The Effects of Using Likert vs. Visual Analogue Scale Response Options on the Outcome of a Web-based Survey of 4th Through 12th Grade Students: Data from a Randomized Experiment

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Abstract

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For more than a half century surveys and questionnaires with Likert-scaled items have been used extensively by researchers in schools to draw inferences about students; however, to date there has not been a single study that has examined whether alternative item response types on a survey might lead to different results than those obtained with Likert scales in a K-12 setting. This lack of direct comparisons leaves the best method of framing response options in educational survey research unclear.

In this study, 4th through 12th grade public school students were administered two versions of the same survey online: one with Likert-scaled response options and the other with visual analogue-scaled response options. A randomized, fixed-effect, between-subjects experimental design was implemented to investigate whether the survey with visual analogue-scaled items yielded results comparable to the survey with Likert-scaled items based on the following four methods and indices: 1) factor structure; 2) internal

consistency and test-retest reliability; 3) survey summated scores; and 4) main, interaction, and simple effects.

Results of the first three indices suggested that both the Likert scale and visual analogue scale produced similar factor structures, were equally reliable, and yielded summated scores that were not significantly different across all three school levels (elementary, middle, and high school). Results of the factorial ANOVA suggested that only the main effect of school level was statistically significant but that there was no significant interaction between item response type and school level. Results of the post-survey questionnaires suggested that students at all school levels preferred answering questions on the survey with the VAS compared to the LS nearly three to one.

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Chapter 1: Defining the Problem

Introduction

For more than a half century surveys with Likert scale (LS) response options have been used extensively in schools to draw inferences about students. To date, however, educational researchers have not examined whether a different scale—such as a scale that employs a continuous response format—would have a similar effect on students' responses or lead to different results than those obtained from a LS survey in a K-12 setting. This lack of direct comparisons between the LS and other scales leaves the best method for framing response options in K-12 educational survey research unclear.

Originally proposed by Rensis Likert (1932) as a summated scale[1] for the measurement of respondents' attitudes, the LS format generally consists of an item prompt or statement about the attitude being measured (e.g., I enjoy reading mystery novels) followed by a limited or discrete set of responses designed to capture a respondent's personal opinion about (or attitude toward) the item prompt. Typically, the LS has four to seven response options, each consisting of a single word or short phrase that differs by varying degrees ranging from one negative extreme to its polar opposite positive extreme (e.g. from *strongly disagree* to *strongly agree* or *not at all likely* to *highly likely*). Respondents are instructed to choose only one response option from those

[1] "A scale or index made up of several items measuring the same variable. The responses are given numbers in such a way that responses can be added up [or *summated*]" (Vogt, 1999, p. 284).

presented to indicate their level or degree of agreement with the item "stem" or prompting statement (see Figure 1-1 below).

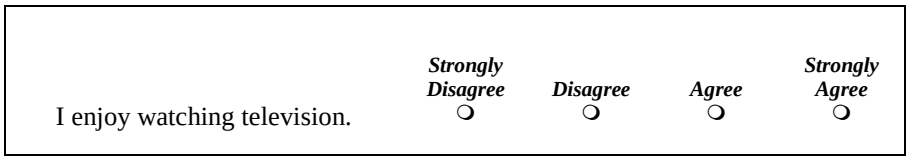

Figure 1-1. Typical item with the Likert scale response format.

The Problem

Given the immense popularity of LS surveys used by teachers and researchers in today's classrooms, it would seem to the casual observer no better option exists. Yet, the literature suggests there is little consensus on whether the LS is the best scale to use for survey research (Grigg, 1978). Proponents argue LS are the most widely used scale type in the social sciences because:

1. *they are relatively easy to construct and administer* (Jaeschke, Singer, & Guyatt, 1990; Vickers, 1999)
2. *they place few cognitive demands on respondents* (Jaeschke, Singer, Gordon, & Guyatt, 1990; Joyce, Zutshi, Hrubes, & Mason, 1975; Scott & Huskisson, 1977).
3. *scores can be easily computed and are easy to interpret* (Guyatt, Townsend, Berman, & Keller, 1987; Vickers, 1999).
4. *they have been found to be easy for children to use and respond to* (Shields, Cohen, Harbeck-Weber, Powers, & Smith, 2003; van Laerhoven, van der Zaag-Loonen, & Derkx, 2004).

5. *they tend to have high reliabilities* (van Laerhoven, van der Zaag-Loonen, & Derkx, 2004; Cook, Heath, & Thompson, 2001).

6. *they make it easier to identify and interpret a clinically significant change* (Brunier & Graydon, 1996; Guyatt et al., 1987).

On the other hand, critics have argued LS surveys and/or Likert-type items can:

1. *yield only a rough estimate comprising simple, discrete, ordinal-level data that lack subtlety* (Krieg, 1999) *and fail to adequately describe the construct being measured* (Brunier & Graydon, 1996; Hain, 1997).

2. *lack sensitivity or responsiveness in differentiating between dimensions or factors* (Aitken, 1969; Duncan, Bushnell, & Lavigne, 1989; Joyce, Zutshi, Hrubes, & Mason, 1975; Ohnhaus & Adler, 1975).

3. *limit the amount of information transmitted by responses* (Osgood, Suci, & Tannenbaum, 1957; Viswanathan, Bergen, Dutta, & Childers, 1996)

4. *restrict respondents' ability to precisely convey how they feel* (Aitken, 1969; Joyce et al. 1975; Viswanathan et al. 1996)

5. *force respondents to choose from a limited response set* (Duncan et al. 1989; Ohnhaus & Adler, 1975; Viswanathan et al. 1996) *scaled on an artificially restricted response range, which can result in a "poorer match between subjective state and response"* (van Schaik & Ling, 2003, p. 548)

6. *encourage "habitual response behavior"* (e.g., responding without careful consideration or cognitive effort) *from respondents* (Lange & Soderlund, 2004).

The lack of consensus in the literature provides little guidance to educational researchers developing assessment tools or selecting surveys to administer to students. Moreover, because there is a dearth of empirical evidence to support the selection of one scale over another, educational researchers may be less inclined to discriminate among scales for survey response options and more inclined to select what is most familiar (e.g., the Likert

scale) or easiest to create (or score or administer) rather than what is the most appropriate measurement (e.g., based on age of sample, context of study, construct being measured) or what will yield the most accurate results.

With its coarse measurement approach to scaling, the LS can induce statistical biases that can be of great consequence because they can "artificially augment" (Ohnhaus & Adler, 1975, p. 383) or attenuate reported effect sizes, correlation coefficients, and reliability (Hasson & Arnetz, 2005; Joyce, Zutshi, Hrubes, & Mason, 1975; Krieg, 1999; Martin, 1973; Viswanathan, Bergen, Dutta, & Childers, 1996). Given researchers' extensive use of LS surveys to make inferences based on the assumption respondents would not respond differently had they been presented with an alternative item-response type, there could be serious implications for past, present, and future survey research if this assumption proves to be empirically untenable. Further, since researchers tend to assume the variable of interest, *x* is measured without error (Viswanathan et al. 1996), there could be serious implications in terms of statistical conclusion validity for researchers whose results hinge on the accuracy of LS surveys.

In addition to statistical biases, critics have argued LS items limit a respondent's ability to accurately express his or her opinions and therefore are not capable of providing unbiased evidence about specific degrees of agreement or disagreement because they fail to capture the more subtle nuances of personal expression (Flynn, van Schaik, & Middlesorough, 2004; Ohnhaus & Adler, 1975). In effect, what the LS attempts to do is to transfer a fluid, continuous construct into a digital system that is serrated and ordinal. Consequently, by forcing respondents to choose from a set of "suggested/provided"

responses—which may or may not accurately reflect how they truly feel or what they really think—the results obtained from LS items can be biased to reflect only the limited degrees of agreement (e.g., *agree, strongly disagree*) provided by the person(s) who constructed the scale rather than to reflect the perceived or intended responses of the respondents, themselves (Bowling, 1998; Brunier & Graydon, 1996; Hasson & Arnetz, 2005; Vickers, 1999). To that end, it would seem the LS is capable of only providing researchers with a homogenized approximation of respondents' attitudes due to the crude categorization of individual responses. As a result, the LS may be incapable of yielding the most accurate reflection of the measured phenomenon because it lumps respondents into artificially distinct groups (e.g., respondents who *strongly disagree* vs. those who *neither agree nor disagree*) that assume lockstep categorical conformity of members to a single unified response. In short, the LS method of categorizing responses can offer, at best, only limited scale sensitivity, which could directly encumber a researcher's ability to obtain the most accurate results.

What is needed in educational survey research is an alternative to the LS response option that can offer respondents more freedom to personalize their responses and has the potential to achieve a more accurate estimate of the measured construct. One possible alternative to the LS is the *visual analogue scale*, which gives respondents the ability to express their personal opinions more precisely (Givon & Shapira, 1984) and is capable of providing increased scale sensitivity so researchers can obtain more theoretically accurate results.

The visual analogue scale (VAS) is a unidimensional scale—meaning only one ability, attribute, or dimension is measured at a time (Bond & Fox, 2001)—and is often presented as a single, horizontal[2] line anchored on the left side by a negative trait or the most negative statement and on the right side by a positive trait or the most positive statement. Respondents are typically asked to select a point along the continuum between the two extremes that best matches their degree of alignment or strength of agreement with some statement (see Figure 1-2 below).

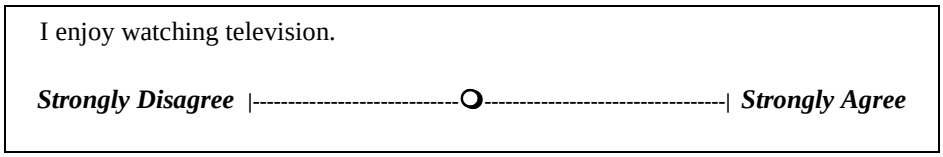

Figure 1-2. Typical item with the visual analogue scale response format.

By comparison, the LS response options (e.g., Figure 1-1 above) offer only a fraction of the VAS' possible response options, which are not limited to the discrete set of pre-determined responses (e.g. *strongly agree, agree, disagree, and strongly disagree*) offered by LS items.

As an item response format, the VAS can be administered by itself (e.g., using a single item strategy for the measurement instrument) or in combination with other VAS to measure multiple constructs on multi-item instruments (Wewers & Lowe, 1990). Although it has been widely used in other fields since the 1920's in clinical and research settings (Wewers & Lowe, 1990), the educational survey research literature is virtually

[2] The VAS can also be presented vertically with the positive trait or statement positioned at the top and the negative at the bottom of the scale, but it appears most often in the literature as horizontal.

silent on the VAS. Moreover, of the published studies that have involved VAS items or indices, the vast majority have focused on adult populations (e.g., 18 and older) and results can not necessarily be extrapolated to K-12 populations (e.g., younger than 18). Moreover, it remains to be seen whether results observed in studies with adults are constant over different measurement contexts (such as schools), respondent groups (such as K-12 students), or traits (such as identification with school).

Research Purpose

In addition to the gap in the current K-12 educational survey research literature about students' reaction to the visual analogue scale, very little is known in any field of research about how children respond to Web-based surveys with VAS response options. Further, it remains unknown whether they will respond differently to VAS items online than they would have had they been presented with LS items instead. The purpose of this study was to contribute to the literature in K-12 educational survey research by comparing a previously validated and highly reliable LS survey[3] to the same survey with VAS response options instead. Both versions of the survey administered in this study were Web-based and both had the same number of items and same prompts but with different response option formats. The LS version's response options were presented as radio buttons with choices such as "Strongly Agree" or "Disagree" and the VAS version had slider-type response options presented with only the two extreme verbal cues of the

[3] Meaning that the survey was originally comprised of items with LS response options.

LS (e.g., *Strongly Disagree* and *Strongly* Agree) on each end of a continuum. Respondents used their mouse to click anywhere on the continuum and a marker appeared that could be manipulated (slid) in either direction to indicate varying degrees of "agreement" or "disagreement" with the item prompts.

The purpose of this study was to explore whether the VAS could be a more suitable alternative to the Likert scale to frame response options for survey research in a K-12 setting. The construct measured in this paper (and thus the subject for the LS vs. VAS comparisons) was *student identification with school,* which has been examined in a number of studies and measured using a number of Likert-scaled instruments. Researchers involved in empirical studies of this construct have, to date, *not* explored the possibility that the survey they administered might have yielded different results had a continuous scale such as the VAS been used instead of the LS. Thus, this study compared LS and VAS versions of the established scale, *Identification with School Survey* (Voelkl, 1996) to determine if the survey's results (e.g., summated scale score) and psychometric indicators (e.g., reliability and factor structure) were comparable, irrespective of the response format. Further, because age had been shown in previous studies to be a significant factor in children's performance on surveys (Cremeens, Eiser, & Blades, 2007; Read & MacFarlane, 2006; Shields, Cohen, Harbeck-Weber, Powers, & Smith, 2003; van Laerhoven, van der Zaag-Loonen, & Derkx, 2004), the effects of age (using school level as a proxy) and item response type were examined in an effort to determine if there were any significant differences between how younger students and older students responded when presented with VAS vs. LS response options.

Research Questions

Evidence has been presented that suggests Likert scale (LS) response options can misrepresent the variability in students' attitudes/beliefs by artificially grouping students into a limited set of discrete categories that may not accurately reflect individual responses. Additionally, evidence has been presented that suggests the visual analogue scale (VAS) may be a more suitable survey response option for researchers to use due to its continuous scaling, which offers a more sensitive measurement of attitudes/beliefs and a much less restricted response range for students to individualize their responses. Evidence has also been presented that suggests children's age is an important factor to consider when selecting an item response format because younger children's cognitive development is less developed than older children's, which could impact the former's ability to accurately self-report. Lastly, evidence has been presented that suggests the VAS may have an advantage over the LS on a Web-based survey due to its ability to communicate an interval continuum to respondents that may yield greater score variability and possibly greater score reliability.

Given that no previous studies have been conducted in educational survey research to directly compare the LS to the VAS on a web-based survey with a K-12 student population in a school setting, the best method of framing response options in educational survey research remains unclear. Consequently, this study seeks to contribute to the literature by addressing the following research questions:

1. *Does the response format change the factor structure of the survey?*
2. *Does the response format affect the reliability coefficient?*

3. *Are there significant mean differences for the summated scores overall between the LS version and the VAS version of the survey?*

4. *Are there significant mean differences of the summated scores on the LS and VAS versions of the survey between Elementary, Middle, and High School students?*

5. *Is there a significant interaction between level of schooling and item response type? If so, is it dependent on item response type?*

Significance of the Study

The results of this study could provide answers to questions that have thus far been overlooked in educational survey research. Further, the results of this study could have implications for social scientists, particularly those whose survey research is used to influence policy directly or indirectly affecting the lives of children. Moreover, because results could have some bearing on children's self-reports, in general, and for future measures designed for students in elementary, middle, and high schools, in particular, the results of this study could influence ways in which survey research is conducted in tomorrow's K-12 classrooms.

Summary

A standard tenet in research is that conclusions based on computed statistical values are valid only insofar as the data used to calculate these values were collected in an appropriate manner. Some critics have argued researchers run the risk of drawing

unwarranted conclusions when they rely exclusively on LS categorical surveys because yielded data may not have been obtained using the most appropriate[4] method (Brunier & Graydon, 1996; Ohnhaus & Adler, 1975; Svennson, 2001; Wewers & Lowe, 1990). This line of thinking stems from the view that LS items limit a respondent's ability to accurately or precisely express his or her opinions and therefore are not capable of providing tenable evidence about varying degrees of agreement/disagreement or of capturing the more subtle nuances of personal expression (Flynn, van Schaik, & van Wersch, 2004). To that end, an LS survey's validity and reliability could be called into question. Moreover, since the quality of any research study is heavily dependent upon the researcher's ability to collect and interpret valid and reliable data, it could be argued the LS may serve to restrict or implicitly limit attempts to achieve an accurate estimate of the construct being measured, which, in turn, may also confound data interpretation or otherwise impinge on sound decision making. This raises important questions about the extent to which LS survey results used in educational research can be used to make inferences about students or their schools.

The importance of accurate information is imperative in all fields of research, and educational survey research is no exception. With the demand for data-driven decision-making in today's high stakes educational environment, it is imperative the instruments used in data collection are as accurate and useful as possible. Given the limitations mentioned above, the LS' ability to provide researchers with the most accurate data is

[4] *Appropriate* in this context refers to the scale's ability to accurately measure the substantive construct or variable of interest.

questionable and therefore may not be the best possible or most appropriate choice for measuring respondents' attitudes or opinions in empirical educational research.

Chapter 2: Literature Review

Introduction

Today, survey research includes a broad range of methods for gathering data, ranging from the more traditional one-on-one interview conducted in-person or on the phone, to the more progressive, self-administered surveys such as those that capitalize on today's technology to collect responses via text-messaging or the Internet. Researchers have used surveys for many years and although myriad forms have been proposed and tested over the last century, the Likert scale is still by far the most widely used technique for scaling item response options (Lange & Soderlund, 2004; OhnHaus & Adler, 1975; Polit, 2004). This chapter proposes to focus specifically on measurement issues as they relate to surveys in general, and the Likert scale (LS) and visual analogue scale (VAS), in particular. The chapter concludes with a discussion of challenges related to surveying children using LS and VAS response options as well as with an overview of issues related to Web-based or online surveys.

Measurement Issues in Educational Survey Research

In the social sciences, one of the most frequently cited definitions of measurement has been that of Stevens (1946). Stevens broadly defined measurement as the assignment of numbers to aspects of objects or events according to one or another rule or convention. In survey research, there is an ongoing debate about which scaling "rule or

convention" is most appropriate for use in the measurement procedure to ensure accurate results and the meaningful interpretation of survey scores. Unlike most physical scientists, social scientists tend to deal mostly with unobservable constructs that cannot be directly measured. Survey researchers, in particular, must therefore rely on psychometric theory to measure subjective phenomena such as attitudes. Psychometrics is the field of study concerned with the theory and technique of measurement in education and psychology, which includes methods such as the operationalization of variables for the purposes of measurement and the scaling of attitudes. According to Bowling (2005b),

> Psychometric theory dictates that when a concept [or construct or variable] cannot be measured directly…a series of questions that taps different aspects of the same concept need to be asked. Items can then be reduced, using specific statistical methods, to form a scale of the domain of interest, and the resulting scale tested to ensure that it measures the phenomenon of interest consistently (reliability), that it is measuring what it purports to measure (validity), and is responsive to relevant changes [sensitivity] over time. (p. 344).

The primary purpose of conducting a survey is to enable the researcher to examine some characteristic or trait as it relates to the people being surveyed and/or the phenomena about which the people are being asked (Fink, 1995). If the researcher's conclusions are to have merit, they must be based on reliable scores obtained from valid surveys. As with any research study, dependable results are contingent upon the researcher's ability to collect valid and reliable data that provide an accurate estimate of

the construct, characteristic, or attribute being measured (Litwin, 1995). In other words, to be dependable, the survey instrument must measure what it was designed to measure and provide a consistent estimate of what is actually being measured, intended or otherwise (Linn & Miller, 2005; Nunnally, 1978). In survey research, the unintended or unaccounted for measurements (or those "otherwise" measurements) are cause for concern because they constitute measurement error.

Survey Errors

Researchers strive for, but fail to achieve, error-free measurement. Unfortunately, perfect measurement does not exist. In many cases, "substantial mismeasurement [remains] no matter how much care and expense is devoted to measuring the variable in question" (Gustafson, 2004, p.3). Two types of error associated with survey research, in general, and measurement, in particular, are *random* errors and *systematic* (or *non-random*) errors. The first, random errors, are errors without qualification. Random error (also known as random variation) represents differences in a variable due to chance rather than to one of the other variables being studied. Although random variations tend to cancel one another out in the long run, these types of error are *not* under the control of the researcher and therefore were not examined in this dissertation. The second type of errors, non-random errors, are those that are consistent or *not* random and therefore should (or could) ostensibly be controlled or eliminated by the researcher. Controlling or eliminating systematic errors is important because, as Blalock, Wells, and Carter (1970) argue, "the existence of…nonrandom measurement errors becomes a serious problem for

inference in any study that is designed to go beyond merely locating correlates of a particular dependent variable" (p. 76). Given that this dissertation aspires to examine inaccuracies or errors resulting from possible design limitations or flaws in the measurement instrument,[5] in general, and errors related to response option design or scaling technique, in particular, this study focuses exclusively on non-random errors.

In addition to random and non-random errors, there are several other types of errors often associated with surveys including *sampling error*, *coverage error*, *non-response error*, and *measurement error*. The first two essentially relate to errors involving the sampling method or approach to contacting participants. These are methodological errors not associated with the survey instrument itself; therefore, they were not examined. The third, *non-response* errors, are a function of the respondent and were not examined in this dissertation. The fourth, *measurement* error, is error that occurs when the observed value is different from the *true*[6] or actual value of the measured variable. In terms of this study, these types of survey research errors were defined as those associated with the measuring instrument itself—as contrasted with other sources of measurement error—and were the only type of survey research error examined in this dissertation.

Reliability.

Reliability refers to the extent to which a measure or score is repeatable and consistent and free from random errors. Put another way, it is a measure of how

[5] As opposed to "flaws" in the respondent. These respondent-based errors include instances such as when respondents do not understand the question or cannot remember the relevant information, or when they strategically edit responses in a misleading way before reporting (or selecting) them.
[6] The *true* value is a hypothetical value that is yielded if a variable were perfectly measured (e.g., without error).

reproducible a survey's data are (Litwin, 1995). Crocker and Algina (1986) remind us, "reliability is a property of the *scores* [italics added] on a test for a particular group of examinees" (p. 144) and *not* of the test or survey itself. Therefore, it is inappropriate to refer to an instrument as either "reliable" or "unreliable." Alwin (2007) expounds on the importance of reliability as it relates to measurement by observing:

> reliability is not a sufficient condition for validity, but it is necessary, and without reliable measurement, there can be no hope of developing scientific knowledge. The obverse of this logic is that if our measures are *unreliable* they are of little use…[for] detecting patterns and relationships among variables of interest. Reliability of measurement is therefore the sine qua non of any empirical science" (p. 16).

There are several types of reliability analyses that can be conducted to estimate a reliability coefficient for a test or survey including *alternate-form, inter-observer, intra-observer, test-retest, and internal consistency reliability.* In this study, only one form was administered, therefore alternate-form reliability does not apply because, according to Crocker and Algina (1986), "the alternate form method requires constructing two *similar* forms [e.g., with equivalent but not identical items] of a test and administering both forms to the same group of examinees" (p.132). Inter-observer or *interrater* reliability is not relevant to the study either because the study does not examine the extent of agreement among two or more independent raters judging the same phenomena. Similarly, *intra*-observer reliability is not relevant to the study because it refers to the extent to which an individual observer is consistent in her observational codings if she

twice codes (rates) an object or occurrence (e.g., student essay or video of a teacher's response to classroom disruption).

Test-retest reliability ($r_{xx'}$) is a common indicator of response consistency. Often referred to as a co-efficient of stability, it is defined as the consistency of measurement based on the correlation between test and retest scores for the same individual. Typically, the same test is administered twice to the same people after a period of time and after the retest, two scores on the same measure for each person are generated and the correlation between the scores is obtained. Depending on the type of data being analyzed, the researcher will either apply Pearson *r* or Spearman rho on the total scores of the two administered tests or surveys.

Internal consistency estimates of reliability (ICR) are applied to groups of survey items (as opposed to single items) thought to measure different aspects of the same construct (Litwin, 1995). Cronbach (1951) defined a survey with high internal consistency as one comprising positively intercorrelated items and not necessarily one reflecting a high degree of unidimensionality. To measure ICR, *Cronbach's coefficient alpha* (α) is generally calculated as an index of a survey's internal consistency, which is determined by "the ratio of the sum of the item covariances to the total observed score variance" (Crocker & Algina, 1986, p. 153). Although there are other ways to measure ICR besides Cronbach's alpha, evidence suggest they all arrive at essentially the same estimates of reliability (Pedhazur & Pedhazur Schmelkin, 1991).

Ordinal vs. Interval Measurement

It is important for the researcher to bear in mind that the type of measurement scale used to take measures will affect the validity, reliability, and usefulness of the data collected. With Likert scale (LS) surveys, there is a general lack of consensus on whether they should be treated as ordinal- or interval-level measurement, and rightfully so. In social science research, the distinction between the two is often blurred.

Ordinal Measurement Scale

Ordinal measures require that "…the objects of a set can be rank-ordered on an operationally defined characteristic or property" (Kerlinger, 1992, p.399). This means, in general, a hierarchy is in place to "rank" responses from a lesser or lower degree to a more or higher degree of some specified characteristic. For example, *strongly agree* is a "higher" degree of affirmation than *agree*, therefore *strongly agree* would be assigned a higher numeric value than *agree*. Although intervals are implied by these varying degrees of verbal categories as well as by the numeric values often assigned, traditionalists argue an ordinal scale's intervals are purely arbitrary and therefore no meaning can be attached to the size or distance between measurements and no meaning can be attached to the shape of the set of measurements' frequency distribution (Gardner, 1975). Traditionalists further maintain only non-parametric statistics can be used with ordinal scales because they do not require the estimation of population values and no assumptions are made about interval equivalencies or the shape of the distribution of population scores (Armstrong, 1981).

Interval Measurement Scale

To qualify as an interval measure, the scale must represent "equal distances [or intervals] in the property being measured" (Kerlinger, 1992, p.400). As such, relative sizes of the intervals between two different measurements along the scale can be meaningfully interpreted and meaning can be attached to the frequency distribution's shape (Gardner, 1975). In addition to their capability of providing a more precise estimate than ordinal measures, interval measures have the added benefit of enabling the researcher to use more powerful parametric statistical techniques (Kerlinger, 1992; Labovitz, 1970).

