

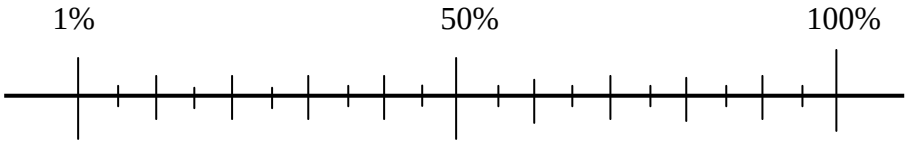


**Figure 3**: Graduated VAS in Option A Questionnaire

Percentages were chosen as anchors as frame of references for the respondents to be able to quantify the magnitude of attributes being assessed. The assumption is that percentages may be easier to locate on VAS than locating figures that represent proportions of the length of a VAS.

The two types of questionnaire contained on the left side of the paper the follow percentages 54%, 11%, 97%, 34%, 51%, 22%, 73%, 66%, 49%, 88%, 46%, and 33% arranged vertically in that order. While the line scales to measure them were placed on the right side of the percentages, with each percentage and VAS occupying a line on questionnaire page. The only difference between the two questionnaires is the type of VAS. The percentages were chosen so that figures of 5, 10 and their multiples were avoided because they can easily be located on graduated VAS and may introduce bias in the experiment.

Fifty Higher Diploma Estate Management Students were randomly chosen as respondents. The respondents were trained for three days in the use of VAS. Since the objective of the experiment is to assess the precision of the scales and not the discriminating abilities of the respondents; they were to mark the same percentage figures listed in the questionnaires. The first questionnaire (Option A) was first administered this was immediately followed by administration of the second questionnaire (Option B), all to the same set of respondents. The respondents were asked to mention the questionnaire option that was easier to locate the percentage figures on the VAS.

The responses were measured on the VAS and the total score for each respondent was computed. The means of the total scores for the respondents for each questionnaire option were computed. The actual mean for all the percentage figures if they are marked correctly is 62.4cm. The computed means were then compared with the actual mean of 62.4cm using one sample t-test of SPS statistical package. Also computed was the percentage of opinions of the respondents on the VAS options that was easier for them to mark the intended points.

The hypothesis is that if a line scale design facilitates respondents to mark precisely their intended points and if all the respondents are measuring the same magnitudes for a set of attributes; the mean of scores for all the respondents should be equal to the actual mean of the measurements. This hypothesis was tested by comparing the actual mean with the means of scores of the same respondents that measured the same set of figures using the traditional and graduated VASs.

## 4. Results and Discussion

This section presents the results of descriptive statistical analysis and One-Sample test that compares the mean scores of the measurements by the two VASs with the true mean. Table1 presents descriptive statistics of respondents' measurement scores.

**Table 1:** One-Sample Descriptive Statistics

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| OptionA | 50 | 59.802 | 2.937 | .415 |
| OptionB | 50 | 62.354 | .5191 | .0734 |

The computed mean scores of respondents for Option A questionnaire that used traditional VAS is 59.8cm which is below the actual means of 62.4cm by 2.6cm. While the mean scores of respondents for Option B questionnaire that used graduated VAS is 62.35cm which is below the actual mean by 0.05cm. This indicates that Option B mean is closer to the actual mean than the mean of Option A. The standard deviation of respondent's scores for Option A questionnaire is 2.94cm while that of Option B is .52cm which indicates that there is greater variability in the measurement scores of traditional VAS than that of graduated VAS. This suggested that graduated VAS might be more precise as a measuring instrument than traditional VAS.

Table 2 contains the test results of comparison of the mean scores of respondents Options A and B questionnaire with the actual mean of 62.4cm. The results indicated that Option A mean is significant beyond 5 percent level of significance which suggested rejection of the null hypothesis of equality of Option A mean and the actual mean. The test statistic indicated that Option B mean is significant at 5 percent level of significance which suggested the acceptance of null hypothesis of equality of Option B mean and the actual mean.

**Table 2:** One-Sample Test Results

| | Test Value = 62.4 | | | | | |
|---|---|---|---|---|---|---|
| | | | | | 95% Confidence Interval of the Difference | |
| | t | df | Sig. (2-tailed) | Mean Difference | Lower | Upper |
| OptionA | -6.255 | 49 | .000 | -2.598 | -3.433 | -1.763 |
| OptionB | -.627 | 49 | .534 | -.046 | -.194 | .102 |

The conclusion that could be drawn from the statistical test is that, it might be easier for the respondents to precisely identify and mark the intended point on graduated line scale than the traditional line scale.

Also 100% of the respondent indicated that graduated line scale was easier for them to identify the intended point than traditional line scale. We may conclude that graduated line scale could produce more precise measurements than traditional line scale.

## 5. Conclusion

The measurement scores from traditional VAS have more variability than that of graduated scale. The results of analysis of data collected from the two VASs options indicated that the mean of respondent's scores from graduated VAS is closer to the actual mean and was significant beyond 5 percent. All these suggested that graduated VAS might be more precise as measuring instrument than traditional VAS. Moreover the respondents' opinions were in favour of graduated line scale. Graduation of VAS may not defeat the objective of making it a continuous scale as graduations would not indicate predefined levels of magnitude of attribute of interest.

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