In attempting to decide whether to treat data as ordinal or interval, researchers face the potential loss of information because of the limited resolution of ordinal measurements. Kriege (1999) calls this an issue of "scale coarseness" and argued it causes biases that "…can affect the mean, variance, covariance, correlation coefficient, and the reliability of the scores" (p.763). Moreover, since ordinal scales offer only a "coarse" estimate, they can potentially impact the internal consistency, test-retest reliability, and concurrent and predictive validity of a survey (Champney & Marshall, 1939; Bowling, 1998).

Treating ordinal data as interval.

A problem survey researchers routinely face is whether the use of more powerful statistical techniques are justified with ordinal-level scales of measurement. To directly address the issue of whether it is acceptable to use an interval scale when an ordinal scale is, by definition, more appropriate, Labovitz (1970) conducted an empirical investigation

in which he manipulated ordinal (e.g., ranked) data from a previously published study[7] and substituted his own equidistant (linear), monotonic numbers and randomly generated numbers[8] according to 18 different monotonic scoring systems. His results demonstrated negligible error in comparison to the "true" scoring systems, which led Labovitz to conclude:

> (1) certain interval statistics can be used interchangeably with ordinal statistics and interpreted as ordinal, (2) certain interval statistics (e.g., variance) can be computed where no ordinal equivalent exists and can be interpreted with accuracy, (3) certain interval statistics can be given their interval interpretation with only negligible error if the variable is "nearly" interval, and (4) certain interval statistics can be given their interval interpretations with caution (even if the variable is purely ordinal), because the "true" scoring system and the assigned scoring system, especially the equidistant system, are almost always close as measured by r and r^2 (1970, p. 523).

Thus, Labovitz (1970) argued, even though some "small error" may result from treating ordinal variables as interval, doing so is justified because it enables the researcher to use "more powerful, more sensitive, better developed, and more clearly interpretable statistics with known sampling error" (p.515). While this may be true, Labovitz failed to provide the researcher with guidance on when it is "worth the risk" to ignore the error introduced when ordinal scales are treated as interval scales in favor of using advanced

[7] Labowitz (1970) examined the relationship between occupational prestige (which is based exclusively on the principle of ordinal ranking) and male suicide rates. The data comprised prestige rankings of 36 U.S. occupations obtained from a 1947 national survey and suicide rates by occupation obtained from the 1950 U.S. Census.

[8] The assigned numbers were all within the range of 1 to 10,000 and their assignments were all consistent with the ordinal ranking monotonic function.

statistical techniques. Moreover, he failed to mention this risk may be reduced or eliminated altogether if a suitable alternative, designed for the interval scale, was used. As Krieg (1999) suggested, "the simplest way to avoid the biases induced by coarse measurement scales [e.g., Likert scales] is not to use them in the first place" (764).

Measuring Survey Responses

This section provides a general discussion about the two item response types that are the focus of this dissertation: the Likert scale (LS) and the visual analogue scale (VAS). The LS is presented first, followed by the VAS and then a discussion of whether either is ordinal or interval level measurement follows. Each is discussed in terms of how it captures a respondent's survey responses and in terms of measurement error that results due to item response format.

The Likert Scale

In his seminal monograph, Rensis Likert (1932) originally proposed that his scale was a summated scale[9] to be used to assess the attitudes of survey respondents. Although technically the term *Likert scale* refers to a summated score produced by a survey comprised of *Likert-type* items rather than to an individual item itself, the term *Likert scale* (LS) is commonly used today to refer to the universal fixed format approach to measuring attitudes—and more broadly to virtually any survey item with labeled, *bipolar*

[9] "A scale or index made up of several items measuring the same variable. The responses are given numbers in such a way that responses can be added up [or *summated*]" (Vogt, 1999, p. 284).

(e.g., *agree*/*disagree*) response options typically delineated by a discrete set of monotonic categories.

The LS format on a survey characteristically consists of an item prompt such as a statement about the attitude being measured (e.g., I enjoy reading mystery novels) followed by a limited or discrete set of responses designed to capture a respondent's personal opinion about (or attitude toward) the item prompt. Typically, the LS has four to seven response options, each consisting of a single word or short phrase that differs by varying degrees ranging from one negative extreme to its polar opposite positive extreme (e.g. from *strongly disagree* to *strongly agree* or *not at all likely* to *highly likely*). From the range of options presented, respondents are generally instructed to choose only one to indicate their level or degree of agreement or disagreement with the statement presented (see Figure 2-1 below).

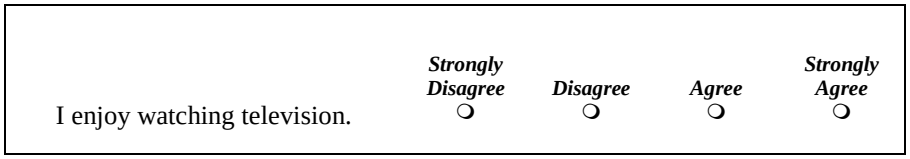

Figure 2-1. Typical item with the Likert scale response format.

Originally, Likert (1932) proposed attitudes could be measured with relative ease by using a five-category scale including three signature elements: The first two were designed to measure the direction (e.g., positive vs. negative or *agree* vs. *disagree*) and strength (*strongly agree vs. strongly disagree*) of the attitude and the third element served as a neutral point (*neither agree nor disagree*) for respondents who could not (or would

not) choose between the options presented. He also advocated the use of including *don't know* as a response option so researchers could make distinctions between people who had no opinion (or honestly did not know) and those who were genuinely neutral. While there is no consensus on the optimal number of response options to use, it is fair to say more researchers claim the ideal number is five (Lissitz & Green, 1975; Jenkins & Taber, 1977) or seven (Symonds, 1924; Grigg, 1980; Preston & Colman, 2000; Witteman & Renooij, 2002) than any other number; and most agree an odd number is best to allow for an "average" position on the scale (Grigg, 1980).

Response issues with LS items.

Because LS items are used so extensively in today's surveys, respondents may go into "auto pilot" mode when responding due to their over-familiarity with this format. That is, respondents may be less apt to fully consider responses before selecting one of the LS response options. This habitual response behavior might be avoided if respondents were presented with a "cognitive speed bump" (Lange & Söderlund, 2004) such as an alternative, less- commonplace item response format to force them to personally reflect on what each question really means and how best to respond (see, for example, Gardner, Cummings, Dunham & Pierce, 1998 or Shamir & Kark, 2004). Although the idea of designing a survey incorporating a response format (e.g., the VAS) that somehow gets respondents to pause and reflect rather than responding automatically makes sense theoretically, I question whether the novelty or positive effect(s) would diminish over time (or even over the course of the survey) as familiarity increases with each subsequent encounter. Moreover, because the validity and long-term effects of this survey design

approach are, to date, unexamined in survey research, it remains unclear whether using the VAS response option in place of the LS creates enough of a *cognitive speed bump* to have a significant effect on a survey's outcome or results.

Another common problem associated with LS items stems from a respondent's overuse of the mid-point (e.g., *neither agree nor disagree* or neutral response) or apparent refusal to select one of the options presented because they do not accurately reflect the response he/she wishes to convey (Brunier & Graydon, 1996). Holmes and Dickerson (1987) suggested that the midpoint of an odd-numbered LS response set may be an easy or "default" choice for respondents to make when they find it difficult to select a response that precisely conveys how they feel or perhaps find the item prompt too sensitive or painful to reflect upon. Under these circumstances, respondents typically opt to: 1) skip the item, 2) write in their own response, or 3) indicate their response by placing a mark *between* the options presented. As a result, data analysis can be compromised as such responses must either be dropped or imputed. These types of behaviors could potentially be avoided with an alternative response option that offers respondents more freedom to personalize their responses and that has the potential to achieve a more accurate estimate of the measured construct. One possible alternative that gives respondents the freedom to express their personal opinions more precisely is the *visual analogue scale* (Givon & Shapira, 1984).

The Visual Analogue Scale

The visual analogue scale (VAS) is a unidimensional scale—meaning only one ability, attribute, or dimension is measured at a time (Bond & Fox, 2001)—and is often presented as a single, horizontal[10] line anchored on the left side by the most negative statement or trait and on the right side by the most positive statement or trait. Respondents are typically asked to select a point along the continuum between the two extremes that best matches their degree of alignment or strength of agreement with some statement (see Figure 2-2 below).

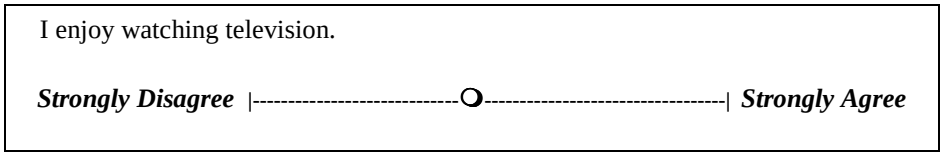

Figure 2-2. Typical item with the visual analogue scale response format.

By comparison, the LS response options (e.g., Figure 2-1 above) offer only a fraction of the VAS' possible response options, which are not limited to the LS' discrete set of pre-determined responses (e.g. *strongly agree, agree, disagree, and strongly disagree*). As an item response format, the VAS can be administered by itself (e.g., using a single item strategy for the measurement instrument) or in combination with other VAS to measure multiple constructs on multi-item instruments (Wewers & Lowe, 1990).

The VAS has been in existence for nearly 90 years. The first published research involving the VAS is attributed to Hayes and Patterson (1921), who introduced it as a

[10] The VAS can also be presented vertically with the positive trait or statement positioned at the top and the negative at the bottom of the scale, but it appears most often in the literature as horizontal.

"new method for securing the judgment of superiors on subordinates" (p. 98) and extolled the virtues of the VAS,[11] which they described as "simple, self-explanatory, concrete and definite" (p. 99). Although in the beginning, the VAS was used mostly for external-rater or objective measurements (e.g. job evaluation or task performance), over the years, it became increasingly associated with the measurement of subjective phenomena such as "feelings, perceptions, or sensations [which are traditionally] difficult to measure on scales with predetermined intervals [e.g. Likert scales]" (Lee & Kieckhefer, 1989, p. 128).

The bulk of the published research involving the VAS has been, to date, focused on adult populations. Of this research, the most comprehensive and well-documented studies involving the use of VAS are found in the medical or health-related field's *pain* literature, where it has been regarded as the best method or "gold standard" for the subjective measurement of pain (Yarnitsky, Sprecher, Zaslansky, & Hemli, 1996; Scott & Huskisson, 1976). In general, the *pain* literature involving adults has been mixed. Proponents have argued that the VAS:

1. *can have better responsiveness* (i.e. ability to detect clinically significant change) than the Likert scale (Ohnhaus & Adler, 1975)
2. *can yield a greater variation of scores and produce scores more normally distributed than LS formats* (Brunier & Graydon, 1996; Grigg, 1980)
3. *can be easy to understand and use—especially for non-native speakers and individuals with less-than-average reading ability* (Pfennings, Cohen, & van der Ploeg, 1995; Ahearn, 1997; Kerlinger, 1992; Freyd, 1923)
4. *may require little to no verbal or reading skill* (Lee & Kieckhefer, 1989)

[11] Hayes and Patterson (1921) referred to their scale as a "graphic rating method," which, for all intents and purposes, is a VAS.

5. *can be administrable in a variety of settings* (Averbuch & Katzper, 2004)

6. *can yield a more sensitive and accurate representation of the measured construct* (Grant, Aitchison, Henderson, Christie, Zare, McMurray, et al. 1999; Sriwatanakul, Kelvie, Lasagna, Calimlim, Weis, & Mehta, 1983; Witteman & Renooij, 2002)

7. *can be easy to score* (Joyce, 1975)[12]

Conversely, critics of the VAS have presented less favorable views. Some studies have shown respondents disliked VAS items because they are 1) "harder" than LS items; 2) take more time to complete; and 3) require training because of their unfamiliar format (Jaeschke, Singer, & Guyatt, 1990; van Laerhoven, et al., 2004; Williamson & Hoggart, 2004).[13] Further, some researchers have presented evidence suggesting respondents may find the VAS difficult to use because it requires them to think about responses in terms of (or within) a "mathematical dimension" (Duncan, Bushnell, & Lavigne, 1989; Joyce, Zutshi, Hrubes, & Mason, 1975).

Although it has been widely used in other fields since the 1920's in clinical and research settings (Wewers & Lowe, 1990), the educational survey research literature is virtually silent on the VAS. Moreover, of the published studies involving VAS items or indices, the vast majority have focused on adult populations (e.g., 18 and older) and results can not necessarily be extrapolated to K-12 populations (e.g., younger than 18). Moreover, it remains to be seen whether results observed in studies with adults are

[12] Especially now that VAS can be administered via computer and scored electronically rather than by hand as with the paper-pencil versions.
[13] It bears noting that the vast majority of these studies involved respondents that were at least 18 years old.

constant over different measurement contexts (such as schools), respondent groups (such as K-12 students), or traits (such as identification with school).

Likert Scales: Ordinal or Interval?

Likert scales are a controversial "middle case." Proponents of the use of interval measurement of LS response options argue that

> although most measures used in sociobehavioral research are not clearly on an interval level, they are not strictly on an ordinal level either. In other words, most of the measures used are not limited to signifying "more than," or "less than," as an ordinal scale is, but also signify degrees of differences, although these may not be expressible in equal interval units (Pedhazur & Schmelkin, 1991, p. 28).

Technically, data obtained from fully anchored LS (e,g., all response options are labeled and arranged as fixed anchor points from *Strongly Disagree* to *Strongly Agree*) are considered to be inherently ordinal because respondents most likely do *not* uniformly perceive the specified anchors as forming equal intervals (Goldstein & Hersen, 1984). Critics of the legitimacy of claiming the LS can be measured at an interval level maintain that the degrees of separation between terms do not represent equal units (Williamson & Hoggart, 2004), which would, of course, mean data obtained via mathematical averaging would be untenable.

Since, traditionally, the numbers assigned to Likert response options are arbitrary (e.g., 1-5) and do not have any meaningful connection to the responses they represent (Hasson & Arnetz, 2005), one cannot assume the difference between *Agree* and *Strongly*

Agree is equal to or the same as the difference between *Disagree* and *Strongly Disagree*. This is not to say the numbers associated with LS response options do not have meaning, it is just their meaning is not very precise because they do not represent "like quantities." For example, with a quantity such as dollars, the difference between $1 and $2 is the same as between $2 and $3. This is not really the case with numbers associated with LS response options. For example, if a survey item has four response options, researchers can be sure nearly all respondents understand a rating of two (*Disagree*) is *between* a rating of one (*Strongly Disagree*) and a rating of three (*Agree*), but they cannot be sure respondents interpret that *Disagree* lies precisely halfway between *Strongly Disagree* and *Agree*. This is also true with an odd number of LS response options (e.g., five or seven) where, for example, the mid-points of the scale are often presumed to be "neutral," meaning *Neither Agree nor Disagree*. Here, one cannot be sure respondents interpret that this response option lies precisely halfway between *Strongly Disagree* and *Strongly Agree* or that respondents do not have even a slight preference toward one or the other. For example, if a respondent does not fully *Agree* with the item prompt but is forced to choose a response, he may decide the next lower option serves as a better indicator. Thus, this respondent's overall or summated score will be negatively biased or lower than it should be.

Depending on the frequency with which this biasing effect occurs over the course of an entire LS survey, a respondent's summated score may be significantly different from what it would be if he were given the opportunity to respond with an interval-level

response option such as the VAS,[14] for example. In cases such as these, the LS fails to accurately capture respondents' true intentions because it assumes a single interpretation of all response options when respondents may (and most likely do) have varying degrees of *Agree*-ment in mind when selecting their responses.

Visual Analog Scales: Ordinal or Interval?

VAS responses are not as constrained as LS responses because technically, the VAS are continuous scales of measurement essentially offering an infinite number of places along the line to indicate one's response as opposed to the LS's typically limited four to seven responses (Noel & Dauvier, 2007). Although in practice, researchers tend to divide the VAS line up into an ordered, defined number of segments to make it easier to measure or score survey responses, respondents do not see these divisions in an effort to promote the perception and interpretation that the VAS line is a continuous response format. With the possibility of constructing online versions of surveys, previous recommendations based on paper-based surveys with VAS response options no longer apply. For example, according to several empirical studies involving paper-based VAS surveys, researchers have used varying lengths ranging from 5cm to 10.5cm, although 100mm (or 10cm) is most often used because it can be broken into 100 equal segments of 1mm each[15] (Grigg, 1980). However, when presented online for Web-based surveys, the length of the VAS line is difficult to standardize due to differences in screen sizes, video

[14] Of course, it bears noting that while the intervals in a VAS are considered equidistant, they may in fact *not* be equal in terms of intensity of a person's belief or her interpretation of the scale.
[15] Or 10 equal segments of 1cm each.

modes, settings, etc. Thus, pixels are likely to become the best unit of measurement. Another former problem associated with paper-based VAS items was the quantification of results, which required manual measurement (e.g., with a ruler) of each response for every survey. As you can imagine, this could present a huge burden to researchers, especially with large samples, not to mention problems with accuracy in measuring the precise distance from one end of the continuum to where the respondent placed his/her mark. This problem is all but eliminated with Web-based surveys because absolute judgments about where respondents place their marker are made possible via computer-programmed calculations yielding its precise location[16] along the VAS line, resulting in increased sensitivity and reliability of scores (Funke & Reips, 2007; Noel & Dauvier, 2007) in addition to faster scoring and retrieval of results for researchers.

To explore the impact on data quality and the measurement error of the VAS response option when administered online, Funke and Reips (2007a) conducted four Web experiments. In the first experiment, they demonstrated data from the VAS approximate the interval scale (e.g. equidistant) level and concluded the VAS should be used to measure continuous variables and parametric statistical tests are duly warranted. In experiments two and three, they compared LS items to VAS items and found the LS differs "systematically" from interval level and produces ordinal level data only. Their fourth experiment examined test-retest reliability of the VAS and LS by repeatedly administering a 40 item personality inventory and concluded, "although VAS facilitate a

[16] The degree of precision is limited only by the number of decimal points the researcher chooses to employ in the calculations.

far more precise judgment, there was no negative influence on retest reliability" (Funke & Reips, 2007a, p. 10).

Children and Surveys

The subjective and multidimensional nature of phenomena such as feelings, attitudes, or sensations can present particularly challenging measurement difficulties when working with children, especially younger children, because they are often limited developmentally in their abstract and verbal abilities (Tesler, Savedra, Holzemer, Wilkie, Ward, & Paul, 1991). According to Chambers and Johnston (2002), using and responding to rating scales accurately is a difficult developmental task for younger students. While the literature is inconclusive about whether it is appropriate to use chronological age as the primary or sole determinate of a child's ability to use scales such as the LS and VAS, doing so appears to be the prevalent method used by the majority of researchers (Shields, Palermo, Powers, Grewes, & Smith, 2003). A conventional alternative to using chronological age is to use cognitive development as a predictor of children's ability to use various scales successfully.

Cognitive Development

Piaget's concrete operations vs. formal operations.

Piaget conceptualized cognitive development as a series of periods or stages characterized by qualitatively different abilities (Piaget, 1970). Although Piaget identifies four stages of cognitive development, only his latter two stages—*concrete operations* and

formal operations—are applicable to this dissertation because the sample only included children ages 9 through 18.[17]

Piaget proposed children's thought processes gradually become organized and integrated with one another into larger systems of thought processes. These systems—known in Piagetian terminology as *operations*—allow children to pull their thoughts together in a way that makes sense, and thus to think logically. Such integrated and coordinated thought processes emerge at the beginning of the concrete operations stage. Although they are capable of many forms of logical thought and can exhibit many signs of logical thinking, their cognitive development is not yet complete and thus children in this stage of cognitive development (generally 7 to 11 years old) may find it difficult to grasp hypothetical scenarios that they cannot directly observe or experience or that are not true-to-fact. They may also have difficulty understanding abstract ideas or notions (e.g., democracy, human rights) and struggle with proportional reasoning or mathematical concepts such as infinity or negative numbers. These cognitive "limitations" could have an impact on a concrete operational child's ability to grasp the concept of the VAS response format, given that it is presented as a continuum (although no studies to date have investigated the legitimacy of this claim). To that end, this group of students may actually prefer the LS given its "concrete" presentation of verbal anchors or descriptors that could serve as a guide or signpost with which they could identify. This would support the findings of van Laerhoven, van der Zaag-Loonen, and Derkx (2004), who

[17] See Chapter 3 for a description of the sample and inclusion/exclusion criteria.

found that when surveying children[18] (ages 6-18, n=120) about their feelings[19] and opinions[20] the younger children (6-12) preferred the Likert scale over the VAS because they thought it was "easier to complete."

As children progress to the fourth and final stage, formal operations (generally 12 years old and above), they begin to be able to think about concepts having little or no basis in concrete reality—concepts that are abstract, hypothetical, or contrary-to-fact—and they become more independent thinkers capable of unique self-expression. Furthermore, children in the formal operations stage begin to recognize what is logically valid is different from what is true in the real world. A number of abilities essential for sophisticated mathematical reasoning also emerge in the formal operations stage that enable these children to use and understand proportions, ratios, and continuums in their reasoning. This would suggest students in the formal operations stage would not only understand the VAS, but may prefer it over the LS due to the ability of the VAS to allow them to convey precisely how they feel.

Children's Ability to Self-Report

While there are many important factors to keep in mind besides item response format when both designing and administering surveys for children (e.g., item phrasing, number of items, time constraints), it has been suggested the rater's (respondent's) competence to self-report is the most important of all (Guion, 1986; Cronbach, 1990).

[18] This study took place in the Netherlands and the subjects were described as either" immigrants (first, second or third degree non-native children) and native Dutch children" (van Laerhoven, van der Zaag-Loonen & Derkx, 2004, p. 831).
[19] These items asked the children about their feelings about dreams and their current mood.
[20] These items asked the children about school, sports, and height.

Research suggests children as young as 8 years old are able to provide reliable reports on their well being (Rebok et al., 2001). However, asking children using survey-style questions may be a major challenge especially with younger children because their views and opinions are often "black and white," meaning no "shades of grey" exist in their views. Thus, younger children tend to respond to scale questions by selecting extreme values (e.g. very satisfied or very unsatisfied). Another challenge is that children's verbal and reading abilities have much more variability than those of adults and they often interpret response choices literally. As a result, survey items must be reviewed with the utmost care to ensure words used have the same meaning for all participants (Shields, Palermo, Powers, Fernandez, & Smith, 2005). Even though there is no perfect solution to all the problems arising from conducting surveys with children, most experts recommend that surveys are kept short because children tend to have short attention spans and that the survey is fun and administered in a child-friendly environment. Additional issues needing to be taken into consideration when conducting survey research with children include: (1) the level of literacy/reading level of respondents; (2) their tendency to want to choose a response they think will please the researcher rather than what they, themselves, truly feel; and (3) their responses tend not to be reliable over time (Borgers, Hox, & Sikkel, 2003).

Children and Likert Scales vs. Visual Analogue Scales

VAS have been used to assess the strength of perceptions of children in many clinical and research settings. While numerous studies have used the VAS with children (e.g., Champion, Goodenough, von Baeyer, & Thomas, 1998; Goodenough, Addicoat, Champion, McInerney, Young, Juniper, et al., 1997; Svensson, 2000), and several have demonstrated the ease of use, effectiveness, and sensitivity of the VAS when used with children (Abu-Saad, 1984; Abu-Saad & Holzemer, 1981; Abu-Saad, Kroonen, & Halfens, 1990; Berntson & Svensson, 2001), results tend to be mixed with regard to children's opinions about using the VAS. For example, some studies on pain experience in children found that they preferred the VAS over a Likert-type response option because of its specificity and accuracy (Stinson, Kavanagh, Yamada, Gill, & Stevens, 2006) and because the VAS "felt the most free to answer" and allowed them to "put a mark wherever [they] want" (Berntson & Svensson, 2001, p. 1134);[21] whereas others found children, regardless of age, preferred the LS response option to the VAS because it was "easiest to complete" (van Laerhoven, van der Zaag-Loonen, & Derkx, 2004)[22] or because it provided "more choices" (Rebok et al., 2001).[23] In theory, children with less reading potential such as younger children or children with limited English (or majority

[21] This study involved Swedish children 2-18 years old (n=26) suffering from juvenile chronic arthritis and examined their perception of pain using three different scales: VAS, graphic rating scale (which is like the VAS but has word descriptors at specified points beneath the line), and a 4-point verbal descriptor scale (which is essentially a Likert scale with more detailed response options). Results of this study should be interpreted with caution due to its small sample size.

[22] This study involved Dutch children 6-18 years old (n=120) and examined their preference for the LS, VAS, or a 10-point numeric rating scale. It also asked the children to evaluate the level of difficulty they had with each response type. The questionnaire used in the study asked basic questions about students' dreams, frequency of riding the bus to school, views on sports, television, and school, and about students' general feelings.

[23] Due to its small sample (n=19), conclusions from the Rebok et al. (2001) study should be interpreted with caution and perhaps considered tentative, at best.

language) proficiency would be more likely to prefer VAS response options because VAS response options generally require shorter reading times and less sophisticated reading skills than LS response options; however, as van Laerhoven, et al. (2004) reported, these groups differed as well with younger, native Dutch children preferring the Likert scale due to its ease of use and "non-native" immigrant children preferring the VAS because they found it to be simple and made filling out the survey easier for them.

VAS and Children

As with studies involving the use of VAS with adults, the most comprehensive and well-documented studies involving the use of VAS with children are found in the medical or health-related field's *pain* literature. Here the VAS is often used as a *pain scale* and is presented in a number of formats including: 1) the basic, horizontal VAS line (e.g., Figure 2-2 above), or 2) the basic VAS with verbal descriptors along the line and sometimes scale marks dividing the line into distinct segments,[24] or 3) the strictly non-verbal VAS format, which typically presents the basic horizontal VAS line with illustrations or faces in varying degrees of distress on each end of the continuum (as opposed to verbal descriptors such as "strongly disagree" on one end and "strongly agree" on the other). With the non-verbal format, which is typically used with children too young to read, the child rates her degree of pain or discomfort, for example, by using the facial expressions on either end as indicators of where to mark her response on the VAS to indicate her current state, where *no pain* is typically indicated by a smiling face

[24] Some authors refer to this type of VAS as a "graphic rating scale" or GRS

and *pain as bad as it ever can be* is typically indicated by a frowning, crying face (Lee & Kieckhefer, 1989). In addition to measuring the *intensity* of pain, the VAS has been used to measure the *frequency* of pain. Figure 2-3 below depicts a hybrid of the verbal and non-verbal visual analogue scales that includes both verbal and visual cues. This item was one of several used along with cognitive interviewing to examine school-aged children's self-reported health (Rebok, et al. 2001).

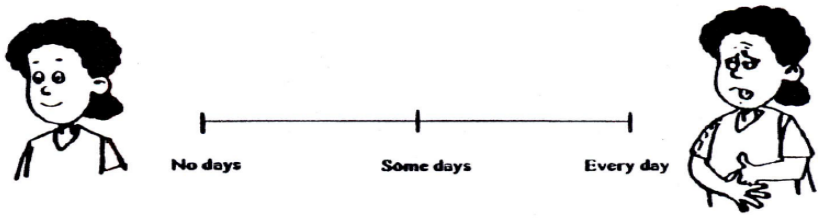

Figure 2-3. Pediatric health status questionnaire item measuring the frequency of stomachaches for children 6-11 years old.

Interestingly, much of the pediatric pain research literature demonstrates the same measure or scale should *not* be used with all types of pain, in all types of circumstances, or with all types of children's populations. In their extensive review of self-report pain measures for use in clinical trials in children and adolescents (ages 3-18), Stinson, Kavanagh, Ymada, Gill, and Stevens (2006) sought to identify only well-established measures that met a priori criteria of having sound empirical evidence of their reliability, validity, responsivity, interpretability, and feasibility. Of the more than 30 pediatric self-report pain intensity scales they identified, only six—one of which was the VAS—met all of the inclusion criteria (see Stinson et al. 2006, p. 147 for exclusion rationale). The results of this study led the authors to conclude that of the six measures included in their

review, “no single scale was found to be reliable and valid across age groups or pain types” (p. 153). This evidence suggests children of different ages (where age is a proxy for developmental level) *can* be expected to self-report effectively or accurately with various response formats as long as the instruments used are age appropriate and appropriate according to the children’s cognitive development and ability. This corresponds to the findings of several other studies that suggest that age, cognitive development, and cognitive ability are the best predictors of whether a child is capable of using scales such as the VAS or LS (Cremeens, Eiser, & Blades, 2007; Malviya, 2006; Shields, Palermo, Powers, Grewes, & Smith, 2003). These findings also suggest the use of the LS may *not* be appropriate across all grade levels or ages or across all contexts or constructs as it is often used presently.

VAS and children’s ability to understand measurement and scale.

Duncan, Bushnell, and Lavigne (1989) maintain that “non-verbal tests, such as the visual analogue scale require a person to imagine his pain in terms of a mathematical dimension, a task that may be difficult…especially for some age groups” (p. 301). Given the typical design of the VAS, with its presentation of a continuum between two diametrically opposed verbal or visual descriptors (e.g., *strongly disagree/strongly agree*, *never/always,* ☺/☹), children need to have at least a basic understanding of how to convey an intrapersonal physical or emotional experience, for example, within the parameters of a linear or mathematical format. That is, children need to be able to connect what they are feeling with what it means to place a mark on the VAS closer to

one end of the line versus the other end. This skill requires the use of analogy and proportional or spatial reasoning and the use of estimation.

Research has shown that children as young as three and four years old demonstrated analogical reasoning and an understanding of proportional reasoning (Goswami & Brown, 1989; Singer-Freeman and Goswami, 2001); however, in order to use the VAS effectively, children must also be able to form an estimate of what they are feeling, for example, and to quantify that estimate in terms of its linear magnitude or proportion of the VAS line that best expresses their feeling.

According to Sowder (1992), in order to form an estimate, "one must have a mental reference unit, that is, a mental 'picture' or 'feel' for the size of the unit" (p. 371). Thus, children using the VAS need to be able to establish a "mental reference unit" of the pain they are feeling, for example, and visually estimate its magnitude in relation to the VAS line. This process has been facilitated by the use of verbal or visual end-point indicators on the VAS line that children can connect with. Rebok et al. (2001) demonstrated that children as young as five years old were able to use the VAS effectively when illustrated characters were used with whom children could identify and "who illustrated the health concept…used to anchor each end of the [VAS]" (p. 63). This suggests that when children are able to connect their "mental reference unit" with the reference unit(s) used for VAS items, whether they be visual or verbal, children can use the VAS effectively and have a working understanding of what various points along the continuum indicate for them personally.

VAS and K-12 educational research.

While little is known in K-12 educational research about how students respond to various item response formats in general (Chambers & Johnston, 2002), virtually nothing is known about how they respond to a survey measuring education-related outcomes in a school setting using VAS response options (Myford, 2002). Only two studies to date have looked at how K-12 students respond to VAS, but neither looked at education-related issues or measured attitudes or beliefs relevant to schools. Furthermore, neither study involved the online administration of the VAS survey.

One study involved a convenience sample of Kindergartners (n=40, ages 5-6) who were asked to rate the size of various circles using a VAS to indicate their perception of each circle's size (Shields, Palermo, Powers, Grewes, & Smith, 2003). The results of this and two follow-up studies suggested the VAS was not effective or useful with children younger than seven because they do not fully understand the concept of a sliding scale with a virtually unlimited continuum of response options (Shields, Cohen, Harbeck-Weber, Powers, & Smith, 2003; Shields, Palermo, Powers, Fernandez, & Smith, 2005). The second study involving students using a VAS in a school setting involved a convenience sample of children (n=958, ages 8 to 17, grades 3 to 12) recruited for a study testing the validity and developmental appropriateness of five different pain intensity scales (Tesler, Savedra, Holzemer, Wilkie, Ward, & Paul, 1991, *Study 1*). The purpose of this study was to determine which scale type the children preferred and which they

thought hospitalized children[25] would find easiest to use (Tesler et al., 1991). The results of this study reported that although the VAS was a valid and reliable measurement of children's pain, the VAS was the *least liked* scale (only 27 out of 896 of children or 3% chose it as their favorite) and it was judged to be *easiest to use* by only 5% of the sample (which was the lowest percentage of the five scales used in the study). Upon examining the "ease of use" data further using chi squared tests of significance, Tesler et al. discovered that age, ethnicity, and first language were significantly[26] associated with children's selection of their favorite scale.

While Tesler et al. did not speculate why the VAS was not well received by the children in their study, there are several aspects that could have contributed to this finding. First, children were required to evaluate a set of five drawings using each of the five item response types being assessed in the study. Each drawing was copied five times with a different item response type on the bottom of each drawing and "randomly assembled" into a packet given to each child who then completed 25 individual assessments. Thus, fatigue and/or boredom could have impacted to children's evaluations as they went through the 26 page packet of drawings (the 26th page was used to measure student preference for the item response type they liked best). Second, the way that item response types were presented could have affected student response. Of the five scales assessed in the Tesler et al. study, the VAS was the *least* visually appealing, appearing as a plain black line at the bottom of the page and the words, "No Pain" and "Worst Possible

[25] "Well children were selected for this [study] because the task was considered to be too taxing for children who were hospitalized and potentially in pain and a large sample was required to evaluate the effects of gender, age, and ethnicity" (Tesler et al.. 1991, p. 363).

[26] Age: $\chi^2(16) = 58.8, p < .0001$, ethnicity: $\chi^2(20) = 65.5, p < .0001$, English proficiency: $\chi^2(4) = 20.5, p < .001$

Pain" at either end of the line. The most popular scale, by far, was the "Color Scale," which appeared in colors that "ranged from yellow, through orange and deepening shades of bright red" (1991, p. 364). Given that the Color Scale as it appeared in this study was nothing more than a "colorized" VAS with a half-inch wide color bar instead of a plain black line (the same verbal descriptors appeared at the ends of both scales), there seems little else than visual appeal to justify children's preference for the former.

It bears noting at this juncture that none of the above studies presented the VAS items online or electronically but instead administered the items via the traditional paper-pencil method. This may have negatively influenced the children's opinions of the VAS in the Tesler et al. (1991) study. Research has shown "preferences [for one scale type over another] can be influenced by extraneous factors such as visual appeal" (Cremeens, Eiser, & Blades, 2007, p.133) and stylistics elements such as color, shape, or the presence or absence of visual elements (e.g., mid-points, verbal-, or numeric indicators) on response options. Given that the VAS was presented as a simple line with a verbal indicator at each end whereas the others incorporated color and/or verbal- or numeric features, it is possible the children's preferences were influenced by aesthetics. To that end, results may have been different if these surveys were administered online because the VAS would be more interactive and could include more visually appealing and/or engaging elements.

Web-Based Surveys

Web surveys in general are becoming increasingly attractive to today's researchers because they are relatively inexpensive to create, administration can be quick and easy, and results can be obtained in a fraction of the time it would take for traditional paper-based surveys. However, good Web surveys (as measured by accepted indicators of survey quality) require a little extra effort because researchers must take into consideration not only the population they are trying to reach but also mode-specific issues related to the format of the response options, the types of questions being asked, as well as the data collection process.

VAS and Web-based research

As mentioned above, one noticeable gap in the current literature is that no studies have looked at how K-12 students respond to the VAS online. To be fair, there is a dearth of studies involving Web-based VAS surveys with *any* population, so the fact that the K-12 student population has thus far been excluded from these investigations is not unexpected. For obvious reasons, the vast majority of studies that have been published to date involving survey research with VAS items have been conducted using the paper-pencil format. It has only been roughly ten years since the first published study that included a computerized VAS survey component and seven years since the first web-based study involving the VAS. In 2000, Stubbs, Hughes, Johnstone, Rowley, Reid, Elia, et al. used hand-held *Apple Newtons*[27] to administer a scale measuring 20 adults'[28]

[27] Apple Newton Message Pad (Apple Computer Inc., Cupertino, CA, USA).

motivation to eat. The graphical user interface and use of a stylus essentially replicated a paper-based VAS and enabled respondents to indicate responses by marking on the screen along the presented continuum.

In 2001, Cook, Heath, and Thompson (2001) created a web-based survey assessing users' perceptions of library service quality (n = 420).[29] The purpose of this study was to compare *sliders* (VAS) with numeric scales with 1 to 9 *radio-buttons* (which are the analogue to an LS) to determine effects on score reliability and whether respondents were able to cognitively discriminate between the varying levels of measurement sensitivity or fineness. The study also investigated whether sliders improved score reliability and how scale coarseness affected reliability by administering a 41-item survey consisting of 7 subscales and one of 2 different item response formats: a slider format with 1-100 scale points and a 1-9 radio-button format. Interestingly, the authors also rescored the slider data on a 1-to-5 and 1-to-9 scale to determine scale coarseness effects on score reliability. Results suggested that for the three slider formats, reliability increased monotonically as scale points went up although the differences between the alpha coefficients for the 1-to-5 and 1-to-100 formats were not appreciably different (e.g., .694 vs. .714, respectively, for one of the subscales). Surprisingly, the 1-9 radio-button format yielded the *highest* alpha coefficients of all four item response formats and six of the seven sub-scales' total scores. Once again, however, differences were not large between the radio-button and, for example, the 1-to-100 slider format

[28] Subjects were described as 10 men (ages 22-39) and 10 women (ages 22-32).
[29] Total sample size was 4,407 but authors purposely over-sampled the radio-button format by collecting data from 3,987 respondents (Cook et al. 2001, p. 702). Sample consisted of undergraduate and graduate students as well as faculty and other university employees and 12 disciplines were represented. Ages ranged from "younger than 22" to "older than 45."

(e.g., .965 vs. .960, respectively for one of the subscales). The authors concluded although the sliders may have slightly increased the time,[30] on average, for respondents to complete the survey, the sliders have a "psychometric advantage of communicating to respondents that they are responding on an interval continuum" (Cook et al. 2001, p. 705).

Web-based vs. paper-based VAS surveys.

With the advent of computerized surveys, the old reason for not using VAS (e.g., it is difficult to standardize the length of the line when copying, they take to long to score, etc.) no longer applies. Photocopied or mimeographed paper or hard copies are replaced with on-screen survey presentation, data can be quickly retrieved for analysis automatically when data are downloaded directly into a database, and surveys can be scored accurately and consistently by the computer rather than manually by hand. Thus, by administering the VAS via Web surveys, surveying of large samples becomes feasible.

Computerized versions of VAS surveys are quite different from the traditional paper-and-pencil format in terms of their construction and how data are quantified. Whereas the paper-based VAS construction is very simple and done by virtually anyone (e.g., just draw a line), quantification of results can take weeks due to the scoring process[31] and preparing the data for analysis can take time because data have to be manually entered into a database. For Web-based VAS surveys, essentially the opposite is true. Their construction can be very challenging (e.g., requiring labor-intensive

[30] "On average, participants using the Web-based slider response format took 71.2 seconds longer to complete the survey" (Cook et al., 2001, p. 704).

[31] Because each survey has to be hand-scored using a ruler or some other type of manual device to measure from the point of origin (left-most side of the continuum) to the place where respondents marked on the line to indicate their response to each item.

programming skills) and expensive (e.g., costs involving survey development and Web site hosting), but quantification and preparation for data analysis are relatively easy. Here, the Web-based VAS survey has a distinct advantage over the paper-based format. Whereas on paper, the researcher has to measure each rating manually—which takes a lot of time, energy, and resources and can be prone to errors—if the survey is online, the calculations are automated, fast and precise, and can be downloaded directly into a database. In an effort to make creating VAS survey easier, one site now offers freeware that can generate the items relatively quickly and easily. See, for example, the Java-based tool developed by Zikmund-Fisher and Johnson of the Center for Behavioral and Decision Sciences in Medicine and described in Couper, Tourageu, and Conrad (2006) or the freeware, "VAS Generator" provided by Funke and Reips (2007b) at http://www.vasgenerator.net/index.php.

Mode Effects and Sensitive Questions

The literature on sensitive questions demonstrates the method of collecting data can affect the answers obtained. According to Tourangeau and Smith (1996), "a question is sensitive if it raises concerns about disapproval or other consequences (such as legal sanctions) for reporting truthfully or if the question itself is seen as an invasion of privacy" (p. 276). Several studies have demonstrated self-administration methods such as the Computer Assisted Self-Interview (CASI) can increase the levels of the reporting of sensitive questions relative to administration of the same questions by an interviewer (Aquilino, 1994; London & Williams, 1990). Data suggests respondents are reluctant to

admit to an interviewer they have engaged in illegal or otherwise embarrassing activities (Aquilino & LoSciuto, 1990).

By itself, computerization of the data collection process may increase the accuracy of the responses given to sensitive questions. Comparisons of computer-assisted self-interviews (CASI) with traditional paper-and-pencil interviews suggest computer administration of survey items produces gains similar to those from conventional self-administration because respondents rate the CASI survey as more private and less embarrassing (Tourangeau & Smith, 1996; Bowling, 2005a). Researchers have obtained 30 to 35 percent gains in reported sensitive information when a computer administers survey questions than when an interviewer conducts a face-to-face interview (Waterton & Duffy, 1984; Lucas, Mullen, Luna, & McInroy, 1977).

One drawback to using CASI, according to Tourangeau and Smith (1996) is "by requiring respondents to read the questions, it is subject to some of the same limitations as other methods of self-administration. The requirement that respondents read the questions and follow the directions may make it difficult to use CASI among populations with poor reading skills [such as younger children, ELL/ESL/LEP students]" (p. 281).

Summary

In general, chronological age has been one of the best predictors of a child's accurate use of a VAS (Shields et al., 2005). While studies involving children have been conducted to determine how they respond to the VAS (e.g., Did they like it? Did they find it easy to use? Did they understand how to use it?), the vast majority were conducted

in a clinical or hospital setting and none, to date, have been specifically designed for K-12 students in a school setting to measure school-related attitudes. Moreover, none to date have directly compared the VAS to the LS using the same survey—either online or otherwise—to determine if there are any outcome effects for K-12 students that may impact a survey's accuracy and reliability.

Chapter 3: Methods

Introduction

The purpose of this chapter is to present the research design used in this study. In particular, the following discussion provides a description of how the study sample was obtained, the data collections methods following, the survey instruments used, and the statistical analyses used in the present study. The chapter concludes with the potential threats to the validity of this study.

Research Design

This study used a between-subjects two-by-three (2x3) experimental design with a blocking factor (school level). A randomized two-factor fixed-effects model was used to examine the effect of varying an online survey's item response formats on student outcomes using two formats with identical questions: one with only LS response options and the other with only VAS response options. The item stems were unchanged. The order in which the surveys were presented to students was randomly assigned to reduce the potential of order effects.

To conduct a true experiment, "at least one of the variables has to be manipulated, and subjects have to be randomly assigned" (Pedhazur, 1991, p. 506). For this study, the *manipulated* variable (Factor A) was the response format, which had two levels: LS and VAS. Because I wanted to maximize the chances of demonstrating an experimental

effect, this study focused exclusively on an homogeneous sample by including a *blocking* variable (Factor B), level of schooling. The blocking variable had three levels: *Upper Elementary*, *Middle*, and *High School*. These three groups were purposively selected in an effort to examine whether differences in school level were associated with differences between the LS and VAS response formats. Further, these groups represented three commonly defined age groups. In the developmental psychology literature, it is generally accepted that children must proceed through several stages in their development toward adulthood. For most individuals, there are four or five such stages of growth: infancy (birth to age two), early childhood (ages 3 to 8 years), later childhood (ages 9 to 12) and adolescence (ages 13 to 18). For the purposes of this study, the adolescent stage was divided into early and later stages to correspond with the middle and high school levels of schooling. Thus, to match the targeted sample and blocking variable for this study, three groups based on level of development were formed: later childhood or pre-adolescence (ages 9-12), early adolescence (ages 13-15), and later adolescence (ages 16-18). These three groups were organized as follows: The *Upper Elementary* level comprised grades 4-6, the *Middle* level comprised grades 7-9, and the *High School* level comprised grades 10-12.

Participants were grouped or *blocked* by the school level (e.g., elementary, middle, or high school) that roughly corresponded with the appropriate age group/level of developmental stages described above and then randomly assigned to one of two conditions: Participants in *condition 1* comprised students who were administered the survey with LS items first and *then* the VAS version and those in *condition 2* comprised

students who were administered the survey with VAS items first followed by the LS items. Simple random assignment via a computer-generated randomization program was used to assign each participating student to one of the two conditions. Table 3-1 below represents how the groups were defined:

Table 3-1: Randomized Treatment Conditions

		School Level (*Between-Subjects Blocking Factor B*)		
		***B*$_1$**	***B*$_2$**	***B*$_3$**
		Upper Elementary *(grades 4-6)*	***Middle*** *(grades 7-9)*	***High School*** *(grades 10-12)*
Response Type (*Within-Subjects Manipulated Factor A*) ***A*$_1$**	***Likert***	$X_{A_1B_1}$	$X_{A_1B_2}$	$X_{A_1B_3}$
***A*$_2$**	***VAS***	$X_{A_2B_1}$	$X_{A_2B_2}$	$X_{A_2B_3}$

Where $X_{A_1B_1}$, $X_{A_1B_2}$, and $X_{A_1B_3}$ represent *Upper Elementary*, *Middle*, and *High School* students respectively taking the survey with LS items first followed by the VAS version and where $X_{A_2B_1}$, $X_{A_2B_2}$, $X_{A_2B_3}$ represent *Upper Elementary*, *Middle*, and *High School* students respectively taking the survey with VAS items first followed by the LS version.

Justification for the Experimental Design

The primary purpose of the experimental design is to observe the combined effects of the factors, *item response type* and *school-level*, as they act together and/or separately to influence the outcome variable (*Identification with School*). This design provides: A) main effects, which refer to the effect of *item response type* when *school level* is ignored; B) simple effects, which refer to the results of the single-factor experiments (e.g., *item response type* for *High School* students); and potentially C) interaction effects between the two factors (e.g., comparing simple effects of *item response type* with *school level* to see if such effects are the same or different across school levels).

Overall, although this type of study design can be challenging to implement effectively in K-12 classrooms, challenges were overcome by taking proper precautions to maintain as much control as possible over conditions. To do so, implementation procedures were standardized, teachers were instructed on the importance of providing a stress- and interruption-free environment for the students to take the survey, and adequate participant instructions were provided to clearly explain each step of the process.

Sampling Method

Teacher Recruitment

Teachers of grades four through twelve were invited to contact me if they were interested in having their class participate in the study. Posts on teacher-focused

LISTSERVs as well as emails to several districts and schools with details of the study were used as the primary modes of recruiting (see Appendix E). Thirty six teachers responded and requested additional information about the study. Of the 36 teachers who contacted me about the study, 32 agreed to participate and confirmed that their students fit the inclusion criteria (described below in the *Participants* section. Once teachers successfully registered to participate in the study, they were sent the information necessary for students to access the Web-based survey. Teacher participation was incentivized by offering the chance to win a new 4GB Apple iPod Nano® or one (1) of three new 1GB Apple iPod Shuffles®. A drawing was held after all survey data were collected and winners were notified via the email address they initially provided to participate in the study.

Student Participation

Once teachers received the survey access information, they were instructed to tell students that they did not have to participate in the study if they did not wish to do so. Teachers were further instructed to not unduly influence or otherwise exert any pressure on any students to take the survey or participate in the study. Participation in this minimal risk study was completely voluntary and all participants had the right to withdraw consent or discontinue participation at any time. To access the survey, which was active for 60 days to accommodate teachers' and students' schedules, teachers were instructed to either write the Web address on the chalkboard or to create a shortcut on the computer desktops or a bookmark that students could use to access the online survey

directly. Once students accessed the online survey, they were presented with a brief description of the study and told that they did not have to participate unless they wanted to (see Appendix F). Students were given a choice of either clicking on a button saying, "I DO want to participate," at which time students were hyperlinked to the survey "Welcome" page and instructed to start the survey (see Appendix G) or "I DO NOT want to participate," at which time they were re-directed to a "Thank You" screen that concluded their participation in the study (see Appendix G).

Participants

Inclusion Criteria

The reading level[32] of the survey and post-survey questionnaires was 4th grade and above; therefore, participants comprised a convenience sample of only 4th through 12th grade students. It was assumed that all participants could, at a minimum, read at a 4th grade level.

Exclusion Criteria

Although the typical 4th grade student and 12th grade student in the second-half or spring semester of the school year is 9 or 10 and 17 or 18 years old, respectively, there was no way to determine if a student had been retained or promoted ahead of his/her

[32] Details on how reading level was determined are discussed below.

peers. Participants were excluded from the study if their reported aged was younger than nine years old or if they failed to provide their age and grade.

Another important consideration was that the survey was publicly available and log-in information was not required to access the survey, therefore a possibility existed that students in 2nd or 3rd grade or perhaps college-aged students, for example, could have attempted to take the survey. To reduce the likelihood of students outside of the specified ranges gaining access to the study site, two processes were established: First, only those teachers who agreed to let their classes participate in the study and whose students met the inclusion criteria were sent the Web address via email to enable student access to the survey. Although this could not control for teachers or students who may have given the link to colleagues or friends, for example, this process attempted to control the number of people given direct access to the survey. Second, the demographic questionnaire—which was given to students after they took both versions of the survey and the post-survey questionnaire (details below)—included two items designed to "flag" students who were not in 4th-12th grade and/or were younger than age nine. The grade-level item ("*What grade are you in?*") included responses ranging from 1st grade to 12th grade as well as an "*other*" option. Those students who responded they were in any grade lower than 4th were excluded from the study. Similarly, the age item ("*How old are you?*") included responses ranging from 5-18 as well as a "*19 or older*" option. Accordingly, students who selected any age younger than nine or who failed to provide their age and grade were excluded from the study. One additional criterion for exclusion was for those students who responded with a single response option for an entire scale (e.g., all 1's or all 99's).

Due to the nature of the items on the *Identification with School* survey, a single response for all items was inappropriate and inconsistent with the construct being measured and therefore considered evidence that the student did not take the survey seriously or did not understand the questions.

The specified inclusion/exclusion criteria above attempt to reduce the number of factors that could potentially confound or bias the results. By including only students who were age- and/or grade-appropriate and who responded appropriately to survey items, it could be argued that a reasonable effort had been put forth to control for extraneous variables that could possibly have confounded the results.

Random Assignment

In an effort to make the groups probabilistically equivalent random assignment was used so every member in the sample had an equal chance of being assigned to either treatment condition. The intent of conducting random assignment was to remove all initial systematic differences among treatment groups. Random assignment also had the effect of probabilistically equalizing the contribution of all other extraneous variables across both treatment conditions. In the experiment conducted in this study, the item response format on each version of the survey was the only systematic difference introduced. As such, this manipulated factor would theoretically be the "cause" of any statistically significant differences observed in the outcome of the experiment.

Effect Size, Power, and Sample Size

Effect size.

A meaningful effect size was considered one that was "substantively" meaningful. In other words, one that would be the smallest effect a researcher could hope to find and still feel confident in concluding his investigation had yielded practical and useful information. Effect size *delta* (δ) values are typically in the range of zero to three. In social science applications, values of δ = 0.2, 0.5, and 0.8 or greater correspond to "small", "medium", and "large" effects, respectively (Cohen, 1988) and are specified by the difference between the largest mean and the smallest mean, in units of the within-cell standard deviation as follows:

$$\delta = \frac{\text{(largest mean) - (smallest mean)}}{\sigma} \qquad (3.1)$$

where δ is effect size delta and σ is *sigma*, which is equal to the (common) within-population standard deviation or the square root of the mean squared error (MSE) (Cohen, 1988, p. 274).

Power and sample size.

Determining the sample size for a factor or effect can be difficult for experimental designs because of the need to specify *all* of the treatment means in order to calculate the non-centrality parameter of the *F*-distribution, on which power depends (Tabachnik & Fidell, 2001). The minimum power specification corresponds to the alternative hypothesis that all means are equal to the grand mean. The computations for power and

sample size assumed: (a) fixed effects, and (b) equal sample sizes in all treatments. Under these assumptions, the non-centrality parameter of the *F*-distribution can be calculated as: $\frac{\mathrm{N}(delta^2)}{2}$, where N is the sample size per treatment.

The sample size estimate for this study was based on the hypothesis that the younger students' summated group scores on the Web-based, *Identification with School* survey would be statistically significantly different (e.g., higher or lower) than the older students' as a function of the item response format presented. *G-Power 3.0.1* was used to calculate the power for this study (Faul, Erdfelder, Lang, & Buchner, 2007). To achieve the standard 80% power to detect a meaningful effect size, which was established as .20[33] with an alpha of .05 (Cohen, 1988), a total sample size of at least 199 students was determined to allow for the detection of effect sizes as small as .20 with a power of .80 [F_{critical}=3.889, α=.05, $\mu = (6-1) = 5$].

Instrumentation

This study sought to determine if students responded differently to the LS item response type compared to the VAS when presented with identical item stems on back-to-back surveys administered online. For the purposes of this study, the actual construct being measured was deemed secondary to the importance of measuring how students

[33] According to the Best Evidence Encyclopedia (2008), "an effect size of +0.20 (20% of a standard deviation) is considered by the Best Evidence Encyclopedia (and others) to be a reasonable minimum effect size worth paying attention to."

respond to the two item response types; nevertheless, I wanted to choose a survey that would be likely to yield *non*-neutral responses from the students. Therefore, I purposely selected an instrument that measured a construct with which I expected (nearly) all students could identify. That is, a construct with which my intended sample would likely be familiar or have a personal connection. The construct chosen was the student's identification with school and the instrument selected for this study was the *Identification with School* survey (Voelkl, 1996).

Identification with School Survey

The *Identification with School* survey (Voelkl, 1996) comprises 16 items designed to measure a student's identification with—or personal sense of belongingness in—school and how important school and school-related outcomes are to the student (Voelkl, 1997; see Appendix A). Each of the original survey's 16 LS items had the same four response options: *Strongly Agree, Agree, Disagree, and Strongly Disagree*. These response options were left unchanged for the online version used in this study (see Appendix A). The reason that I decided to administer the LS version of the survey in its original form (e.g., no modification of item wording or response options) was because the only variable I was interested in manipulating in the current study was item response type. Therefore, the only change to the survey itself was to change the item response format from a bi-polar, four-point LS to a bi-polar, continuous-format VAS. To create the VAS version, only the original LS response options, *Strongly Agree* and *Strongly*

Disagree were used to indicate the two polar extremes of the continuum along which respondents placed their markers (see Appendix B).

Reported survey reliability.

Studies using the *Identification with School* survey in the literature have shown a composite test coefficient alpha reliability of .80 (Ruiz, 2002) and .84 (Voelkl, 1996) and both of these reported alphas were obtained with middle school students (e.g., grade 7 and/or 8)[34]. Additionally, in her initial report of the construction of this survey, Voelkl (1996) tested a single-factor model and a two-factor model. She determined that a single-factor model worked just as well as the two-factor model. Although Voelkl (1996) noted that "…the separate belongingness and valuing subscales [of the two-factor model] yielded scores reliable enough to suffice for some applications" (p. 768), she did not elaborate on the circumstances under which this claim would hold true. Voelkl reported individual alphas for her *belonging* and *valuing* subscales[35] of .76 and .73, respectively (1996).

Criteria for selection of instrument.

My criteria for selecting the *Identification with School* survey (Voelkl, 1996) included: 1) students in the specified grade-levels would be able to read and respond to the items; 2) students would likely feel personally motivated to respond to the items presented; 3) the original Likert format was easily adapted to a VAS format; and 4) it had

[34] Ruiz (2002) administered the survey to a sample of 173 Latino/Hispanic 7th and 8th grade public school students. Voelk (1996) administered the survey to a sample of 974 African American and 2,565 White 8th grade public school students (n=3,539).

[35] The subscale that measured a student's feelings of "belongingness" at school comprised nine items: 1, 2, 4, 5, 8, 9, 10, 12, and 13 whereas the subscale that measured his or her "valuing" of school and school-related outcomes comprised seven items: 3, 6, 7, 11, 14, 15, and 16 (see Appendices A or B)..

been shown to be a valid and reliable measure of student identification with school (Voelkl, 1996).

Survey Modifications

The *Identification with School* survey (Voelkl, 1996) was not originally designed to be administered online; therefore, a few adaptations were necessary. First, according to Thomas and Couper (2004), when administering VAS items respondents should only see one item at a time because respondents' "judgments with [VAS] may be affected by other judgments made on the same screen" which in turn may cause them "…to make evaluations that are less divergent[36] or…may increase their differentiation to distinguish responses one from the other" (p. 11). This approach was also advocated in recent online empirical studies by Torangeau, Couper, and Conrad (2007) as well as Gerich (2007). As a result, modifications were necessary so that only one item was presented on screen at a time rather than presenting the entire survey on a single screen (e.g., all items presented at once) in a table with the item stems in stacked rows on the left and the response options (e.g., *Strongly Agree*, *Agree,* etc.) listed once at the top as column headers.

Secondly, because some students might be unfamiliar with taking surveys online and/or would likely not have encountered the VAS response option and thus not understand how to respond appropriately, two practice items were introduced for both versions of the survey prior to the administration of the full survey (see Appendices H and I for examples). Specifically, the practice items were presented *before* students took

[36] Meaning that a habitual response pattern (e.g., choosing the same or similar response for all items) may be present, which would result in a limited range of responses.

either survey to enable students to acclimate to the response format using their mouse to click on the LS radio buttons and to click and drag the cursor of the VAS response option's sliding scale (see below for further details).

Survey reading level.

Because the *Identification with School* survey (Voelkl, 1996) was originally designed for 8th grade students I wanted to make sure that the reading level would be suitable for all students in general who met the inclusions criteria, and all 4th grade students in particular. Therefore, I tested the readability of this instrument using the Flesch-Kincaid Index (Flesch, 1948) to determine if it would be appropriate for 4th grade students. The Flesch-Kincaid Index (1948) is an indicator of how easy or difficult a text is to read and is calculated using the following formula:

$$0.39\left(\frac{\text{total words}}{\text{total sentences}}\right)+11.8\left(\frac{\text{total syllables}}{\text{total words}}\right)-15.59 \qquad (3\text{-}2)$$

Based on this test, the readability was determined to be 4.3. This indicated that this survey was suitable for students with a 4th grade or higher reading level. Thus, all respondents that met the inclusion criteria (and at a minimum read at a 4th grade reading level) should have been able to read and interpret the questions accurately. For the purposes of this study, it was assumed that all participants read at the 4th grade level or above, and fully understood the survey directions and all of the survey questions. [37]

[37] This issue is further addressed in the Discussion section (Chapter 5) as a possible limitation to this study.

Web-based survey design features.

Both versions of the survey were Web-based and had the same number of items and same prompts but with different ways for participants to respond. The LS version's response options were presented as radio buttons with choices ranging from *Strongly Disagree* to Strongly *Agree* and the VAS version had a slider-type response option presented with only the two extreme verbal cues of the LS (e.g., *Strongly Disagree* and *Strongly Agree*) on each end of the slider (see Appendix J for an example of an LS and VAS item). Respondents used their mouse to click anywhere on the continuum and a marker appeared that could be manipulated (by sliding) in either direction to indicate varying degrees of "positive" (e.g., *agree*) or "negative" (e.g., *disagree*) responses. Given that it was not possible to control the settings in which the survey would be administered or the type of computer monitor on which the survey would be presented to students, pixels were used as the standard measurement for the length of the VAS line rather than stipulating the more traditional 10cm or 100mm length established for paper-based versions of surveys. In this way, I was able to obtain the most accurate scores possible without having had to administer the survey with a standardized computer and monitor across all settings and conditions.

Supplemental post-survey questionnaire.

Subsequent to completing the *Identification with School* survey, all respondents were asked three additional web-based, open-response questions to assess their immediate reaction to the survey and to the two response formats used (see Appendix C). The readability of these post-survey questions was tested using the Flesch-Kincaid Index

(Flesch, 1948) to determine if they were appropriate for participants with at least a 4th grade reading level. Upon completion of this test, the readability was determined to be 4.6, which indicated that this questionnaire was suitable for students with a 4th grade or higher reading level. Thus, all respondents that met the inclusion criteria (and at a minimum read at a 4th grade reading level) should have been able to read and interpret these questions accurately.

Student demographic questionnaire.

A six-item demographic questionnaire (see Appendix D) was administered after participants took the LS and VAS surveys and the post-survey questionnaire (see Appendices A, B, and C). A Flesch-Kincaid (1948) analysis of the readability of this questionnaire suggested that the reading level was 4.2. Thus, all respondents that met the inclusion criteria (and at a minimum read at a 4th grade reading level) should have been able to read and interpret these questions accurately as well.

Scoring Criteria

Because the LS and VAS response options were qualitatively different, it was necessary to develop scoring criteria that would allow comparisons of the two response formats. Below is a description of how each version was scored.

Scoring the Likert scale version.

To respond using the Likert scale, participants were required to use their mouse to click on a radio button that corresponded with their desired response (e.g. *Strongly Disagree* to *Strongly Agree*). The LS items were scored as follows: *Strongly Disagree* =

1, *Disagree* = 33, *Agree* = 66, and *Strongly Agree* = 99. The 16-items in the *Identification with School* survey were summed to create an "identification with school" score for each participant, with a possible range of summated scores of 16-1584. This scoring method was selected in an effort to closely match that of the VAS, which is explained in further detail in the next section. Lastly, it was assumed that low identification with school was an undesired personal attribute. Therefore, all items that reflected a negative identification with school (e.g., a high score indicated a low sense of belongingness or of valuing school and school-related outcomes) were re-coded so that higher values on all 16 items indicated a higher identification with school. After examining the wording of each item and confirming that negatively-worded items had a negative correlation with other items in the inter-item correlation matrix, it was decided that items 3, 4, 7, 8, 9, and 14 needed to be recoded (see Appendix A). For the LS version, student responses for these six items were recoded as follows: 99 = 1; 66 = 33; 33 = 66; and 1 = 99.

Scoring the VAS version.

To respond using the VAS, participants were asked to select a place along the continuum between *Strongly Disagree* and *Strongly Agree* that best matched how they felt in response to the presented item prompt. Participants indicated their perceived status for each of the 16 items by using their mouse to click on each 99-pixel horizontal line (or continuum) at a point that was personally "most appropriate" (Flynn, van Schaik, & van Wersch, 2004, p.50). The positions of each respondent's "clicks" or "marks" on the VAS line were scaled as one of 99 distinct points, resulting in score points from a possible range of 1-99 for each item (e.g., each of the VAS line's 99 pixels was a score point).

Thus, as with the LS version, the possible range of summated scores for the 16-item VAS survey was 16-1584—with a higher summated score indicating a *higher* level of a student's identification with school—and items 3, 4, 7, 8, 9, and 14 were recoded because they reflected a negative identification with school (see Appendix B). To recode items 3, 4, 7, 8, 9, and 14 for the VAS, responses were subtracted from 100 and the differences replaced the old values so that higher values indicated a higher identification with school.

Research Questions

This study attempted to address the following research questions:

1. *Does the response format change the factor structure of the survey?*
2. *Does the response format affect the reliability coefficient?*
3. *Are there significant mean differences for the summated scores overall between the LS version and the VAS version of the survey?*
4. *Are there significant mean differences of the summated scores on the LS and VAS versions of the survey between Elementary, Middle, and High School students?*
5. *Is there a significant interaction between level of schooling and item response type? If so, is it dependent on item response type?*

Statistical Analyses

Data Analysis

Using the SPSS statistical package (*version 14.0*), variables were tested for violation of the normality distribution assumptions for the use of parametric statistics. All

variables were checked for skewness and kurtosis ratios to ensure they are within the limit of three. As mentioned above, this study sought to contribute to the literature in K-12 educational survey research by comparing a previously validated survey originally comprising items with LS response options to an equivalent survey with *visual analog-scaled* (VAS) response options. To do so, this study examined each response format's affect on four indices: *factor structure, reliability, summated mean scale scores*, and *simple-*, *main-*, and *interaction effects*.

Index 1: Factor Structure

Factor structure was examined to determine whether items in the *Identification with School* survey measured a "single, common phenomenon" (McIver & Carmines, 1981) and if the survey's unidimensionality differed as a function of item response type. In other words, each version of the survey was examined to determine if altering the survey's response options from the LS to the VAS resulted in equivalent factor structures. To examine the factor structure of the *Identification with School* survey, correlation matrices were factor analyzed using principal components analyses with Varimax rotation. Multiple criteria were used to decide the optimal number of components to retain.

Principal components analysis.

A principal components analysis (PCA) was conducted for the LS and VAS versions of the *Identification with School* survey to determine if the underlying factor structure was consistent between the two item response formats. The underlying objective

in PCA is to obtain orthogonal linear combinations of the original variables in a data set that account for as much of the total variance in the original variables as possible (Tabachnick & Fidell, 2001). Put simply, PCA groups highly correlated items together with the assumption that they were influenced by the same underlying dimension (component). One goal of conducting PCA in this study was to extract from the data a reduced set of uncorrelated components that accounted for most of the variance in the original set of variables. Although factor structure (i.e. determining the number of components) was of primary interest, a secondary goal was to summarize the pattern of intercorrelations among the items on the *Identification with School* survey.

Typically, the most critical problem a researcher faces when conducting a PCA is determining the number of components to retain (Hayton, Allen, & Scarpello, 2004; Velicer, Eaton, & Fava, 2000; Zwick & Velicer, 1986). Specifying too few (e.g., *under*-extraction) can lead to a loss of information and/or distorted[38] component loadings, and specifying too many (e.g., *over*-extraction) can lead to the inclusion of minor or "false" components in the model that can obfuscate interpretation and detract from the major or "true" components (Fabrigar, Wegener, MacCallum, & Strahan, 1999; Zwick & Velicer, 1986). Because of these pivotal consequences, multiple criteria were employed in this study to determine the optimal number of components to retain for each version of the survey. Although the Kaiser rule or the "eigenvalue greater than one" rule (K1) is one of the most popular methods (Velicer, Eaton, & Fava, 2000) for determining the number of

[38] Distorted component loadings due to underextraction can result when a researcher ignores the presence of a major component or when a component is conflated with another thus resulting in a loss of important information.

components to retain when conducting a PCA , it was not used in this study primarily due to the large body of literature that recommends K1 not be used because it tends to yield inaccurate results (Cattell & Vogelmann, 1977; Cliff, 1988; Fabrigar, Wegener, MacCallum, & Strahan, 1999; Gorsuch, 1983; Hayton, Allen, & Scarpello, 2004; Schomemann, 1990; Velicer, Eaton, & Fava, 2000). Specifically, K1 has been shown to consistently overestimate the number of components to retain (Horn, 1965; Linn, 1968; Zwick & Velicer, 1986).

The first criterion employed to determine the number of components to retain in the present study was Catell's (1966) scree test, which is based on a visual inspection of a graph of eigenvalues for significant breaks or discontinuities. Catell's rationale for this approach was that only "major" components account for a sizeable portion of variance and thus have sizeable eigenvalues. As a result, when eigenvalues are plotted a distinct break or "cliff" emerges such that major components' eigenvalues appear higher in the plot and the remaining, increasingly smaller eigenvalues of lesser or "minor" components appear as "scree" or rubble at the bottom of a cliff. Once this break is identified, only those components that are above the scree in the plot are retained. This method was selected because it is easily applied and because it has been recommended as a useful procedure when used in conjunction with other criteria to determine the number of components to extract and retain (Fabrigar, Wegener, MacCallum, & Strahan, 1999; Velicer, Eaton, & Fava, 2000).

The second criterion involved the interpretation of component loadings and was used to validate the number of components yielded from the scree test and also helped to

ensure that only those components that would be considered "major" would be retained (Guadagnoli & Velicer, 1988; Norusis, 2005). With PCA, component loadings represent the correlation between each variable and the extracted component (which itself represents a linear combination of the set of variables). According to Stevens (2002), too often investigators blindly employ the rule-of-thumb of only interpreting |.30| or greater components loadings without taking sample size into account, which is known to affect statistical significance. He further noted that the use of the basic standard error formula that has been traditionally used to determine a correlation coefficient's significance ($1/\sqrt{N-1}$) was far too likely to capitalize on chance when used with the PCA method and thus result in component loading standard errors that were "seriously underestimate[d]" (2002, p. 393). Thus, in accordance with the recommendations of Stevens (2002), to account for the possibility of underestimated component loading standard errors and to yield an acceptable estimate of whether component loadings were statistically significant, I doubled the standard error used to calculate statistical significance. To do this, I doubled the critical value required for an ordinary correlation to achieve statistical significance for a sample of 269 participants (r = .163) and then tested each component loading at r = |.33| (df = 267, $\alpha/2$ = .01) to reduce the probability of at least one false rejection (Stevens, 2002).

As an indicator of whether a component was "major" and thus retained for the final model, it had to have at least four substantial or *high* factor loadings (Guadagnoli & Velicer, 1988; MacCallum, Widaman, Zhang, & Hong, 1999; Norusis, 2005; Velicer & Fava, 1998; Zwick & Velicer, 1986). A high factor loading was defined as one that was

|.60| or above. This definition is consistent with the recommendations of Hair, Anderson, Tatham, and Black (1998), who maintained that loadings at or above |.60| can be interpreted as "high" and therefore provide a very good basis for component interpretation. Thus, for the purposes of this study, component loading values had to be at least |.33| to be considered statistically significant and components had to have at least four component loadings of |.60| or above to be considered “major” and thus be retained for the final model.

The third and final criterion employed to verify that the optimal number of components had been retained was Horn’s (1965) *parallel analysis procedure*. Parallel analysis has been cited as one of the most effective methods for researchers to use to empirically determine the number of factors or components to retain (Lance, Butts, & Michels, 2006; O’Connor, 2000; Velicer, Eaton, & Fava, 2000; Zwick & Velicer, 1986). Horn (1965) introduced this method of component selection as an alternative to Kaiser’s “eigenvalue greater than one” (K1) rule. Zwick and Velicer (1986) referred to parallel analysis as a “sample-based adaptation of the population-based K1 rule” (p. 434). Their rationale was that sampling variability will produce eigenvalues greater than one even if all eigenvalues of a correlation matrix are exactly one and no major components exist (as would occur with independent variates) (Zwick & Velicer, 1986). Therefore, if the eigenvalues of a correlation matrix generated from an actual study’s data set are compared with the eigenvalues of a correlation matrix generated from a simulated data set (of the same dimensions comprising only random numbers), then it can be assumed that the “actual” (or observed) eigenvalues of major components should be larger than

their “simulated” eigenvalue counterparts. In short, parallel analysis enables an investigator to extract only major components and to ignore “minor” components that account for less variance than could be obtained from random data (O’Connor, 2000).

With parallel analysis, the traditional eigenvalue threshold of +1 is replaced with mean eigenvalues generated from a simulated set of random data correlation matrices that mirrors the observed data correlation matrices in the number of variables and participants. For example, the present study’s data set comprised 269 observations for each of the 16 variables on the *Identification with School* survey. Thus, a series of simulated or parallel random data matrices of the same size (269 x 16) was generated and eigenvalues were computed for both the observed data set’s correlation matrices and for each of the parallel data set’s correlation matrices. The number of generated parallel data sets is pre-determined by the investigator (although there is technically no limit to the number that can be generated, the program used for this study maxed out at 9,999). With each new simulated data set, a correlation matrix is generated, a PCA is conducted, and eigenvalues are calculated until the specified maximum number is reached and then, as Hayton, Allen, and Scarpello (2004) describe,

> the average eigenvalues from the random [parallel] correlation matrices are…compared to the eigenvalues from the real data correlation matrix, such that the first observed eigenvalue is compared to the first random eigenvalue, the second observed eigenvalue is compared to the second random eigenvalue, and so on. Factors corresponding to actual eigenvalues that are greater than the parallel average random eigenvalues should be retained. Actual eigenvalues less than or equal to the parallel average random eigenvalues are considered due to sampling error (p.194).

Once the investigator determines (from the generated output) that an observed eigenvalue is smaller than its parallel counterpart, the procedure is stopped and the researcher retains only the observed components that had eigenvalues larger than the simulated eigenvalues. Although the parallel analysis is not currently available in SPSS or SAS, programs are available to implement this method in both of these statistical programs (O' Connor, 2000; 2008). These programs can be downloaded for free at http://people.ok.ubc.ca/brioconn/nfactors/nfactors.html

Index 2: Reliability

Reliability is the extent to which a score or measure is free of measurement error; therefore, the lower the amount of measurement error, the higher the value for reliability. Crocker and Algina (1986) caution that when interpreting this index, it is important to keep in mind that "…this estimate implies nothing about the stability of the [survey] scores over time or their equivalence to scores on one particular alternate form of the [survey]" (p. 142). Norusis (2005) further cautions that "the reliability of a scale depends on the population to which it is administered. Different populations of subjects may result in different scale properties" (p.428).

Although the meaning of a reliability coefficient will vary as a function of the type of characteristic measured and the method of obtaining the estimate(s) of reliability, there are several ways of interpreting a reliability coefficient of a given value. One method is to interpret a reliability coefficient as the proportion of observed score variance that is "true" rather than "error" variance. For example, a reliability coefficient of .749

would indicate that roughly 75% of the variance in a survey's scores is true score variance, while the remaining 25% is error variance. In this sense, one minus the alpha coefficient (1-α) served as a proxy of measurement error for each response format in this study.

Another method used to interpret a reliability coefficient is to measure the variability of errors in estimated scores by calculating the *standard error of measurement* (SEM). The SEM provides an estimate of the relative size of the error component for scores obtained from the administration of an instrument (e.g., a survey). In other words, it yields an estimate of the degree of closeness of the observed or obtained score to the participants' true level of the trait being measured, using the same units by which the survey itself was scored. The formula for the standard error of measurement is as follows:

$$SEM = \sigma_{test}\sqrt{1 - r_{test}} \tag{3-3}$$

where σ_{test} is the standard deviation of the survey score distribution and r_{test} is the estimated reliability of the survey. It should be noted that the higher the reliability is, the smaller the standard error is relative to the standard deviation of the survey.

To estimate the reliability of the *Identification with School* survey, two reliability indices were examined in this study: 1) *Cronbach's coefficient alpha*, which provided an indicator of the internal consistency of the scale to determine the extent to which the two response formats produced different levels of reliability; and 2) *test-retest reliability coefficient*, which provided an indicator of the stability of the responses across the LS and VAS versions of the survey.

Cronbach's alpha.

Cronbach's alpha (α) is a measure of internal consistency directly affected by the number of items, the variability in the item responses, and the magnitude of the intercorrelation between items. Although there are other ways to measure internal consistency besides Cronbach's alpha, each of which begins with different assumptions and uses different analytic approaches in studying relationships between the items, evidence suggests that they all arrive at virtually the same estimates of reliability (Pedhazur & Pedhazur-Schmelkin, 1991). In view of this, Cronbach's alpha was selected due to its popular use and familiarity in the educational research literature.

Test-retest reliability.

Test-retest reliability ($r_{xx'}$) is often referred to as a *coefficient of stability* and depending on the type of data being analyzed, the researcher will either apply Pearson *r* or Spearman *rho* to the total scores of the two tests or surveys that were administered. For the purposes of this study, I assumed that the LS and VAS response options yielded interval-level data. As such, I used the Pearson product-moment correlation coefficient to examine the linear relationship or correlation between the scores on the administrations of the two forms of the survey, with a high correlation indicating high test-retest reliability, thus suggesting that the responses across both administrations were stable. Lastly, to obtain an estimate of random error, I subtracted the resultant correlation from 1 (e.g., 1 - *r*).

Index 3: Summated Mean Scale Scores

Summated mean scale scores were evaluated to determine whether the LS and VAS response formats produce significantly different summated scale score means, in general, and different means for the students, in particular. The LS items were scored as follows: *Strongly Disagree* = 1, *Disagree* = 33, *Agree* = 66, and *Strongly Agree* = 99. The 16-items in the *Identification with School* survey were summed to create an "identification with school" score for each participant, with a possible range of summated scores of 16-1584. To score the VAS items, the positions of each respondent's "clicks" or "marks" on the VAS line were scaled as one of 99 distinct points, resulting in score points from a possible range of 1-99 for each item (e.g., each of the VAS line's 99 pixels was a score point). As with the LS version, the possible range of summated scores for the 16-item VAS survey was 16-1584, with a higher summated score indicating a *higher* level of a student's identification with school.

Index 4: Simple-, Main-, and Interaction Effects

Chronological age has been shown in previous studies to be a significant factor in children's performance on surveys due to developmental factors that can impact cognitive abilities involving spatial reasoning or understanding and manipulating ordinal relations (Cremeens, Eiser, & Blades, 2007; Read & MacFarlane, 2006; Shields, Cohen, Harbeck-Weber, Powers, & Smith, 2003; van Laerhoven, van der Zaag-Loonen, & Derkx, 2004); therefore, in this study the effects of age and item type were examined in an effort to determine if there were any significant differences between how younger

students and older students responded when presented with VAS vs. LS response options. Consequently, simple-, main-, and interaction effects focused on the differences among group means to determine if manipulating the response-type variable yielded significant effects.

Simple effects are comparisons of differences between means for the levels of one independent variable (IV) within the levels of a second IV, and main *effects* are differences on the dependent variable (DV) attributed to an IV (Keppel & Wickens, 2004). Put another way, a main effect is the effect of an IV uninfluenced by other variables. *Interaction effects,* are an indication that the effect of the levels of one IV is not the same across the levels of a second IV (2004). When examining simple effects, it is important to remember to adjust the reported significance levels in accordance with the level of heterogeneity of variances of score deviations from group means in order to keep the Type I error rate below the 5 percent threshold (Klockars & Sax, 1986). According to Keppel and Wickens (2004), if there are large deviations of scores from the mean/median within each group and heterogeneous differences in variances across groups, reducing the level to roughly half (e.g., =.025) would be appropriate because this reduction would "…[bring] the actual Type I error rate back to where it belongs [e.g., =.05]" (p.153). Nonetheless, one must be careful if the variances do not differ at all or differ only a little because reducing alpha reduces power, which could result in the rejection of a true null (Type I error). To measure simple, main, and interaction effects, a *factorial ANOVA* was conducted.

Factorial ANOVA.

The advantage of a randomized, 2x3 between-subjects experimental design is that *factorial ANOVA* can be used to examine the joint effect of the two factors acting in concert to influence the dependent variable (DV). Advantages of the factorial ANOVA design include its efficiency, power, and the detection of interactions. Conducting a factorial ANOVA offers a more efficient use of both the researcher's and participants' time because it allows for the study of the effects of two (or more) factors on the same dependent variable with a single experiment as opposed to the two or more required for separate one-way designs (Kerlinger, 1992). Additionally, power is increased when both factors A and B are determinants of variance in the participants' dependent variable scores because factorial ANOVA tends to yield a smaller error term (denominator of the *F* ratio) than would a one-way ANOVA on just one factor (1992). That is, the error variance due to factor B and AxB is removed from the denominator of the *F* ratio (MS_{Error}), which tends to increase the *F* for factor A (thereby increasing power). With simultaneous analysis of the two factors, the researcher is in essence able to carry out two separate research studies concurrently.

Steps taken to conduct the ANOVA.

In order to examine whether *age/school level* and/or *item response type* were related to students' summated scores on the *Identification with School* survey, a two-way fixed-effects, between-groups factorial ANOVA was conducted and *F* ratios were calculated for each of the following:

- The main effect of *school level* (Factor *A*)

- The main effect of the *item response type* (Factor *B*)
- The interaction between *school level* and *item response type* (AxB)
- *The simple effects within school level (Factor A)*

The following null hypotheses addressed the main effects for each factor and the possible interaction between factors:

1. The means of the LS and VAS conditions (Factor *A*) are the same:

   $H_0 1$: $\mu_{A_1} = \mu_{A_2}$

   $H_1 1$: $\mu_{A_1} \neq \mu_{A_2}$

2. The means of the different school levels (Factor *B*) are the same:

   $H_0 2$: $\mu_{B_1} = \mu_{B_2} = \mu_{B_3}$

   $H_1 2$: $\mu_{B_1} \neq \mu_{B_2} \neq \mu_{B_3}$

3. The differences between the means of the different levels of the interaction are the same:

   $H_0 3$: $\mu_{AB_{11}} - \mu_{AB_{21}} = \mu_{AB_{21}} - \mu_{AB_{22}} = \mu_{AB_{13}} - \mu_{AB_{32}}$

   $H_1 3$: $\mu_{AB_{11}} - \mu_{AB_{21}} \neq \mu_{AB_{12}} - \mu_{AB_{22}} \neq \mu_{AB_{13}} - \mu_{AB_{32}}$

Criterion for Rejecting H_0

The test statistic used for all three hypotheses was the *F* ratio and the sampling distribution was the *F* distribution with appropriate degrees of freedom. The degrees of freedom associated with the main effects, the interaction, and the within cell mean squares are presented in Table 3-2 below.

Table 3-2. Main Effects, Interaction, and Degrees of Freedom Summary Table

ANOVA Sources of Variation	SS	*df*	*MS*	*F*
Main Effect for Factor *A* (*LS or VAS*)	SS_A	J-1	$\frac{SS_A}{J-1}$	$\frac{MS_A}{MS_W}$
Main Effect for Factor *B* (*school level*)	SS_B	K-1	$\frac{SS_B}{K-1}$	$\frac{MS_B}{MS_W}$
Interaction between *A* and *B*	SS_{AxB}	(J-1)(K-1)	$\frac{SS_{AxB}}{(J-1)(K-1)}$	$\frac{MS_{AB}}{MS_W}$
Within-cells (*error*)	SS_{within}	JK(N-1)	$\frac{SS_{within}}{JK(N-1)}$	--
TOTAL	SS_T	N-1	--	--

When the observed *F* ratio exceeded the critical value of *F*, the respective null hypothesis was rejected. Following the rejection of the null hypothesis on either the row or column main effect, post hoc multiple-comparison procedures were applied. Similarly, when the null hypothesis for the interaction was rejected, post hoc test procedures, including plotting the cell means and tests of simple effects, were applied.

Possible Threats to Validity

Internal Validity Issues

Internal validity issues in experimental studies generally revolve around a study's operation and the relationship between the outcome and the treatment(s) (Kerlinger, 1992). In this study, threats to internal validity such as sample selection, maturation, attrition or mortality were not a serious concern because the participants were randomly

assigned[39] to treatment conditions and then immediately took the online survey. Further, because the treatments were only administered during a single session rather than over time, students neither had time to mature nor leave the study for any number of reasons.

External Validity Issues

External validity issues generally deal with populations, settings, and variables and whether or not they can be generalized to a population. In this study, given that the focus was on how students responded to the LS and VAS item response types rather than on students' responses in isolation, it is important to note that it is not the intention of the researcher to generalize the results of the *Identification with School* survey beyond the scope of this exploratory study. Therefore, the meaningfulness of the outcome of the survey administered in this study (e.g., whether students like school or identify with school) was not examined in detail. As such, the findings of this study as they relate to the construct that was measured should be interpreted with caution.

[39] It bears noting that even with randomization the groups could have been different due to chance.

Chapter 4: Results

Introduction

In this chapter, the results are organized according to the analyses performed to answer each of the five research questions. To begin, a description of the sample is presented. Next, results of the principal components analysis are presented, followed by the reliability analyses of the two versions of the survey, the summated score comparisons, and the factorial ANOVAs. Finally, the results of the post-survey questionnaires are presented.

Sample

The online survey was accessed 455 times between May 1, 2008 and June 30, 2008. The study's exclusion criteria—which excluded participants from the study if their reported aged was younger than nine years old, if their reported grade was lower than Grade 4, or if they failed to provide their age and grade—yielded 269 students for the final analyses. Students ranged in age from 9 to 19 years (M=13.67, SD=3.07) and were in grades 4 through 12. More than one-fourth of the participants were in Grade 12 (n=68) and nearly one-fourth were 11-years-old (n=60). The smallest groups of students by grade and age were grade 7 (n=3) and ages 9 and 13 (n=9 for both). There was a slightly greater percentage of girls than boys in the sample (48.3% vs. 45.0%) and nearly 75% of the students were native English speakers. Table 4-1 presents detailed demographic data for the sample used for this study.

Table 4-1

Sample demographic characteristics

Variable		*N*	*%*
Age			
9		9	3.3
10		36	13.4
11		60	22.3
12		19	7.1
13		9	3.3
14		14	5.2
15		31	11.5
16		16	5.9
17		23	8.6
18		48	17.8
19 or older		1	.4
	Sub-Total	266	98.9
	Missing	3	1.1
Grade			
4th		42	15.6
5th		13	4.8
6th		32	11.9
7th		3	1.1
8th		4	1.5
9th		46	17.1
10th		7	2.6
11th		10	3.7
12th		68	25.3
Other		40	14.9
	Sub-Total	265	98.5
	Missing	4	1.5
Gender			
Boy		121	45.0
Girl		130	48.3
Prefer not to respond		16	5.9
	Sub-Total	267	99.2
	Missing	2	0.8
English			
Native English speaker		197	73.2
English is a second language		65	24.2
	Sub-Total	262	97.4
	Missing	7	2.6

N=269

Of the 40 students who selected "Other" as their grade-level, 95% (n=38) were the same age as students in the *Upper Elementary* (Grades 4-6) school level. The remaining 5% (n=2) were the same age as students in the *Middle* school level. Because summated scores for the students in the *Other* group were similar to those of their same-aged peers on the LS and VAS versions of the surveys, these students were "re-assigned" into the school-level group that best matched their reported age. Similarly, there were four students who reported only age and not grade and they were subsequently merged into their respective school-level peers' group. Results in all subsequent tables include these school-level reassignments.

Categorical Variables

To address the potential biasing effects of students being "misclassified" into the incorrect age/developmental level group or grade/school level group, the *age* and *grade* variables were dummy coded so that analyses could be conducted based solely on reported ages or on reported grades for comparison purposes. For the A*ge* groups variable, participants were classified according to one of three categories: 1) *Later Childhood*, 9 to 12 years-old; 2) *Early Adolescence*, 13 to15 years-old; or 3) *Later Adolescence*, 16 to18 years-old. For the *School-Level* groups variable, participants were classified according to one of three categories: 1) *Upper Elementary*, 4^{th} to 6^{th} grade; 2) *Middle*, 7^{th} to 9^{th} grade; or 3) High *School*, 10^{th} to 12^{th} grade. Table 4-2 presents the number and percentages of students within each group. For the remainder of this chapter, only the results of the School-Level groups are reported because no significant

differences between the School-Level and Age groups were found in subsequent analyses of reliability coefficients or summated scores on either version of the *Identification with School* survey.

Table 4-2.

Grouping Variables by School-Level and Age

Variable	*n*	*%*
School-Level groups		
Upper Elementary (grades 4-6)	126	46.8
Middle School (grades 7-9)	58	21.6
High School (grades 10-12)	85	31.6
Total:	269	100.0
Age groups		
Later Childhood (ages 9-12)	124	46.1
Early Adolescence (ages 13-15)	54	20.1
Later Adolescence (ages 16-18)	87	32.3
Sub-Total:	265	98.5
Missing:	4	1.5

N = 269

Experimental Conditions

As described in Chapter 3, students in grades four through twelve were *blocked* or grouped by school level as they entered the system and then randomly assigned to one of the two different conditions. Students assigned to Condition One (n = 146, 54.3%) were administered the LS version of the survey first followed by the VAS version and students in Condition Two (n = 123, 45.7%) were administered the VAS version of the survey first followed by the LS version. Although a randomization program kept participant levels of both conditions approximately balanced overall, there were 23 more students in

Condition One than in Condition Two after deletions due to exclusion criteria. No significant differences emerged between the two conditions in subsequent analyses (e.g., *t* tests of summated scores and reliability coefficients) thereby demonstrating no order effects.

Factor Structure

Research question #1

Does the response format change the factor structure of the survey?

Principal Components Analysis

To determine the appropriateness of factoring the LS and VAS correlation matrices, the Kaiser-Meyer-Olkin (KMO) overall measure of sampling adequacy[40] was conducted, which yielded .83 and .85 for the LS and VAS versions, respectively. The KMO measure varies between 0 and 1 and values closer to 1 are desirable. Kaiser (1974) categorized KMO measures in the 0.80's as "meritorious" and anything below 0.50 as unacceptable. Norusis (2005) suggested that KMO values above .60 ("mediocre" in Kaiser's terms) indicate a factorable correlation matrix with linearly related items, which in turn indicates that it is reasonable for the investigator to proceed with the principal components analysis (PCA). As such, the results from the present study for the KMO

[40] It bears noting that Bartlett's Test of Sphericity was not conducted due to its notorious sensitivity to sample size. Tabachnick and Fidell (2001) suggest that this test only be used with smaller samples where $n \leq 5$ participants per variable.

exceed this threshold indicating that the sample size of N=269 was sufficient for PCA and that both the LS and VAS matrices were highly factorable.

Scree Test

A PCA with Varimax rotation was conducted to determine the underlying variance structure for measures on the 16 items comprising both the LS and VAS versions of the *Identification with School* survey. The orthogonal Varimax rotation method was selected because it minimizes factor complexity by maximizing variance for each factor (Tabachnick & Fidell, 2001). Following a visual inspection of scree plots (see Figure *4-1* below), the initial PCA solutions suggested a single component for both the LS and VAS according to Catell's (1966) criteria for component extraction.

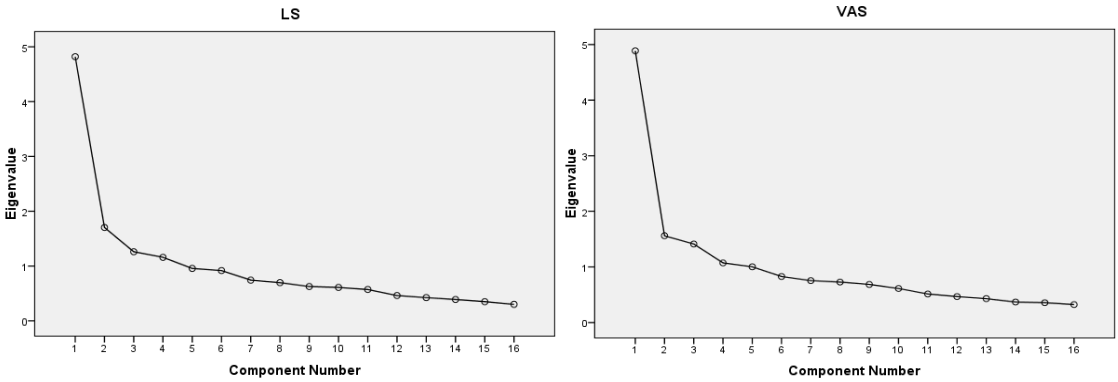

Figure 4-1. Scree plots of LS vs. VAS initial solutions.

Component Loadings Assessment

In her final assessment of the factor structure of the *Identification with School* survey, Voelkl (1996) presented evidence that suggested her scale was unidimensional; however, prior to coming to this conclusion she tested a two-factor solution comprising

two subscales: *Belongingness* and *Valuing*. To compare Voelkl's (1996) results to the present study, LS and VAS component loadings for a one- and two-component solution are presented in Table 4-3.

Table 4-3.

Comparison of component loadings across one vs. two extracted components for the initial solution of the LS and VAS versions of the survey

	1-Component Models		2-Component Models			
	LS	VAS	LS	LS	VAS	VAS
Identification with School survey items	1	1	1	2	1	2
1 I feel proud of being a part of my school.	**0.66**	**0.74**	-	**0.74**	0.39	**0.69**
2 I feel that I am treated with respect at my school.	**0.61**	**0.68**	-	**0.75**	-	**0.71**
3 I can get a good job even if my grades are bad.	-	-	0.52	-	0.42	-
4 The only time I get attention in school is when I cause trouble.	0.48	0.40	-	0.39	-	-
5 I participate in activities at my school.	0.40	0.45	-	0.56	-	**0.65**
6 Doing well in school is important in life.	**0.65**	**0.62**	**0.76**	-	**0.69**	-
7 Most of the things we learn in class are useless.	**0.63**	**0.63**	0.53	0.35	0.59	-
8 I feel that teachers don't care in this school.	**0.68**	**0.67**	0.45	0.51	0.43	0.52
9 I would rather be out of school.	**0.60**	**0.60**	**0.62**	-	**0.61**	-
10 I have teachers that I can talk to at my school.	0.45	0.46	-	0.53	-	**0.60**
11 Doing well in school is useful for getting a job.	0.44	0.42	0.55	-	0.51	-
12 School is one of my favorite places to be.	**0.63**	**0.60**	0.51	0.37	0.51	-
13 I feel that people are interested in me at my school.	0.51	0.51	-	**0.71**	-	**0.66**
14 I feel that school is a waste of time.	**0.66**	**0.72**	**0.64**	-	**0.73**	-
15 I feel that it is a mistake to drop out of school.	-	0.34	-	-	0.36	-
16 School is more important than most people think.	**0.67**	0.57	**0.74**	-	**0.66**	-
Total number of statistically significant loadings ≥ |.33| :	14	15	9	9	11	6
Total number of practically significant loadings ≥ |.40| :	14	14	9	6	9	6
Total number of loadings ≥ |.60| :	**9**	**8**	**4**	3	**4**	**5**
Total percent variance explained (before rotation):	30.13	30.55	30.13	10.65	30.55	9.76

Note: Values < |.33| were deemed not statistically significant at $p<.01$ and were therefore replaced with a dash (-). **Bolded** values indicate component loadings that met or exceeded the |.60| criterion necessary for the retention of a component.

A PCA was conducted to retain one component for both the LS and VAS and then a second PCA with Varimax rotation was conducted to extract two components for both the LS and VAS. As shown in Table 4-4, the LS one-component solution accounted for

30.13% of the variance and the VAS one-component solution accounted for 30.55% of the variance. For the LS two-component solution (before rotation), the first component accounted for 30.13% of the variance and the second component accounted for 10.65% for a total of 40.78% of the variance accounted for by the two components. For the VAS two-component solution (before rotation), the first component accounted for 30.55% and the second component accounted for 9.76% for a total of 40.31% of the variance accounted for by the two extracted components.

Using the second criterion for extraction (see Chapter 3), each component loading from the rotated component matrices was tested for statistical significance at |.33| (N=269; α = .01, two-tailed test) to reduce the probability of at least one false rejection in accordance with the recommendations of Stevens (2002, p. 394). As an indicator of whether a component was *practically* significant or "major" and thus retained for the final model, it had to have at least four substantial or *high* factor loadings (Guadagnoli & Velicer, 1988; MacCallum, Widaman, Zhang, & Hong, 1999; Norusis, 2005; Velicer & Fava, 1998; Zwick & Velicer, 1986). A high factor loading was defined as one that was |.60| or above.

The observed pattern of component loadings presented in Table 4-4 confirms the findings of the scree tests presented above and suggests that, as Voelkl (1996) concluded, a single-component model would work just as well as a two-component model for the *Identification with School* survey. First, not much was gained by extracting the second component for either the LS or VAS as the amount of variance accounted for was only increased roughly 10%. Second, the LS two-component model did not satisfy the second

criterion for retention as the second extracted component only had three component loadings ≥ |.60| and thus was rejected. Although the VAS two-component model met the second criterion, the factor loadings did not increase substantially over those from the one-component solution. Moreover, the interpretability of the two-component solution was equivocal with notable cross-loading (significant component loadings on more than one component) between the first and second components on survey items #1 and #8. The one noteworthy advantage that the VAS two-component model had over the one-component model was the *practically* significant .42 component loading on survey item #3. For the VAS one-component model, the component loading for item #3 was not statistically significant. Lastly, the total number of component loadings ≥ |.60| for the LS one-component model was higher than for the two-component model (9 vs. 7, respectively) and the total number for the VAS one- and two-component models were nearly the same (8 vs. 9, respectively).

Based on the evidence presented in Table 4-4, the observed pattern of loadings suggests that retaining a second component for either version of the survey does not appear to be warranted. Additionally, the results presented confirm Voelkl's (1996) unidimensional or single factor structure for both the LS and VAS versions of the *Identification with School* survey.

Parallel Analysis Procedure

The third and final criterion employed to determine the number of components to retain was Horn's (1965) *parallel analysis procedure*. The SPSS program written by

O'Connor (2000, 2008) for the parallel analysis procedure was used to simulate random data correlation matrices that equaled the observed data correlation matrices in the number of variables and participants (see Appendix K for the SPSS syntax used to generate the output in Figures 4-2 and 4-3). The eigenvalues of the correlation matrices generated from the simulated data set were averaged and then compared to the eigenvalues of the correlation matrix generated using this study's observed data. The comparison of simulated- and observed-data correlation matrices is motivated by Horn's (1965) contention that if extracted components are to be considered "major," (or of major importance to explaining variance) the observed eigenvalues should be larger than their simulated eigenvalue counterparts. Otherwise, the investigator risks retaining "minor" components that account for less variance than could be obtained from random data (O'Connor, 2000).

Figure 4-2 presents a side-by-side comparison of the observed LS data eigenvalues vs. simulated eigenvalues. For the LS data it was necessary to generate the maximum number of 9,999 random data sets to clearly differentiate between the observed and simulated eigenvalues. This was done in accordance with O'Connor (2000), who maintained that if the observed and simulated eigenvalues are similar in magnitude the program should be run again using more simulated data sets until a clear difference emerges to ensure more accurate and reliable results. Looking at Figure 4-2, it is apparent that only the first two observed eigenvalues are larger than the corresponding first two mean and 95^{th} percentile random data eigenvalues. However, it bears noting the substantial difference between the first observed data eigenvalue and its simulated

counterpart, which is more than three times smaller in magnitude (4.82 vs. 1.55, respectively). By comparison, the second observed data eigenvalue is only .28 less than its counterpart. This could be interpreted as an indication that only one component should be retained for the Likert scale survey; however, before a final determination was made, the results of the VAS data parallel analysis were examined to see if similar results were obtained.

***Observed Data* Eigenvalues:**

Component	EVs	
1.	**4.821**	[# of components = **2**]
2.	**1.704**	
3.	*1.261*	
4.	1.160	
5.	0.957	
6.	0.918	
7.	0.744	
8.	0.698	
9.	0.627	
10.	0.610	
11.	0.573	
12.	0.462	
13.	0.425	
14.	0.390	
15.	0.350	
16.	0.302	

***Simulated Data* Eigenvalues:**

Component	Mean EVs	95th Percentile EVs
1.	*1.457475*	1.553440
2.	*1.357298*	1.425147
3.	**1.281681**	1.337648
4.	1.217632	1.268119
5.	1.159213	1.204096
6.	1.105303	1.147428
7.	1.055311	1.096702
8.	1.006619	1.044720
9.	0.959410	0.996980
10.	0.913371	0.951821
11.	0.867883	0.907178
12.	0.822404	0.861938
13.	0.776430	0.817230
14.	0.728358	0.770267
15.	0.677066	0.722755
16.	0.614547	0.667603

Figure 4-2. LS Parallel Analysis Output: Observed vs. Random Data Eigenvalues.

Note. LS data parallel analysis specifications: N cases = 253; N variables = 16; N random data sets generated = 9,999; Percentile = 95th

Figure 4-3 presents a side-by-side comparison of the observed VAS data eigenvalues vs. simulated eigenvalues. As with the LS data, the maximum number of random data sets was also generated for the VAS data to clearly distinguish between major and minor components. Another similarity that emerged between the LS and VAS data was with the differences between the observed and simulated eigenvalues. Looking at Figure 4-3, it is apparent that although the first three observed eigenvalues are larger than the corresponding first three mean and 95th percentile simulated eigenvalues, the

first observed data eigenvalue is more than three times larger than its corresponding 95th percentile simulated data eigenvalue. By comparison, the second observed data eigenvalue is only .14 less than its counterpart and the difference between the third observed data eigenvalue and its counterpart is even smaller (.07). As with the LS, this was interpreted as an indication that only one component should be retained for the VAS survey.

Observed Data **Eigenvalues:**

Component	EVs	
1.	**4.888**	[# of components = **3**]
2.	**1.561**	
3.	**1.413**	
4.	*1.072*	
5.	1.002	
6.	0.828	
7.	0.754	
8.	0.728	
9.	0.684	
10.	0.612	
11.	0.513	
12.	0.462	
13.	0.467	
14.	0.430	
15.	0.369	
16.	0.323	

Simulated Data Eigenvalues

Component	Mean EVs	95th Percentile EVs
1.	*1.461980*	1.551341
2.	*1.355844*	1.422422
3.	*1.280275*	1.340971
4.	1.222991	1.270347
5.	1.160694	1.204967
6.	1.107808	1.147467
7.	1.054796	1.098299
8.	1.006571	1.040298
9.	0.960740	0.994281
10.	0.910880	0.943998
11.	0.868450	0.900416
12.	0.823736	0.859276
13.	0.773984	0.819650
14.	0.726105	0.771736
15.	0.671155	0.716644
16.	0.613991	0.667368

Figure 4-3. VAS Parallel Analysis Output: Observed vs. Random Data Eigenvalues.

Note. VAS data parallel analysis specifications: N cases = 250; N variables = 16; N random data sets generated = 9,999; Percentile = 95th

Given the similarities in the results of the LS and VAS parallel analyses (e.g. the magnitude of the first observed-data eigenvalues being notably higher than their simulated-data counterparts and their subsequent identified eigenvalues), a brief discussion is warranted at this juncture to put these findings into context. First, it bears noting that Buja and Eyuboglu (1989) proposed that the parallel analysis method tends to suggest an *upper-bound estimate* of the correct number of components. Second, according to O'Connor (2008), it is common for the eigenvalues of "trivial, negligible"

components in observed data to be larger in magnitude than corresponding simulated data eigenvalues. Third, although parallel analysis has been shown to be one of the most accurate methods available for determining the number of components to retain (Lance, Butts, & Michels, 2006; Zwick & Velicer, 1986), some authors have cautioned that the parallel analysis method can sometimes *overestimate* the number of components and thus include potentially minor components (Hayton, Allen, & Scarpello, 2004; Zwick & Velicer, 1986). Finally, Zwick and Velicer (1986) concluded that while the parallel analysis method was correct more than 97% of the time and presented evidence that it was the most accurate of the five methods tested in their study, its performance was improved as the number of variables per component increases and as sample size increases. Given that only 16 variables were used for the PCA and that the sample was not considerably large (e.g., < 300), and also given that the second and third simulated eigenvalues were so close in magnitude to their observed-data eigenvalue counterparts, it was possible that an over-identification of components occurred. Consequently, the parallel analysis results obtained in this study should be interpreted with caution.

Conclusion

Although eigenvalues from parallel analyses *can* be used to verify that the observed data eigenvalues are beyond chance, additional procedures should be used to trim trivial factors (Zwick & Velicer, 1986). As such, to add robustness to my conclusions about the number of components to retain and to facilitate interpretation of the final LS and VAS models, multiple criteria were examined. The results of conducting

a visual inspection of the scree plots, of verifying that minimum criteria were met for the magnitude and number of component loadings, and of performing the parallel analysis procedure provided consistent results. Moreover, the concurrent use of these three criteria strongly suggest that both the LS and the VAS versions of the survey were unidimensional and that retaining a single component for both versions was the most appropriate fit to the observed data for this study. Thus, using the criteria articulated above, the results suggest that the factor structure in this study did not differ between the LS and VAS versions of the *Identification with School* survey and the results did not differ from previously published results (Voelkl, 1996).

Reliability Coefficient

Research question #2

Does the response format affect the reliability coefficient?

Internal Consistency Reliability

Full sample.

Cronbach's alpha was used as an index of internal consistency. The LS and VAS Cronbach's alpha reliability coefficients were identical (a = .83) and were comparable to previously published studies' alpha coefficients of .80 (Ruiz, 2002) to .84 (Voelkl, 1996). Table 4-4 presents the overall Cronbach's alpha reliability coefficients obtained in this study in addition to the survey statistics for both versions.

Table 4-4

Identification with School* Survey *Cronbach's Alpha Reliability and Descriptive Statistics: LS vs. VAS (full sample)

Survey Version	Cronbach's Alpha[a]	*M*	Variance	SD	# of Items	*n*
LS	.830	1097.12	5.330E4	230.88	16	253
VAS	.833	1105.79	5.589E4	236.42	16	250

Note. N = 269.
a. Cronbach's Alpha Based on Standardized Items.

School-level samples.

Table 4-5 presents the overall alphas for each version of the survey, delineated by school level. The highest alphas obtained were for the LS version (a = .86) and VAS version (a = .84) administered to students in grades 4-6. This suggests that younger students' scores were slightly more reliable than older students on the *Identification with School* survey. Students in grades 7-9 yielded the lowest alphas of the three school-level groups (a = .79 and a = .81 for the LS and VAS, respectively). These results should be interpreted with caution, especially given the differences in the number of students in each school level.

Table 4-5

Identification with School Survey Cronbach's Alpha Reliability and Descriptive Statistics: LS vs. VAS (by School-Level)

School Level	Survey Version	Cronbach's Alpha[a]	*M*	SD	# of Items	*n* [b]
Upper Elementary (grades 4-6)	LS	.86	1155.45	237.71	16	119
	VAS	.84	1166.42	238.61	16	118
Middle (grades 7-9)	LS	.79	1057.26	215.90	16	50
	VAS	.81	1075.12	225.54	16	49
High School (grades 10-12)	LS	.80	1038.23	211.28	16	84
	VAS	.82	1037.70	219.47	16	83

Note. N = 269.
a. Cronbach's Alpha Based on Standardized Items.
b. Includes students' who originally selected "Other" as their grade (n=40) or did not report grade (n=4). All were subsequently merged into the school-level that best matched their reported age.

Coefficient of Stability

The *Identification with School* survey was administered twice, back-to-back to all participants and the only difference between the two versions was that one comprised Likert-scaled (LS) items and the other, which presented the same item stems or prompts, comprised Visual Analogue-Scaled (VAS) item response options instead. To examine how consistently participants responded to the survey items administered on the LS version and those on the VAS version, the test-retest procedure known as the *coefficient of stability* was calculated. The results indicated that the two sets of scores were highly correlated (Pearson $r = .87$, $p < .001$, estimated random error = .13), which indicated that participants' responses were highly consistent across the LS and VAS versions of the survey.

Conclusion

Based on the tests conducted above, when estimates of internal consistency were compared across the three school levels and compared using the full sample, observed coefficients were comparable to those obtained by Voelkl (1996). When a test of the consistency of participants' responses across forms was conducted, observed test-retest reliability coefficients indicated that the LS and VAS scores were highly correlated, which is consistent with the results of Funke and Reips (2007a). Results suggest that the reliability coefficients are not affected by item response format.

Summated Scores: LS vs. VAS

Research question #3

Are there significant mean differences for the summated scores overall between the LS version and the VAS version of the survey?

Tables 4-6 and 4-7 present the descriptive statistics for the LS and VAS summated scores as well as for each item on the survey. The two summated scores were highly correlated ($r = .87$, $p < .001$) and nearly identical with a mean of roughly 1085 for both versions. The VAS version yielded a slightly higher standard deviation than the LS ($s = 254.9$ vs. 236.6 respectively), indicating more variation in the VAS scores. The VAS also yielded a slightly higher SEM than the LS version (15.54 vs. 14.43 respectively), indicating greater variance in the scores when the VAS was used as the item response type. Given the notable differences in scale between these two item response types, this is to be expected.

Table 4-6

Survey Summated Score Descriptive Statistics: LS vs. VAS (full sample)

Survey Variable	*M*	N	*SD*	*SEM*
LS Summated Score	1084.46	269	236.61	14.45
VAS Summated Score	1085.28	269	254.90	15.54

Table 4-7

Survey Item Descriptive Statistics: LS vs. VAS (full sample)

#	Survey Item	LS *M*	VAS *M*	LS *SD*	VAS *SD*
1	I feel proud of being a part of my school.	68.28	67.65	27.73	26.63
2	I feel that I am treated with respect at my school.	62.44	63.17	28.37	28.32
3	I can get a good job even if my grades are bad.	58.65	58.42	29.25	31.02
4	The only time I get attention in school is when I cause trouble.	76.22	74.46	27.91	29.43
5	I participate in activities at my school.	68.92	70.97	27.45	27.19
6	Doing well in school is important in life.	84.27	83.33	20.38	20.52
7	Most of the things we learn in class are useless.	67.75	69.01	27.95	29.61
8	I feel that teachers don't care in this school.	71.91	72.95	26.93	28.73
9	I would rather be out of school.	55.84	55.48	32.12	33.32
10	I have teachers that I can talk to at my school.	69.08	71.12	28.54	28.83
11	Doing well in school is useful for getting a job.	81.17	82.81	25.23	23.34
12	School is one of my favorite places to be.	46.59	47.70	28.48	29.75
13	I feel that people are interested in me at my school.	60.06	60.40	25.29	27.01
14	I feel that school is a waste of time.	70.36	71.50	27.66	28.08
15	I feel that it is a mistake to drop out of school.	78.23	76.38	30.93	32.32
16	School is more important than most people think.	77.37	80.44	24.26	21.79

Paired-Samples *t* Test

A paired-samples *t* test was conducted to investigate whether there was a significant difference between LS and VAS summated scores. Results suggested that there was no significant difference between the two versions of the survey: $t(268)$, $p = .92$ (see Table 4-8).

Table 4-8

Paired-Samples t Test of LS-VAS Summated Scores (full sample)

	Paired Differences						
				95% CI			
	M	*SD*	SEM	Lower	Upper	*t*	*df*
LS - VAS Sum. Scores	-.81	128.27	7.82	-16.21	14.59	-.10	268

Note. N = 269.

Conclusion

Based on the tests conducted above, when summated scores of the full sample were compared, a paired-samples *t* test revealed no significant difference between the LS and VAS item response formats (t = -.10, df = 268, p = .92). Results suggest that the summated scores of the *Identification with School* survey are not affected by item response format.

Summated Scores: School-Level Comparisons

Research question #4

Are there significant mean differences of the summated scores on the LS and VAS versions of the survey between Elementary, Middle, and High School students?

School-Level Summated Score Results

Paired-samples *t* tests were conducted to investigate whether there was a significant difference between LS and VAS summated scores for each of the three school-levels: *Upper Elementary*, *Middle*, and *High School*. Because multiple *t* tests were conducted with a single sample, to control for Type I error, Dunnett's correction[41] (Keppel & Wickens, 2004) was used to adjust the alpha level to .016. Results suggest that there was no significant difference (p > .60) between the two versions of the survey, regardless of school-level (see Table 4-9).

[41] The Dunnett's correction procedure involved dividing alpha by the number of *t* tests performed.

Table 4-9

Paired-Samples t Test of LS-VAS Summated Scores (by School-Level)

	Paired Differences						
				95% CI			
School-Level	*M*	*SD*	*SEM*	Lower	Upper	*t*	*df*
Upper Elementary (grades 4-6)	-5.91	125.02	11.14	-27.95	16.14	-.53[a]	125
Middle (grades 7-9)	6.35	162.15	21.19	-36.29	48.98	.30[b]	57
High School (grades 10-12)	1.86	106.38	11.54	-21.09	24.81	.16[c]	84

Note: a. $p = .60$
b. $p = .77$
c. $p = .87$

Conclusion

Based on the tests conducted above, when summated scores of the three school-levels (*Upper Elementary*, *Middle*, and *High School*) were compared, a paired-samples *t* test reveals no significant difference between the LS and VAS item response formats Results suggest that the summated scores of the *Identification with School* survey are not affected by item response format.

Factorial ANOVA

Research question #5

Is there a significant interaction between level of schooling and item response type? If so, was it dependent on item response type?

Main Effects

Levene's test of equality of variances was conducted and indicated homogeneity of variance within the school-level groups, $F(5, 168) = 1.94$, $p=.09$. A univariate ANOVA was conducted to determine the effects of item response type on the *Identification with School* summated survey scores (see Table 4-11). Main effects were examined first to determine if differences among the means for the LS and VAS versions of the survey were significant when averaged over the three levels of schooling. Main effect results revealed scores were significantly different between school levels, $F(2, 168) = 13.14$, $p=<.001$, partial $\eta^2 = .135$. The main effect of item response type yielded an F ratio of $F(1, 168) < 1.00$, $p=.73$, partial $\eta^2 = .001$, indicating that item response type did not have a significant impact on the overall summated scores of the survey.

Table 4-10

Two-way ANOVA Summary Table

Source	*SS*	*df*	*MS*	*F*	*Partial Eta Squared*
Between groups	1.501E6[a]	5	300107.94	5.32*	.14
IRT	6641.52	1	6641.52	.12	.00
School Level	1482912.56	2	741456.28	13.14*	.14
IRT * School Level	10985.60	2	5492.80	.10	.00
Within groups	9480843.66	168	56433.59		
Total	2.117E8	174			

Note. Dependent Variable: *Identification with School* summated score.
*$p < .001$

In Figure *4-4*, the plotted lines clearly indicate the main effect of school level on the results of the *Identification with School* survey. The plot also suggests that a slight interaction was present and that the simple effects of item response type were not equal across school levels.

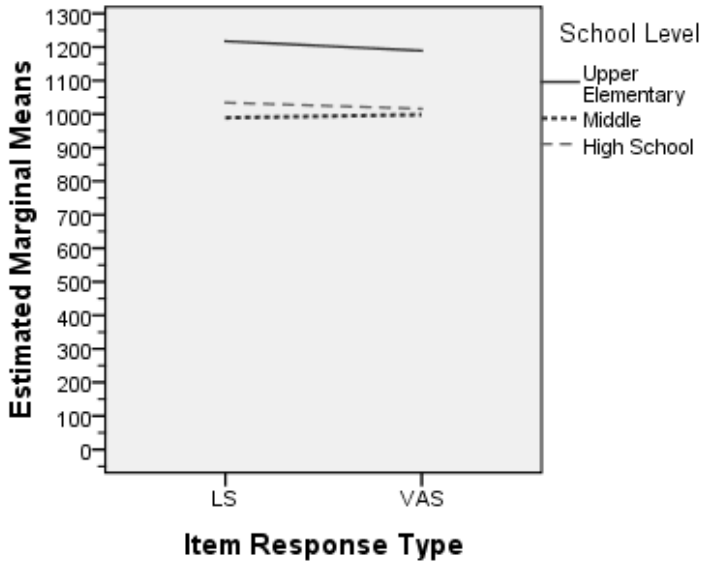

Figure 4-4. Line Plot of Estimated *Identification with School* Survey Marginal Means for Each Item Response Type (LS vs. VAS) by School-Level.

Interaction

Keppel and Wickens (2004) suggest that when the effects of one independent variable (IV) are not the same as they are for the other independent variable at all levels of the dependent variable (DV), an interaction is present. Although the interaction between school level and item response type was not statistically significant, $F(2, 168) < 1.00$, $p=.91$, partial $\eta^2 = .001$, subsequent evaluation of the plotted lines graph shown in Figure 4-4 below indicated that an interaction might be present. As evidenced by the plotted lines crossing over one another in Figure 4-5, it is apparent that the three school-level groups did not perform the same on the survey. First, *Upper Elementary* students' scores were comparatively higher than their *Middle* and *High School* counterparts' scores. Second, it appears in Figure 4-5 that all students' performance on the survey was slightly impacted by item response type. Specifically, both *Upper Elementary* and *High School* students scored slightly higher when they took the LS version of the survey whereas *Middle* students scored slightly higher when they took the VAS version of the survey. While this slight interaction proved not to be statistically significant, simple effects were nonetheless explored to examine this relationship further (see the next section for further details).

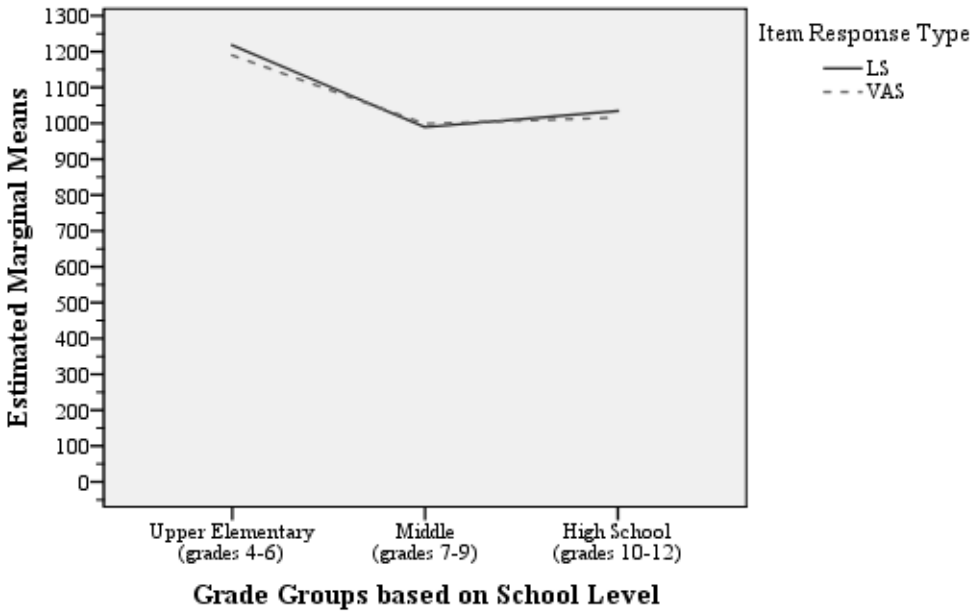

Figure 4-5. Line Plot of Estimated *Identification with School* Survey Marginal Means for Each School-Level by Item Response Type (LS vs. VAS).

Both the Scheffe and Bonferroni post hoc tests were conducted to determine which school-level groups had significantly different *Identification with School* survey summated scores. Results indicated that *Upper Elementary* students' (e.g., students in grades 4 to 6) survey scores were significantly different ($p < .001$) from *Middle* and High School students' scores and *Middle* and *High School* students' scores were not significantly different from each other (see Table 4-11 below).

Table 4-11

Post Hoc Tests for Multiple Comparisons of School Level

	(I) School Level	(J) School Level	Mean Difference (I-J)	*SE*	*p*	95% CI Lower	95% CI Upper
Scheffe	Upper Elementary (grades 4-6)	Middle	209.60	44.11	*p*<.01	100.66	318.55
		High School	178.29	44.11	*p*<.01	69.34	287.24
	Middle (grades 7-9)	Upper Elementary	-209.60	44.11	*p*<.01	-318.55	-100.66
		High School	-31.31	44.11	.78	-140.26	77.64
	High School (grades 10-12)	Upper Elementary	-178.29	44.11	*p*<.01	-287.24	-69.34
		Middle	31.31	44.11	.78	-77.64	140.26
Bonferroni	Upper Elementary (grades 4-6)	Middle	209.60	44.11	*p*<.01	102.93	316.28
		High School	178.29	44.11	*p*<.01	71.62	284.97
	Middle (grades 7-9)	Upper Elementary	-209.60	44.11	*p*<.01	-316.28	-102.93
		High School	-31.31	44.11	1.00	-137.98	75.36
	High School (grades 10-12)	Upper Elementary	-178.29	44.11	*p*<.01	-284.97	-71.62
		Middle	31.31	44.11	1.00	-75.36	137.98

Note. Dependent Variable: *Identification w/School* Summated Score. The error term, Mean Square (Error) = 56433.59.

Simple Effects

A simple effect is one that expresses the difference among the means for one independent variable at a fixed level of the other independent variable (Klockars & Sax, 1986). Simple effects analyze the interaction between variables based on the pattern of significant and nonsignificant differences in the means. To test for simple effects, the differences between the LS and VAS were examined for each of the three school levels. Three separate tests of significance were conducted to determine if the differences between LS and VAS, for a specific school level, differed significantly. Although a significant interaction was not present, simple effects were nonetheless examined due to the pattern observed in Figure 4-5 above, which suggested that a slight interaction was

present between school level and item response type. The intent of the examination was to gain a better understanding of this pattern. Table 4-12 presents the simple effects at each school level. The simple effects are indicated by the *t*-values in the bottom row.

Table 4-12

Cell Means and t-Values for Simple Effects of Item Response Type by School Level

Survey Variable	Elementary	Middle	High School	*Full Sample*
LS Mean Summated Score	1148.95	1014.67	1036.49	1084.46
VAS Mean Summated Score	1154.86	1008.33	1034.64	1085.28
t-Value for *Simple Effects*	-.530	.298	.161	-.104

Using a 5% per comparison error rate, there was insufficient evidence to reject the three null hypotheses that the means for the LS and VAS versions of the survey estimate the same population means for each level of schooling. That is, the simple effects of item response type at each school-level were not significant ($p > .05$), indicating that students within all three school levels responded similarly using either the LS or VAS item response type.

Conclusion

In sum, based on the tests conducted above, when main-, interaction, and simple effects are examined, an ANOVA reveals no significant interaction was present between item response format and school level. Results suggest that students' performance at all three school levels on the *Identification with School* survey is not affected by item response format.

Post-Survey Questionnaire

This section provides a broad understanding of how students typically felt about using the LS and VAS to respond to questions on the *Identification with School* survey.

Dichotomous Item Results

Students in both treatment conditions were asked five post-survey questions. Three of these questions were asked on the *Student Opinion Questionnaire* (see Appendix C) and were specific to only the "LS First" condition or the "VAS First" condition. That is, these three questions were administered immediately following the first survey that students completed. Thus, roughly only half the sample responded to questions about the LS and the other half responded to questions about the VAS (depending on which condition they were assigned to first).[42] The remaining two post-survey questions were asked of *all* students on the *Student Demographic Questionnaire* (see Appendix D), which was administered at the end of the experiment.

In general, roughly 90% of the students indicated that they did not find the items on the *Identification with School* survey hard to answer. Overall, students preferred answering questions with the VAS compared to the LS nearly 3 to 1 (71.4% vs. 27.1%). For the students who received the LS first, when asked whether the LS enabled them to pick an answer that closely matched how they felt, students were nearly evenly divided: roughly half (51%) indicated that the LS did and the other half indicated that it did not.

[42] It bears noting that some of the numbers and percentages presented for the *Student Opinion Questionnaire* are dependent upon the number assigned to a specific initial experimental condition and not of the full sample (N=269).

By comparison, for the students who received the VAS first, a clear preference emerged when they were asked whether the VAS enabled them to choose a response that closely matched how they felt: More than three-fourths of students who responded indicated that the VAS let them pick an answer that matched exactly the way they felt.

Lastly, when asked if there were any desired changes to the response options, 60% of students indicated that the LS items did not need different (e.g., less restrictive) response options and 66% indicated that the VAS did not need a set of provided-response options (e.g., Likert-type) from which to choose. Table 4-13 presents the quantitative results of the dichotomous (e.g., Yes/No) items from the *Student Opinion Questionnaire* and Table 4-14 presents the quantitative results of the supplementary post-survey questions that were administered to all students after the experiment (see Appendix D). Qualitative results of the open-response components of these questions are presented in the following section.

Table 4-13

Post-Survey Student Opinion Questionnaire Item Response Descriptives

	No		**Yes**	
Item	*n*	%	*n*	%
[*LS*] Were the questions on this survey hard for you to answer?	130	87.0	20	13.0
[*LS only*] Did this survey let you pick an answer that matched exactly the way you felt?	72	49.0	75	51.0
[LS *only*] When answering any of the questions on this survey, did you wish that there were different answer choices than the ones you were given?	90	60.0	59	40.0
[*VAS*] Were the questions on this survey hard for you to answer?	110	93.0	8	7.0
[*VAS only*] Did this survey let you pick an answer that matched exactly the way you felt?	28	24.0	88	76.0
[*VAS only*] When answering any of the questions on this survey, did you wish that you had a set of answers to choose from instead of having to choose a place along the line to answer?	84	66.0	44	34.0

Note: n's and percentages are based only on the number of students who responded in each condition.

Table 4-14

Post-Survey Demographic Questionnaire Supplementary Item Response Descriptives

	LS		**VAS**		***Missing***	
Item	*n*	%	*n*	%	*n*	%
[LS *and* VAS] Think about the survey you just took. Which way did you like better for answering the questions?	73	27.1	192	71.4	4	1.5
	No		**Yes**		***Missing***	
[LS *and* VAS] Do you like your school?	50	18.6	215	79.9	4	1.5

Note. N = 269.

Qualitative Item Results

The three post-survey questions on the "Student Opinion Questionnaire" had an "open response" component comprising a follow-up question that asked students to "Please explain why or why not" or to "…give an example" (see Appendix C). The intent

of this section is to provide a broad understanding of how students typically felt about using the LS and VAS to respond to questions on the *Identification with School* survey.

A review of the post-survey open-response items revealed three specific themes that captured student sentiment for each of the open-response items. The themes were: 1) *Specificity/Accuracy*; 2) *Freedom of Response*; and 3) *Ease of Use*. The *Specificity/Accuracy* theme comprises student responses that reflect the ability of the LS or VAS to accurately capture students' feelings or to specify the strength of their responses. The *Range of Response* theme comprises student responses that reflect the ability of the LS or VAS to allow students the freedom to respond in the manner in which they wished to respond. Lastly, the *Ease of Use* theme comprises student responses that reflect the level of comfort students had while using the LS or VAS to respond and/or the level of understanding students had of how to use the LS or VAS to convey their responses.

Likert scale responses.

In general, students who responded negatively to questions about the LS did not like being forced to choose from a limited set of response options and did not like being unable to modify the response options to match more precisely their actual response. Students also expressed that they wanted a neutral mid-point for times when they neither agreed nor disagreed with the item prompt. Students who responded positively to questions about the LS thought that it was easier to respond when specific answer choices were given. In addition, these students expressed that the range of the four LS response options (*Strongly Disagree* to S*trongly Agree*) were sufficient to capture their responses.

In particular, some students stated that the LS captured exactly what they were feeling. Lastly, some students appreciated the four response options because they were easy to choose from and easy to understand. Table 4-15 below presents several examples of positive and negative student responses and the general themes associated with these responses for the LS.

Table 4-15

LS Post-Survey Questionnaire Open-Response Themes and Student Responses

Theme	**Negative Example**	**Positive Example**
Specificity/Accuracy	Because there were no variety in the answers and I was between answers.	On most the questions I found a suitable answer
	I have more strong "feelings" than can go into 4 distinct categories. This seems like a male-oriented survey.	[The LS response options] are all the feelings you can have. A neutral button for if you don't know would be helpful.
	I wasn't able to give my exact opinion.	[The LS response options were] exactly what I felt
	No because the way I felt did not really have an answer that matched my feelings.	Yes it did, because it had the answers that I would pick.
Range of Response	I had to be absolute...very frustrating since everything is not in black or white (slight black or slight white).	It had strongly disagree, disagree, strongly agree, and agree. That is perfectly enough.
	I wasn't opinionated on many of the questions but was forced to agree or disagree and met some difficulty in doing so.	Yes this survey did let me answer the way I wanted to, because they were easy to answer with the answers provided.
	Because some of them I felt different about it instead of agree, strongly agree, disagree, strongly disagree. I wish the answers were broader in some cases.	I think this does not have totally detailed options but it's almost completely satisfying.
Ease of Use	…for some questions it was difficult to determine if I really did disagree or agree. There should of been a 'Maybe' button.	because the choices in this survey are choices that I can understand
	I sometimes wanted to make my answer be somewhere between two answers like one time I picked agree but I wanted to pick like something between agree and strongly agree.	I could express myself easily on these questions.

Visual analogue scale responses.

Table 4-16 below presents several examples of positive and negative student responses and the general themes associated with these responses for the VAS. In general, students who responded negatively to questions about the VAS expressed that they needed or wanted answer choices and using the VAS was difficult because specific answer choices were not provided. Others felt that the VAS was not as precise as the LS because there weren't any words to capture their responses so they had to "guess" the precision of their answers. Students also expressed that they found it difficult to express how they felt using "the bar" (VAS). Students who responded positively to questions about the VAS thought that it was easy to use and accurate/precise at capturing exactly how they felt. In addition, these students expressed that the VAS gave them the freedom they wanted to respond to the questions, such as with the option of using the center of the line to capture neutral or "don't know" or "maybe" responses. Some students stated that the VAS captured exactly what they were feeling. Lastly, some students found the VAS to be "fun" and engaging (as opposed to the standard "multiple choice" items found on exams and others surveys that they had been exposed to previously).

Table 4-16

VAS Post-Survey Questionnaire Open-Response Themes and Student Responses

Theme	Negative Example	Positive Example
Specificity/Accuracy	Because you don't know the exact number that you put down. For example if you think you put down 90, what if you actually put 92 or 93, what if you want it permanently on 90.	Because Sometimes when I have a question I like to say maybe and with the bar I could put it in between.
	Because the line was very inexact and I feel multiple choices are more accurate.	I did not wish that I had a set of answers because choosing a place along the line shows how much a person would agree or disagree.
	Simple responses on a bar cannot adequately convey my views on these subjects. Written responses are a much more effective way of gauging a person's thoughts.	The spectrum was inclusive of all feelings. I am versatile and I feel that placing a restriction on types of answer choices is useless.
	The bar wasn't very specific.	I could decide on my own on a more specific answer. Choosing answers is boring. [Using the VAS] was more fun!
Range of Response	At times I had mixed feelings about the questions and couldn't express that using a bar.	Because [with] the bar you could pick any feeling.
	It didn't have any answer choices.	Because with the bar you can rate instead of just choose. I like ranges. THE WORLD IS NOT BLACK AND WHITE!
Ease of Use	Because it would be easier to choose an answer, and you wouldn't have to think so hard.	It is simple to [choose] how much you like an activity with a continuous spectrum.
	Because it is kind of hard to show how you feel about your school with a line!!!	It's easier this way. Then you could say how much you like or dislike something, rather than having someone else answer things for you.
	Because I couldn't get it where I wanted it to be.	If something is 50/50 I can just put the arrow in the middle bar.
	Multiple choice answers clearly illustrating strongly disagree, disagree, etc. would make it easier to answer the questions because I would see what my answer was instead of guessing.	The [VAS] scale made it easy to answer.

Comparison of LS to VAS by School-Level

The results of the item in Table 4-14 that asked, "Which way did you like better for answering the questions?" indicated a strong overall preference for the VAS over the LS (71.4% vs. 27.1%); however, when all of the open-responses were delineated by school-level and item-response type and then coded as *positive* or *negative*, it became evident that negative and positive attitudes toward the LS and VAS varied. Table 4-17

presents the percentages of positive and negative responses for the LS and VAS by school-level.

Table 4-17

Percent of Negative and Positive Responses Toward the LS and VAS by School-Level

	Upper Elementary		Middle		High School	
Item Response Type	–	+	–	+	–	+
Likert Scale	62.5%	37.5%	71.4%	28.6%	85.5%	14.5%
Visual Analogue Scale	26.6%	73.3%	35.5%	64.5%	25.8%	74.2%

Upper Elementary (grades 4-6).

Upper Elementary students had the most positive responses towards the LS: nearly 10% more *positive* responses about the LS than *Middle* students (37.5% vs. 28.6%) and 23% more than *High School* students (37.5% vs. 14.5%). When *Upper Elementary* students responded positively towards the LS they often indicated that they liked the "answer choices" (e.g. response options) because they were easy to understand and accurate (e.g., "[The LS] let me pick what I really wanted to pick"). When *Upper Elementary* students responded negatively towards the VAS, they often indicated that the VAS was "hard" and that they wanted "answer choices" to help them respond (e.g., "Some questions were kind of hard to answer because the line only had Strongly Disagree and Strongly Agree").

Middle (grades 7-9).

Middle students responded the most negatively towards the VAS: 35.5% negative VAS responses compared to 26.6% and 25.8% for the *Upper Elementary* and *High*

School students, respectively. When *Middle* students responded negatively towards the VAS, the responses were often related to the VAS making it "harder" to express themselves (e.g., "At times I had mixed feelings about the questions and couldn't express that using a bar") and being "less specific" than the LS (e.g., ["Having LS response options] would make my answers more specific than just being kinda random [as with the VAS]"). Of the nearly 30% of *Middle* students who responded positively towards the LS, many indicated that they prefer "multiple choice" (e.g. LS) questions because choosing from a pre-determined or supplied set of responses was "easier" than having to determine on one's own a response from within the wide range of possibilities that the VAS presents (e.g., "I think a [set of LS response options] would have been better than a line because there are more choices than a random spot on the line….Advice for the future: MAKE THESE QUESTIONS MULTIPLE CHOICE INSTEAD OF A STINKIN LINE!").

High School (grades 10-12).

Of the three school-levels, *High School* students responded the most negatively towards the LS: 85.5% negative LS responses compared to 63.5% and 71.4% for *Upper Elementary* and *Middle*, respectively. They responded most positively towards the VAS: 74.2% positive VAS responses compared to 73.3% and 64.5% for *Upper Elementary* and *Middle*, respectively. When *High School* students responded negatively towards the LS, they most often complained that LS response options failed to adequately capture the intensity of their responses (e.g., "I felt at times that I could have marked between choices. I did not agree with the choices [the LS provided]"). *High School* students, in

particular, resented the “limited” choices of the LS and did not like being “forced” to choose from only one of four responses (e.g., “[The LS response options] didn't let me pick an answer that matched exactly the way I felt because on some questions I felt like only sometimes I agreed rather than completely disagree or agree”). Lastly, it is interesting to note that in comparison to the other two groups of students, *High School* students wanted more control over how their responses were interpreted. In responses related to both the LS as well as the VAS, several *High School* students indicated a desire to have an opportunity to “explain” their responses (e.g., “Each time [I responded with LS response options] I think I would have liked a better chance to explain my reasoning”; and “Simple responses on a bar [VAS] cannot adequately convey my views on these subjects. Written responses are a much more effective way of gauging a person's thoughts”). Such a desire to more fully explain responses was not mentioned by students in the other two school levels.

Summary

The analyses presented in this chapter provide evidence that the *Identification with School* survey is a reliable measure of students’ identification with school for grades 4-12 regardless of the item response type used. Results also suggest that the LS and VAS versions of the survey yielded nearly identical results, thus indicating that item response type did not affect the results of the *Identification with School* survey in this study. In addition, results of the post-survey student questionnaires suggest that students preferred

the VAS over the LS 3 to 1 when asked which item response type they liked best. While students were nearly evenly split when asked if they thought the LS allowed them to pick an answer that matched *exactly* how they felt (49%: "No" vs. 51%: "Yes"), a clear majority of students (76%: "Yes" vs. 24%: "No") indicated that the VAS allowed them to respond in a manner that captured their feeling *exactly*. Lastly, while all three school levels had a greater percentage of positive responses than negative towards the VAS than the LS, *High School* students had the highest percentage of positive responses. Conversely, of the students who responded positively towards the LS, *Upper Elementary* students had the greatest percentage of positive responses. These results are consistent with Piagetian stages of child development in that the younger, *Upper Elementary* and *Middle* students were more inclined to prefer the "concrete" response options of the LS whereas the older, *High School* students were more inclined to prefer the VAS because they are more independent thinkers and would be more likely to have an aversion to any limitations of their unique self-expression. A more detailed discussion of this study's findings is presented in the following chapter.

Chapter 5: Discussion and Conclusion

In this chapter, results from the previous chapter are briefly summarized and discussed. Limitations and the implications of the results of this study are also presented, and suggestions for future research are made.

Overview of Findings

The purpose of this study was to investigate whether changing the response format from LS to VAS on the *Identification with School* survey affects the underlying factor structure, reliability, and summated scores of the survey across three levels of schooling: *Upper Elementary*, *Middle*, and *High School*. Additionally, this study sought to examine the main, interaction, and simple effects of item response type and school level (the two predictor variables) on scores yielded by the survey (the outcome variable). The primary findings of this study reveal that: 1) the VAS yields a factor structure similar to the LS; 2) the VAS is equally reliable as the LS in terms of internal consistency and test-retest reliability; 3) the VAS yields nearly identical summated scores as the LS regardless of school level; and 4) the VAS was preferred by a majority of students across all three school levels. Additionally, the results of an ANOVA conducted to examine school level and response mode effects indicate that while school level had a statistically significant main effect on summated survey scores and response mode did not, the mode effect was invariant across school levels. In other words, while there were significant differences in mean summated scores across school levels, these differences were

consistent across the LS and VAS response formats. In total, these findings suggest that while student performance on the *Identification with School* survey was not affected by item response format, student *preference* for the VAS format was nonetheless made evident by their answers to items on the post-survey questionnaire.

Discussion

Consistency of Findings

The findings from this study are consistent with the work of other investigators who have either administered the *Identification with School* survey (Ruiz, 2002; Voelkl, 1996) or compared the effects of using the Likert scale (LS) versus the visual analogue scale (VAS) item response formats with children (Berntson & Svensson, 2001; van Laerhoven et al., 2004). First, the results of Principal Components Analysis (PCA), which revealed that the factor structure of the LS and VAS versions of the *Identification with School* survey was unidimensional, support the findings originally reported by Voelkl (1996), who conducted the first study that explores this topic. Second, the results of the internal consistency reliability tests of the *Identification with School* survey, which yielded identical LS and VAS Cronbach's alpha reliability coefficients of $a = .83$, indicate that this survey's items are highly consistent and provide evidence that the yielded scores are reliable. The findings on reliability are consistent with findings by Ruiz (2002) and Voelkl (1996), who reported Cronbach's alpha reliability coefficients of .80 and .84, respectively for the *Identification with School* survey. Third, while no

previous study has examined the test-retest reliability of the *Identification with School* survey, similar research on the test-retest reliability of the VAS has demonstrated that it does not influence this coefficient of stability (Funke & Reips, 2007a). As such, the findings of this study, which suggest that the scores produced by the survey were statistically similar across both forms of the survey and within the levels of schooling, are consistent with previous research. Moreover, given that item response type did not have a statistically significant effect on students' summated scores, it appears that these two scales are, in effect, interchangeable.

Explaining the Differences in Scores Between School Levels

While there were statistically significant differences between the *Upper Elementary* students' summated scores on the *Identification with School* survey and the scores of the other two school levels, the findings of this study suggest that the observed difference was *not* a function of item response type. The simplest explanation for why the *Upper Elementary* students' summated scores were higher is that they genuinely do enjoy school more than their *Middle* and *High School* counterparts and therefore they more strongly and positively identify with school and school-related outcomes. A slightly more complex explanation for the higher summated scores achieved by the *Upper Elementary* students compared to the *Middle* and *High School* students could possibly be attributed to the survey topic and the questions that were asked on the *Identification with School* survey. In particular, the research literature suggests that younger children may be more prone to "acquiescing" than older children, meaning

younger children are more likely to respond in ways they view as more socially desirable or in ways they feel would "please" adults (Ormrod, 1995). This phenomenon could explain the *Upper Elementary* students' more positive identification with school and corresponding higher summated survey scores on the *Identification with School* survey compared to their *Middle* and *High School* student counterparts.

Lastly, a possible explanation for why the students in the *Middle* school level scored lowest on the survey of all three groups is provided by Eccles, Midgley, Wigfield, Buchanan, Reuman, Flanagan, et. al, (1993), who suggest that in addition to the negative psychological changes often associated with this age range as they develop, young adolescents may experience a "mismatch" between their personal needs and the opportunities provided in their school environment that can impact their motivation and self-perceptions. As such, the younger adolescent students who participated in this study may have experienced a greater disconnect between themselves and the schools they attended, which could have, in turn, affected their summated scores on the *Identification with School* survey.

Explaining the Differences in Item Response-Type Preference

It is interesting to note that while students' responses were consistent across forms and their scores within school-level were not statistically significantly different, all of the students expressed a preference for one or the other item response type. While most students, irrespective of school level, expressed a preference for the VAS over the LS,

this preference was not universal. Two possible explanations for students' item response-type preference are discussed below.

Piaget's stages of development.

The present study's findings highlight possible age effects in the use of surveys and are consistent with Piagetian stages of child development; specifically, younger students are more likely to prefer the concreteness of the LS responses and older students are more likely to prefer the freedom of expression that the VAS provides. As discussed in Chapter 2,[43] although children in the concrete operational stage may be capable of many forms of logical thought, their cognitive development is in its early stages and thus they may have difficulty grasping hypothetical scenarios that cannot be directly observed or experienced. They may also struggle with proportional reasoning, which is evident in the responses of some students in this study who indicated that it was hard for them to convey their feelings on a line (VAS). These cognitive limitations may have had an impact on some students' ability to grasp the concept of the VAS response format (although no studies to date have investigated the legitimacy of this claim). Further, their cognitive limitations could explain why more than one-third of *Upper Elementary* students preferred the LS with its "concrete" set of verbal anchors and why they thought the LS was "easier to complete" than the VAS. By comparison, children in the formal operations stage begin to be able to think about concepts that are abstract, hypothetical, or contrary-to-fact and become more independent thinkers capable of unique self-expression. A number of abilities essential for sophisticated reasoning also emerge

[43] In the Children and Surveys section under the *Cognitive Development* sub-heading.

during this developmental stage that enable these children to use and understand continuums in their reasoning. This was evident among many of the *High School* students in this study who not only understood how to use the VAS, but also expressed a strong preference for it over the LS as the VAS allowed them to convey precisely how they felt.

While Piaget's focus on qualitative child development had an important impact on education, it is important to note that he did not specifically apply his theory to education. Nonetheless, many educational programs are built upon the belief that children should be taught at the level for which they are developmentally prepared. That being said, it is generally accepted today that all children will not, as Piaget maintained, automatically move to the next stage of development as they mature. An additional criticism of Piaget's work is that it failed to take into consideration social or cultural factors that likely influence the rate in which children proceed (or not) from one developmental stage to the next. As such, it is important to note that a child's home environment could have an affect on her emotional and cognitive development. To that end, the lack of uniformity in student preferences observed across school levels for either the LS or VAS could be a function of students at, above, or below their Piagetian-defined level of development.

The "digital generation": Today's media-savvy students.

While Piagetian developmental stages can be helpful with explaining student preference for either the LS or VAS when student preference is consistent with their age, his stages offer little insight into why some of the younger students preferred the VAS and some older students preferred the LS. A simple explanation for why a majority of all

students preferred the VAS is that today's students are part of a new "digital generation" of computer-savvy children, some of whom spend up to 6.5 hours a day with digital media (Rideout, Roberts, & Foehr, 2005). [44] As a result, many students today are naturally adept with technology and used to manipulating things on a computer, whether it be an avatar in a game, text on a page, or an image in a drawing program/photograph. To that end, the VAS may be more similar to the way they use a computer and may also make them feel more involved in the process of answering questions. A possible explanation for the younger students' preference for the VAS could be that their preference is a function of their advanced cognitive development (in comparison to their peers). For example, it is possible that these students were gifted or high academic achievers and therefore have more in common with older students than their younger peers. Similarly, for the older students who preferred the LS, they may be less academically advanced, or developmentally behind their peers emotionally or cognitively. Additionally, it could be possible that these students were not motivated to complete the survey.

Student Motivation Effects

There are three related problems that investigators face when conducting survey research. The first problem is respondent fatigue, which can potentially affect student

[44] According to Rideout, Roberts, & Foehr (2005), "Young people today live media-saturated lives, spending an average of nearly 6½ (6:21) hours a day with media. Across the seven days of the week, that amount is the equivalent of a full-time job, with a few extra hours thrown in for overtime (44½ hours a week). Indeed, given that about a quarter (26%) of the time young people are using media, they're using more than one medium at a time (reading and listening to music, for example), they are actually exposed to the equivalent of 8½ hours a day (8:33) of media content, even though they pack that into less than 6½ hours of time."

motivation to complete the survey. The second problem is attrition, which may be the effect of low student motivation. These two problems then lead to the third problem, item non-response.

Fatigue.

According to Tourangeau (1984), responding to survey questions requires that respondents proceed through four consecutive stages of cognitive processing: 1) understand and interpret the question; 2) search their memory for relevant information and retrieve it; 3) integrate the information into a judgment or cogent response; and 4) respond or report the information in a way that clearly and concisely conveys their (the respondent's) intended meaning. If a respondent carefully goes through all four of these steps each time she answers a question on a survey, then she has "optimized" her response (Krosnick, 1991). If the respondent simply provides a superficial response that required very little cognitive effort, then she is guilty of "satisficing" (1991), meaning her response was not as accurate or complete as it could have been had he gone through Tourangeau's four optimizing steps. Of course, even for the most highly motivated respondents who may strive to optimize every single response, there is a limit to the considerable amount of mental effort that can be reasonably expended (and expected) while responding to a survey.

Respondents may experience fatigue if they require extensive periods of time to respond to a series of challenging items or to complete a lengthy survey. Given that there were a number of students in this study who indicated that the VAS was "harder" than the LS, it is possible that VAS items may require more cognitive resources when responding

than LS items. As such, VAS items may call for an increase in cognitive load (e.g, making students think more about their responses), which may facilitate respondent fatigue. Additionally, by requiring students to supply responses by contemplating the magnitude of each response in terms of a continuous scale and then sliding the locator along a continuum, more time may be required to respond to VAS items compared to LS items. For longer surveys, this may accumulate into increased administration time and increased respondent fatigue, which may lead to higher levels of item nonresponse or respondent attrition.

Attrition.

When respondents leave the study prior to completing all the questions on the survey, the possibility of error bias is introduced into the survey's results because of potentially systematic differences between those who remained in the study and those who dropped out. In the present study, there were several respondents who answered only the first few questions and then dropped out of the study. It is not clear whether these respondents ran out of time, or became bored or frustrated, or whether the survey was simply accessed out of curiosity (which could have happened with teachers checking out the survey before administering it to students). Because respondent identities were anonymous, it is not possible to determine the cause of attrition.

Item nonresponse.

Practically all surveys are accompanied by a loss of information because of item nonresponse. There are a number of reasons respondents may not answer certain items including their belief that the question(s) is too sensitive, embarrassing, or irrelevant.

Nonresponse can also occur if the respondent does not know the answer or feels that the question is too difficult. Lastly, nonresponse can occur if the respondent feels that the question requires too much effort to respond. In the present study, while it is not possible to determine the reason for specific item nonresponse, post-survey questionnaire responses provide some evidence that students may have struggled with the question being asked or may have become frustrated with either the limited options of the LS or the lack of specific response options for the VAS.

Summary

It is possible that while item response type may not have a *statistically* significant affect on student responses, it may have a *practically* significant affect on student motivation to respond and to more actively engage in taking a survey. Increasing motivation for and engagement in the survey process by matching item response types with the cognitive developmental stage of students (e.g., LS with lower grades and VAS with upper grades) may be a strategy for survey researchers to attempt to decrease the effects of issues such as respondent fatigue, attrition, and item nonresponse on study results.

Strengths and Limitations of the Study

Strengths

This study had four primary strengths. First, the experimental design of the study was particularly strong. One of the benefits of doing an experimental design is the strong internal validity. As such, the results of this study are more likely to be attributed to the treatments rather than to subject characteristics threats or other confounding factors, and one can have a high level of confidence in the conclusions drawn and inferences made about the results as they pertain to the students in this study. Second, by using random assignment I was able to provide evidence of design control and reduce the likelihood that any differences between treatment conditions were systematically related to the treatments (Shadish, Cook, & Campbell, 2001). Third, by administering both the LS and VAS versions of the survey to all students, I was able to obtain a coefficient of stability and demonstrate a high degree of consistency in students' responses and stability in their summated scores on the *Identification with School* survey. Fourth, by utilizing multiple analytical approaches, I was able to provide psychometric, descriptive, and applied evidence that the VAS was essentially interchangeable with the LS in this study.

Limitations

There are several limitations to this study that may affect the generalizability of the findings presented here, and thus the results presented should be interpreted with caution. First, this study's sample comprised students in Grades 4-12 who volunteered to participate; as a result, the sample may not be representative of the population of 4th

through 12th grade students in the United States. Therefore, findings of this study may not necessarily be generalizable to all US students in grades 4-12.

Second, students' previous computer experience, level of keyboarding skills, mouse manipulation proficiency, or degree of comfort taking computer-based surveys was not assessed. These skills could have affected the ease with which students were able to respond to LS and VAS items or could have affected students' attitudes toward the LS and/or VAS. Further, considering that students were not asked about their degree of computer proficiency or level of comfort with online survey technology, it was not possible to estimate whether taking the survey on a computer had any effect on student performance or on their attitudes towards school or item response type. Nevertheless, there is insufficient evidence to suggest that a lack of previous computer experience was in any way systematic. Moreover, because random assignment was used both experimental groups were probabilistically equalized; therefore, even if this characteristic were present in the sample, it is likely to have been randomly spread across the groups and thus not necessarily a cause for bias.

A third limitation is that a pre-assessment to determine student reading level was not administered. Although the readability of the *Identification with School* survey and post-survey questionnaires was tested using the Flesch-Kincaid Index (Flesch, 1948) and results indicated that the reading level of the items was appropriate for 4th grade students, it was likely that not all participants were able to read at the 4th grade reading level or higher. Nonetheless, given the primary exclusion criterion that students had to be in 4th through 12th grade in order to participate, I assumed for the purposes of this study that all

participants read at the 4th grade level or higher and fully understood the survey directions and the items on the survey and post-survey questionnaires. It bears noting that while it is highly probable that reading ability would have affected only a small portion of the sample (most likely those students in lower grades who were reading below grade level) and therefore may have affected *some* students' responses, the effect across the sample is likely to have been minimal. Moreover, given the high test-retest reliability achieved with this sample and the numerous examples of coherent responses to the post-survey questionnaires provided by students at all school levels, there is sufficient evidence to suggest my assumption that students understood the questions on the survey was warranted.

A fourth and final limitation is that there was some evidence that not all students made a concerted effort to complete the survey or to take the survey seriously. In particular, there were incidences of missing responses and unintelligible and profane responses to open-response items at all school levels. Administering the survey to students during the last few weeks of the school year and having no consequences or rewards for performance on the *Identification with School* survey may have decreased some students' motivation for completing the online survey. Although it was not possible to determine their motivation for skipping questions or responding inappropriately, it was assumed that these students demonstrated a conspicuous lack of motivation, which could have influenced their recorded or interpretable responses to the *Identification with School* survey. To counteract this possible biasing affect, whenever possible, blatant examples of student indifference—such as the use of the same response

throughout the survey or response to only a few items—were cause for the student's exclusion from analyses. This, in part, was the reason the sample was reduced initially from more than 450 down to 269. Exclusion of less obvious examples of student indifference—such as missing-, profane-, or unintelligible responses on only a few items—were decided on a case-by-case basis.

Implications of the Study

The accurate and reliable assessment of students' perceptions of their well-being and experiences at school and in the classroom is critical for educational research and practice. As such, the results of this study have two primary implications for educational survey research. First, given that item response type appears not to have affected student responses on the *Identification with School* survey and that this finding was invariant across school levels, it is possible that survey designers may be able to use these item response types interchangeably on other surveys. Second, given that most students expressed a preference for the VAS over the LS, there may be implications for both survey designers and educational researchers with regard to designing and/or selecting a survey that may increase student motivation to remain engaged until completion. It bears noting, however, that because the extent of student preference for either item response type differed across school levels in this study (with larger percentages of students in lower grades preferring the LS than in higher grades) and because younger students often find the LS to be "easier" than the VAS, it may be advisable for survey designers and

researchers to employ LS for lower grade levels and VAS for upper grade levels if increasing motivation is a factor when deciding item response type.

Suggestions for Future Research

In general, further research is needed to examine factors that might increase or maximize the likelihood that students provide accurate, reliable, and valid self-reports on surveys. Although the results of this study suggest the two item response options used were virtually interchangeable when administered online, research should explore the circumstances under which the VAS might be more appropriate versus the LS and vice versa in education. This is important for three reasons outlined in detail below.

First, further research is necessary because virtually no studies have been conducted in education to directly compare the LS and VAS with K-12 populations, it remains unclear whether equivalent LS and VAS versions of a survey that measure *objective* phenomena (e.g., with discernibly or verifiably "correct" responses) would yield results similar to those obtain from this study, which measured *subjective* phenomena (e.g., feelings or attitudes). If, for example, findings suggest objective phenomena are best measured with LS and subjective phenomena are best measured with VAS, then there may be implications for the *types* of questions asked with LS or VAS response options on surveys of K-12 populations.

Second, further research is necessary because children's reasoning for preferring one item response type over the other (or for completing a survey vs. choosing not to,

etc.) can vary so widely. As such, it may be difficult for survey designers and educational researchers to identify when, for example, or with whom the LS may be the best option and when the VAS might work better. Thus, in an effort to further explore the extent to which the LS and VAS affect children's judgments and motivation, researchers should consider including a qualitative component to their survey research design to ask students what they are thinking as they respond to LS versus VAS survey items.

Third and finally, further research is necessary to compare the LS and VAS item response types using a larger, nationally representative sample comprising the numerous subgroups in today's schools such as English-language learners or students receiving special education services, etc. Research suggests that survey responses are less valid and reliable when respondents have lower motivation, lower cognitive ability, or have become fatigued (Krosnick, 1991). Thus, if a student whose first language is not English or who has a learning disability struggles to read and/or interpret survey items, she is more likely to become fatigued and/or less motivated to complete the survey and her results will be less valid and reliable than they would have been had her special needs been addressed in the survey design. While no studies to date in education have examined how students receiving special education services respond to the LS or VAS, there is some evidence in the pain literature that children for whom English is a second language may prefer the VAS over the LS because they find it more intuitive and easier to understand (Abu-Saad, Kroonen, & Halfens, 1990).

Final Conclusions

The primary goal of this study was to examine whether changing the item response format of a survey from Likert-scale to visual analogue scale would affect factor structure, internal consistency and test-retest reliability, or summated scores. The analyses presented above contribute to the evidence that the Likert scale and visual analogue scale are virtually interchangeable with the exception of student preference, which was strongly in favor of the VAS. Since children and adolescents often report strong preferences for what they eat, what they wear, what they watch on television or listen to on the radio, etc. and since satisfying (or not satisfying) these preferences can impact motivation, preference and motivation may be important factors for educational researchers to consider when deciding on surveys to use with student populations. That is, if students prefer the VAS over the LS, then it makes sense for educational researchers to consider using the VAS response option instead of the LS if only to encourage students to be more engaged in the survey and to potentially reduce survey fatigue. Given the findings of this study in conjunction with the extent to which students preferred using the VAS over the LS, use of the VAS in future Web-based survey research with students in 4^{th} through 12^{th} grade is recommended.

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Appendix A

The "Identification with School" Survey (*Likert Scale Version*)

The following two questions will give you a chance to practice using your mouse to mark your answers on the first survey you take today. Please answer BOTH questions before moving on to the survey.

SAMPLE QUESTIONS

Read each question carefully and then use your mouse to click on the button with the answer that best describes how you ***really*** feel for each question below. If you want to change your answer, just click on the button with your new answer.	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
a. I like ice cream.	❍	❍	❍	❍
b. I like the color red.	❍	❍	❍	❍

SURVEY QUESTIONS

Read each question carefully and then use your mouse to click on the button with the answer that best describes how you ***really*** feel for each question below. If you want to change your answer, just click on the button with your new answer.	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
1. I feel proud of being a part of my school.	❍	❍	❍	❍
2. I feel that I am treated with respect at my school.	❍	❍	❍	❍
3. I can get a good job even if my grades are bad.	❍	❍	❍	❍
4. The only time I get attention in school is when I cause trouble.	❍	❍	❍	❍
5. I participate in activities at my school.	❍	❍	❍	❍
6. Doing well in school is important in life.	❍	❍	❍	❍
7. Most of the things we learn in class are useless.	❍	❍	❍	❍
8. I feel that teachers don't care in this school.	❍	❍	❍	❍
9. I would rather be out of school.	❍	❍	❍	❍
10. I have teachers that I can talk to at my school.	❍	❍	❍	❍
11. Doing well in school is useful for getting a job.	❍	❍	❍	❍
12. School is one of my favorite places to be.	❍	❍	❍	❍
13. I feel that people are interested in me at my school.	❍	❍	❍	❍
14. I feel that school is a waste of time.	❍	❍	❍	❍
15. I feel that it is a mistake to drop out of school.	❍	❍	❍	❍
16. School is more important than most people think.	❍	❍	❍	❍

Appendix B

The "Identification with School" Survey (*VAS Version*)

The following two questions will give you a chance to practice using your mouse to mark your answers on the first survey you take today. Please answer BOTH questions before moving on to the survey.

SAMPLE QUESTIONS

Read each question carefully and then use your mouse to click on the line and drag the cursor (❍) to the place that best describes how you really feel for each question below. If you want to change your answer, just click on the cursor again and drag it to where you want your new answer to be.	Strongly Disagree ... Strongly Agree |----------❍----------|
a. I like ice cream.	|----------❍---------- |
b. I like the color red.	|----------❍---------- |

SURVEY QUESTIONS

Read each question carefully and then use your mouse to click on the line and drag the cursor (❍) to the place that best describes how you really feel for each question below. If you want to change your answer, just click on the cursor again and drag it to where you want your new answer to be.	Strongly Disagree ... Strongly Agree |----------❍----------|
1. I feel proud of being a part of my school.	|----------|
2. I feel that I am treated with respect at my school.	|----------|
3. I can get a good job even if my grades are bad.	|----------|
4. The only time I get attention in school is when I cause trouble.	|----------|
5. I participate in activities at my school.	|----------|
6. Doing well in school is important in life.	|----------|
7. Most of the things we learn in class are useless.	|----------|
8. I feel that teachers don't care in this school.	|----------|
9. I would rather be out of school.	|----------|
10. I have teachers that I can talk to at my school.	|----------|
11. Doing well in school is useful for getting a job.	|----------|
12. School is one of my favorite places to be.	|----------|
13. I feel that people are interested in me at my school.	|----------|
14. I feel that school is a waste of time.	|----------|
15. I feel that it is a mistake to drop out of school.	|----------|
16. School is more important than most people think.	|----------|

Appendix C

Post-Survey 1: *"Student Opinion Questionnaire"*

1. Were the questions on this survey hard for you to answer?

○ *Yes*

○ *No*

Why?

2a. When answering any of the questions on this survey, did you wish that there were different answer choices than the ones you were given? [45]

○ *Yes*

○ *No*

Why?

2b. When answering any of the questions on this survey, did you wish that you had a set of answers to choose from instead of having to choose a place along the line to answer? [46]

○ *Yes*

○ *No*

Why?

3. Did this survey let you pick an answer that matched exactly the way you felt?

○ *Yes*

○ *No*

Why?

[45] This item was presented after the Likert version of the survey only and was not visible on the "post-VAS" questionnaire.
[46] This item was presented after the VAS version of the survey only and was not visible on the "post-LS" questionnaire.

Appendix D

Post-Survey 2: *"Student Demographic Questionnaire"*

1. **Think about the survey you just took. Which way did you like better for answering the questions?**

   ○ *I liked answering questions better when I had the four answers to choose from* (like the example below).

   [EXAMPLE]

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
❍	❍	❍	❍

   ○ *I liked answering questions better when I had the line to click on to choose my answer* (like the example below).

   [EXAMPLE]

   Strongly Disagree ... *Strongly Agree*

   |----------❍----------|

2. **Are you a boy or a girl?**
   - ○ *Boy*
   - ○ *Girl*
   - ○ *I prefer not to respond*

3. **What grade are you in?** [*drop-down menu*]
   [1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th, *Other*]

4. **How old are you?** [*drop-down menu*]
   [5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, *19 or* O*lder*]

5. **Is English your first language?**
   - ○ *Yes*
   - ○ *No*

6. **Do you like your school?**
   - ○ *Yes*
   - ○ *No*

Appendix E

Study Advertisement for Teacher LISTSERV

Student Identification with School: An Online Research Project

Kevon R. Tucker-Seeley _____@bc.edu

If you teach students in grades 4 through 12, you are invited to participate in the Student Identification with School Project.

Doctoral candidate, Kevon R. Tucker-Seeley, Lynch School of Education at Boston College, is conducting a study to measure and understand differences in student performance on the "Student Identification with School" Survey based on the format of item response options (Likert vs. sliding scale).

The study involves administering a completely anonymous online survey to your students. The total amount of participation time needed from your students is about 20 minutes total. Your participation (and your students' participation) in this study is strictly ***voluntary***.

If you would like to participate, you can register now by sending an email to Kevon R. Tucker-Seeley at _____@bc.edu. Registration involves answering four simple questions in your email:

1. What grade(s) do you currently teach?
2. How many students do you teach?
3. Do your students have **access to computers** with ***Internet capability*** at your school?
4. Can you ensure that your students will take the online survey ***before*** **June 30th, 2008**?

Once you have successfully registered to participate in the study, you will be sent the link to the online survey.

******* PRIZE DRAWING *******

All teachers who sign up and participate in the study will be entered in a drawing to have a chance to win one of four different prizes!

- **GRAND PRIZE: A NEW 8GB Apple iPod Nano** (or $180 Amazon.com Gift Certificate)
- **First Prize: A NEW 4GB Apple iPod Nano** (or $150 Amazon.com Gift Certificate)
- **Second Prize: A NEW 1GB Apple iPod Shuffle** (or $50 Amazon.com Gift Certificate)
- **Third Prize: A $25 Amazon.com Gift Certificate**

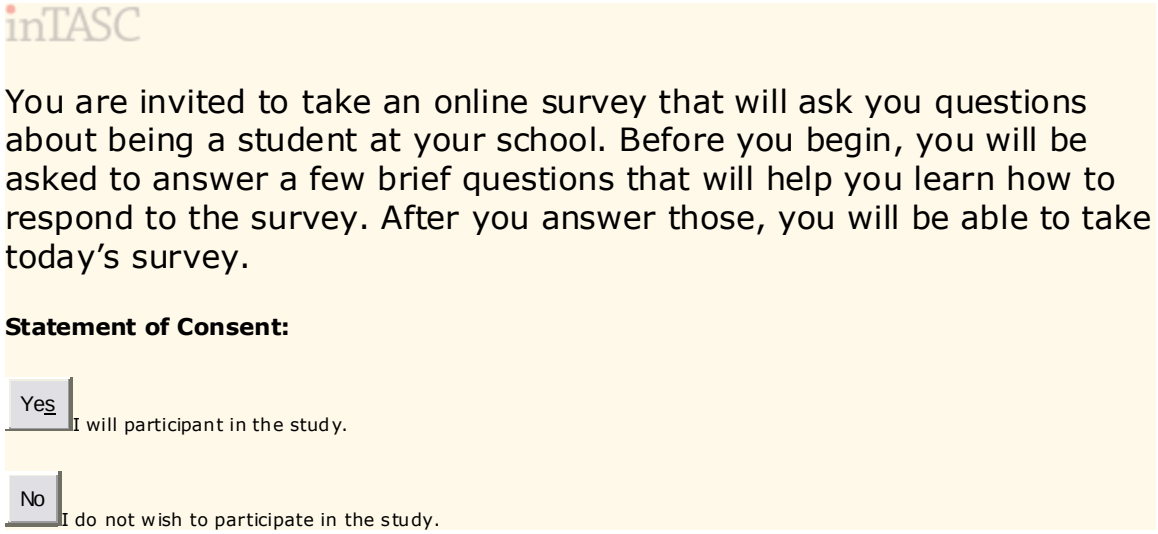
On June 30th, FOUR lucky winners will be randomly selected to receive one of the four prizes. To be eligible for the iPod/gift certificate give-away you must be a 4th-12th grade teacher and 15 or more of your students must complete the online survey. For more information about the study, please contact me at _____@bc.edu

I hope you will participate in this important study.
Sincerely,

Kevon R. Tucker-Seeley, M.A.Ed., Ph.D. Candidate
Educational Research, Measurement, & Evaluation Program, Boston College

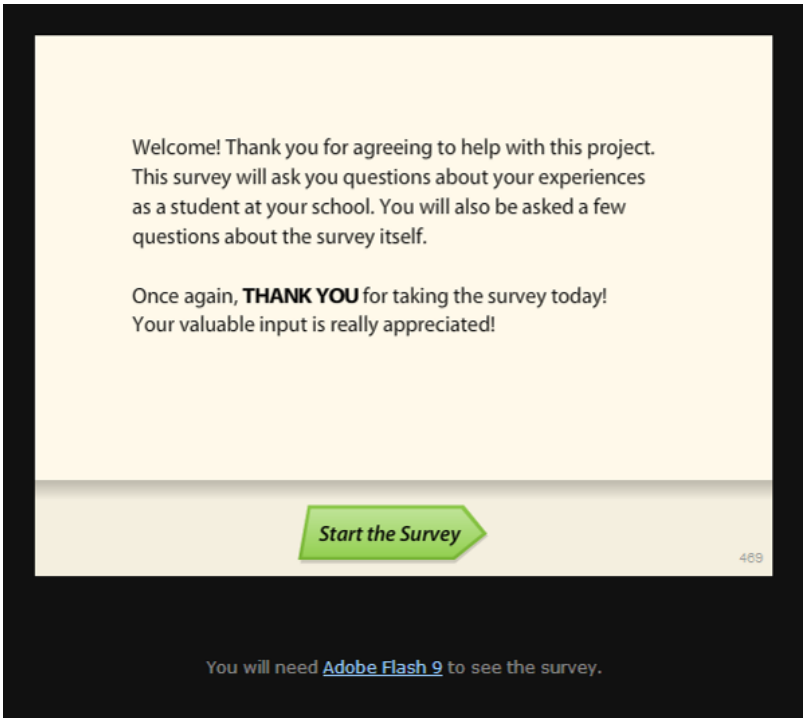
Appendix F

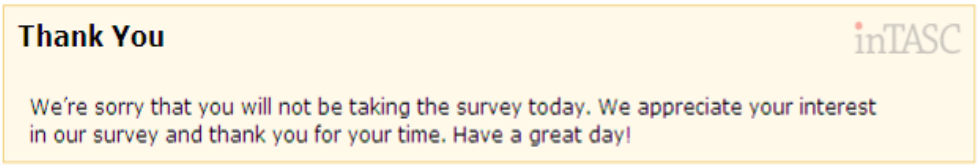
Screen Shot: *Identification with School* Survey Student Assent Form



Appendix G

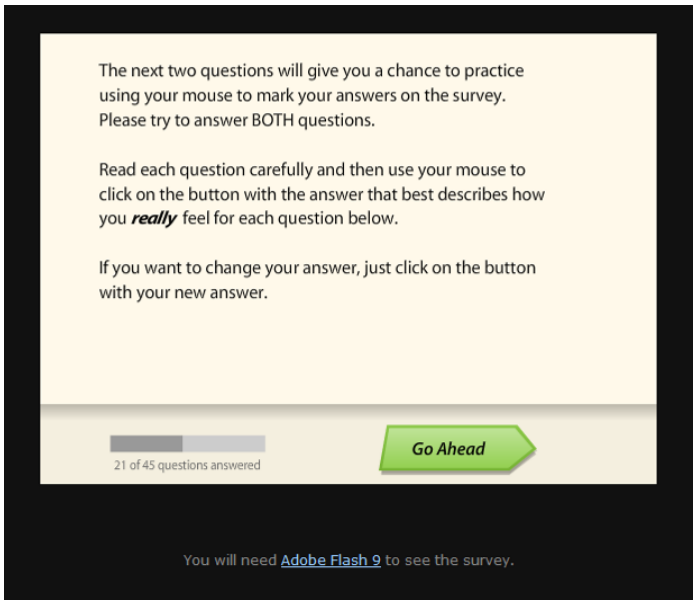
Screen Shot: *Identification with School* Survey "Welcome" and "Thank you" Message

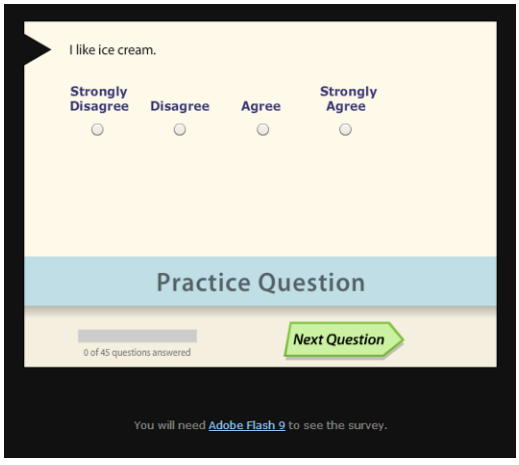


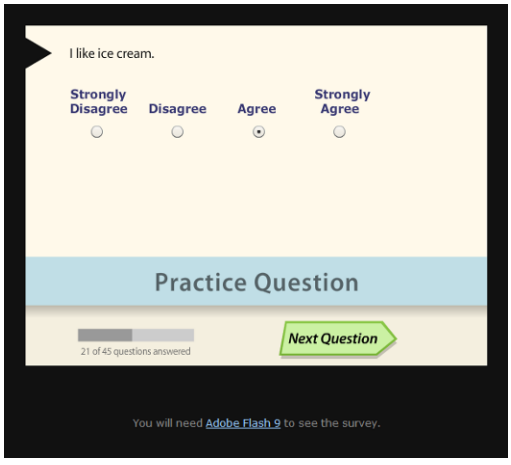


Appendix H

Screen Shots: *Identification with School* Survey LS "Practice Item" Instructions and Example

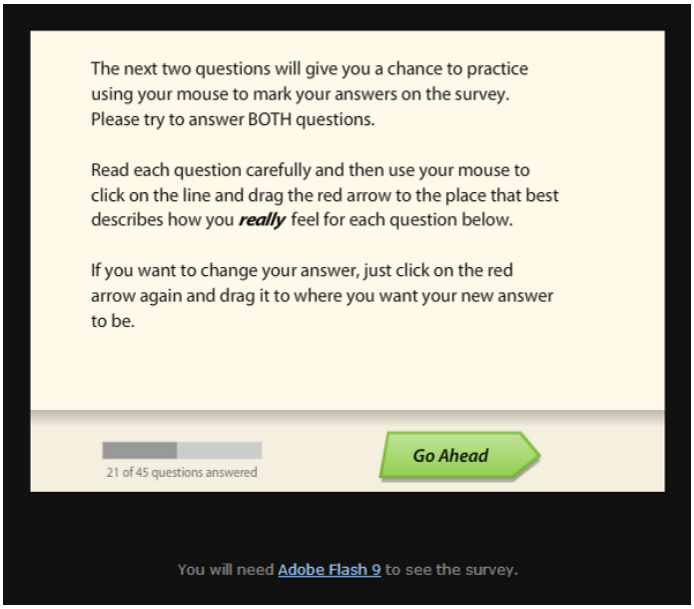


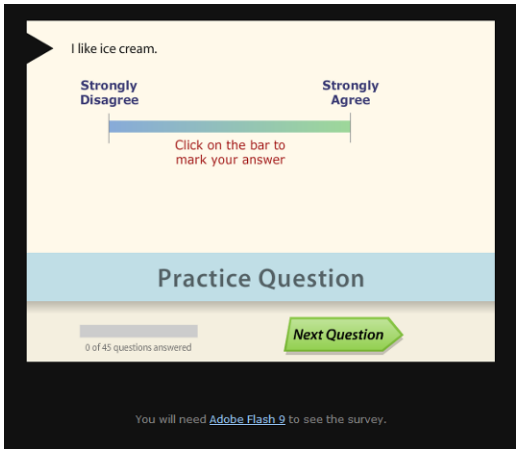


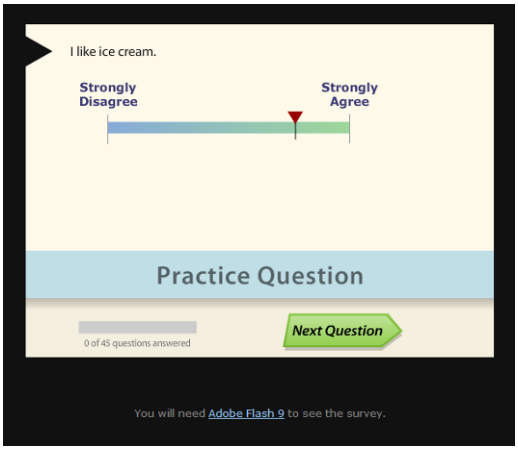


Appendix I

Screen Shots: *Identification with School* Survey VAS "Practice Item" Instructions and Example

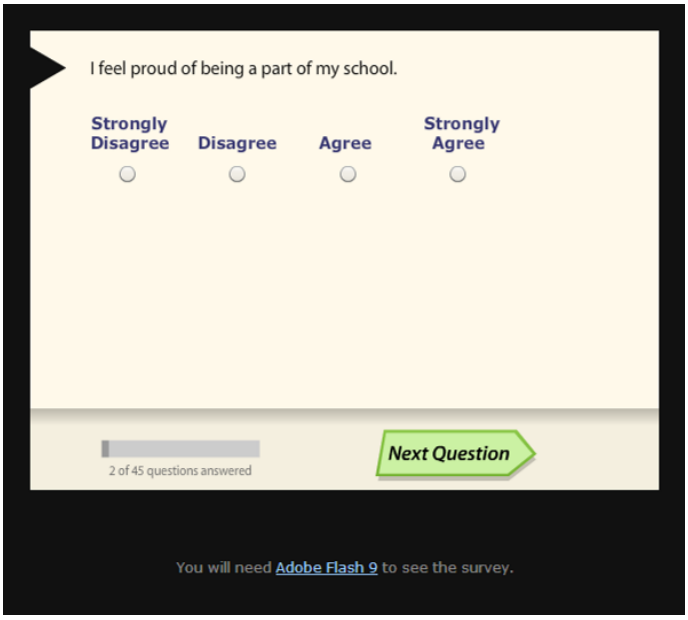


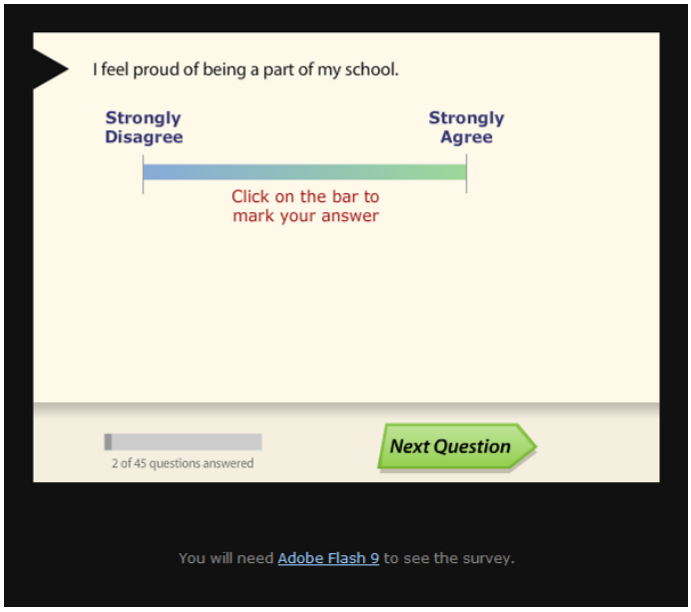




Appendix J

Screen Shots: *Identification with School* Survey LS and VAS Item Examples





Appendix K

Parallel Analysis SPSS Syntax

(page 1 of 2)

The following was obtained from O'Connor's (2000) Web site: http://people.ok.ubc.ca/brioconn/nfactors/nfactors.html

```
* Parallel Analysis program.
set mxloops=9999 printback=off width=80  seed = 1953125.
matrix.
* enter your specifications here.
compute ncases   = 250.
compute nvars    = 16.
compute ndatsets = 9000.
compute percent  = 95.
* Specify the desired kind of parallel analysis, where:
  1 = principal components analysis
  2 = principal axis/common factor analysis.
compute kind = 1 .
****************** End of user specifications. ******************
* principal components analysis.
do if (kind = 1).
compute evals = make(nvars,ndatsets,-9999).
compute nm1 = 1 / (ncases-1).
loop #nds = 1 to ndatsets.
compute x = sqrt(2 * (ln(uniform(ncases,nvars)) * -1) ) &*
          cos(6.283185 * uniform(ncases,nvars) ).
compute vcv = nm1 * (sscp(x) - ((t(csum(x))*csum(x))/ncases)).
compute d = inv(mdiag(sqrt(diag(vcv)))).
compute evals(:,#nds) = eval(d * vcv * d).
end loop.
end if.
* principal axis / common factor analysis with SMCs on the diagonal.
do if (kind = 2).
compute evals = make(nvars,ndatsets,-9999).
compute nm1 = 1 / (ncases-1).
loop #nds = 1 to ndatsets.
compute x = sqrt(2 * (ln(uniform(ncases,nvars)) * -1) ) &*
          cos(6.283185 * uniform(ncases,nvars) ).
compute vcv = nm1 * (sscp(x) - ((t(csum(x))*csum(x))/ncases)).
compute d = inv(mdiag(sqrt(diag(vcv)))).
compute r = d * vcv * d.
compute smc = 1 - (1 &/ diag(inv(r)) ).
call setdiag(r,smc).
compute evals(:,#nds) = eval(r).
end loop.
end if.
* identifying the eigenvalues corresponding to the desired percentile.
compute num = rnd((percent*ndatsets)/100).
compute results = { t(1:nvars), t(1:nvars), t(1:nvars) }.
loop #root = 1 to nvars.
compute ranks = rnkorder(evals(#root,:)).
loop #col = 1 to ndatsets.
do if (ranks(1,#col) = num).
compute results(#root,3) = evals(#root,#col).
break.
end if.
end loop.
end loop.
compute results(:,2) = rsum(evals) / ndatsets.
print /title="PARALLEL ANALYSIS:".
do if   (kind = 1).
```

```
print /title="Principal Components".
else if (kind = 2).
print /title="Principal Axis / Common Factor Analysis".
end if.
compute specifs = {ncases; nvars; ndatsets; percent}.
print specifs /title="Specifications for this Run:"
 /rlabels="Ncases" "Nvars" "Ndatsets" "Percent".
print results /title="Random Data Eigenvalues"
 /clabels="Root" "Means" "Prcntyle"  /format "f12.6".
do if   (kind = 2).
print / space = 1.
print /title="Compare the random data eigenvalues to the".
print /title="real-data eigenvalues that are obtained from a".
print /title="Common Factor Analysis in which the # of factors".
print /title="extracted equals the # of variables/items, and the".
print /title="number of iterations is fixed at zero;".
print /title="To obtain these real-data values using SPSS, see the".
print /title="sample commands at the end of the parallel.sps program,".
print /title="or use the rawpar.sps program.".
print / space = 1.
print /title="Warning: Parallel analyses of adjusted correlation matrices".
print /title="eg, with SMCs on the diagonal, tend to indicate more factors".
print /title="than warranted (Buja, A., & Eyuboglu, N., 1992, Remarks on parallel".
print /title="analysis. Multivariate Behavioral Research, 27, 509-540.).".
print /title="The eigenvalues for trivial, negligible factors in the real".
print /title="data commonly surpass corresponding random data eigenvalues".
print /title="for the same roots. The eigenvalues from parallel analyses".
print /title="can be used to determine the real data eigenvalues that are".
print /title="beyond chance, but additional procedures should then be used".
print /title="to trim trivial factors.".
print / space = 1.
print /title="Principal components eigenvalues are often used to determine".
print /title="the number of common factors. This is the default in most".
print /title="statistical software packages, and it is the primary practice".
print /title="in the literature. It is also the method used by many factor".
print /title="analysis experts, including Cattell, who often examined".
print /title="principal components eigenvalues in his scree plots to determine".
print /title="the number of common factors. But others believe this common".
print /title="practice is wrong. Principal components eigenvalues are based".
print /title="on all of the variance in correlation matrices, including both".
print /title="the variance that is shared among variables and the variances".
print /title="that are unique to the variables. In contrast, principal".
print /title="axis eigenvalues are based solely on the shared variance".
print /title="among the variables. The two procedures are qualitatively".
print /title="different. Some therefore claim that the eigenvalues from one".
print /title="extraction method should not be used to determine".
print /title="the number of factors for the other extraction method.".
print /title="The issue remains neglected and unsettled.".
end if.
end matrix.
* Commands for obtaining the necessary real-data eigenvalues for
  principal axis / common factor analysis using SPSS;
  make sure to insert valid filenames/locations, and
  remove the '*' from the first columns.
* corr var1 to var20 / matrix out ('filename') / missing = listwise.
* matrix.
* MGET /type= corr /file='filename' .
* compute smc = 1 - (1 &/ diag(inv(cr)) ).
* call setdiag(cr,smc).
* compute evals = eval(cr).
* print { t(1:nrow(cr)) , evals }
 /title="Raw Data Eigenvalues"
 /clabels="Root" "Eigen."  /format "f12.6".
* end matrix.
```