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Measuring Factors that Influence Decisions to Become a Veterinarian

Kenneth D. Royal[1]*, Regina Schoenfeld-Tacher[2], April A. Kedrowicz[1], Elizabeth M. Hardie[1], Keven Flammer[1]

[1] Department of Clinical Sciences, College of Veterinary Medicine, North Carolina State University, Raleigh, NC 27607, United States
[2] Department of Molecular Biomedical Sciences, College of Veterinary Medicine, North Carolina State University, Raleigh, NC 27607, United States

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Abstract

Introduction: Veterinary medical education; Psychometrics; Career influence; The purpose of the present study was twofold. First, we sought to evaluate the psychometric properties of a newly developed instrument designed to measure factors incoming veterinary medical students indicated were important (or not) in their decision to become a veterinarian. Second, we sought to produce a measure of these factors by utilizing a state-of-the-art psychometric modeling technique to produce an empirical hierarchy that illustrates the construct of interest and make appropriate inferences about the findings.

Methods: The Career Influence Factors Survey (CIFS) was administered to an incoming class of veterinary medical students. Data were analyzed via the Rasch Rating Scale Model. The psychometric properties of the instrument were evaluated according to Messick's framework of construct validity.

Results: Results indicate the Career Influence Factors Survey is a psychometrically-sound instrument capable of accurately and reliably measuring veterinary medical students' motivations for becoming a veterinarian. Substantive results indicated issues pertaining to animal welfare were the most important in making the decision to become a veterinarian. Previous exposure to a particular animal or family pet was only moderately influential in students' decision to pursue a career in veterinary medicine. Factors such as a desire to work on food production issues and anticipated earning potential tend to be of lesser importance to incoming students.

Conclusion: We encourage others to utilize the instrument and/or adopt the methodology to evaluate the psychometric properties of other instruments. Substantive findings generally corroborated findings from previous studies, but may identify new insights for improving the recruitment of veterinary medical students.

Introduction

The veterinary medical profession has experienced a great deal of turbulence over the past two decades. Shifting views on companion animals, specifically, the strength of the human animal bond,[1-2] as well as increased demand for veterinarians in the areas of public health, food, and research[3] account for shifting workforce needs. The changing nature of employment opportunities necessitates a focus on recruiting, training, and graduating students with varied and diverse career interests. Veterinary medical schools are generally well-regarded institutions that offer high-quality education that prepares professionals who place a premium on animal ethics and welfare. [2,4] Despite perceptions of respect and nobility, the profession has generally experienced a stagnating number of applicants to veterinary schools and a general lack of student diversity.[5] Typically, the decision to become a veterinarian occurs at a rather young age and is guided by the general desire to work with animals.[6,7] Given the changing workforce needs and the current lack of diversity among applicants, it seems necessary to investigate the specific factors that influence individuals to become veterinarians. Answers to these questions could help the profession find ways to increase applicant volume, maximize the potential talent pool, find ways to market the profession to potential applicants, and identify new ways to recruit under-represented minorities. The purpose of the present study was twofold. First, we sought to evaluate the psychometric properties of a newly-developed instrument designed to measure factors

***Corresponding authors:** Kenneth D. Royal, Email:kdroyal2@ncsu.edu

incoming veterinary students indicated were important (or not) in their decision to become a veterinarian. Second, we sought to produce a measure of these factors by utilizing state-of-the-art psychometric modeling techniques to produce an empirical hierarchy that illustrates the construct of interest and makes appropriate inferences about the findings.

Materials and Methods

Participants

The 2014-2015 incoming class at the North Carolina State University (NCSU) Doctor of Veterinary Medicine (DVM) program consists of 100 students. Utilizing a census sampling approach, all students were invited to participate in this study. Of the 100 potential respondents, 67 participated in this study. This resulted in a response rate of 67%. Demographic characteristics for the participants are presented in Table 1. A chi-squared test was performed to determine if the sample of survey respondents differed from non-responders based on gender, in-state vs. out-of-state residency status, and ethnicity. Results indicated no statistically significant differences were found with regard to gender ($p = 0.139$), residency status ($p = 0.089$), or ethnicity ($p = 0.160$). Chi-square tests indicated the sample frame was representative of the larger incoming student population.

Instrumentation and Measure

To assess the importance of factors that influence the decision to become a veterinarian, we administered the Career Influence Factors Survey (CIFS) to students. The (CIFS) consists of 16 items representing a variety of reasons as to why one may choose to pursue a career in veterinary medicine. The instrument utilized a 5-point scale ranging from 1 (Not Important) to 5 (Very Important).

Data Analysis

For convenience, traditional statistical analyses were performed to illustrate the findings from the Classical Test Theory (CTT) framework. SPSS statistical software (version 22) was used to produce descriptive statistics for each item in addition to traditional Cronbach's alpha reliability estimates. However, it is well-documented in the psychometrics literature that traditional statistical analyses of survey data possess a number of significant limitations. Royal[8] lists six significant limitations of traditional survey analyses: 1) ordinal rating scales are erroneously treated as interval measures, which results in a statistical violation; 2) all items are erroneously perceived to be of equal importance; 3) error estimates are erroneously assumed to be equal across all measures; 4) data are sample-dependent and inescapably linked to the survey in which they were attained; 5) parametric analyses necessitate normally-distributed data, which often do not occur with "real" data; and 6) missing data becomes particularly problematic with results in entire response vectors being discarded. Because of the significant limitations of traditional statistical approaches, we opted to use a state-of-the-art measurement model designed specifically for survey analyses.

Table 1. Demographic Characteristics of Sample

Characteristic	n	%
Sex		
Male	13	19.4
Female	54	80.6
Race/Ethnicity		
White	55	82.1
Hispanic	7	10.4
Other	5	7.5
Residency Status		
In-state	56	83.6
Out-of-state	11	16.4

Rasch Measurement

For this study, we elected to use Rasch measurement models, as these models overcome each of the aforementioned limitations of traditional data analysis.[8,9] Further, Rasch models are considered by many measurement experts to be the "gold standard" approach for making mental measurements as they are the only family of measurement models that possess the properties necessary for objective measurement.[10-12] Although the advantages of Rasch models are well-documented in the psychometrics literature, readers unfamiliar with these techniques are encouraged to read Embretson & Reise,[13] Engelhard[14] or Hambleton, Swaminathan & Rogers[15] for thorough overviews.

Briefly, Rasch measurement models are popular item response theory-based psychometric models used to measure latent psychological traits. Rasch models assert that a person with a greater amount of a latent trait will always have a higher probability of endorsing any item than a person with a lesser amount of a latent trait. Likewise, a more difficult item to endorse will always have a lower probability of endorsement than a less difficult item. Thus, the probability that a survey respondent will endorse an item is a logistic function of the relative distance between the person and the item's hierarchical location on a common linear continuum.

For the present study, the Rasch Rating Scale Model (RRSM)[16] was utilized for data analysis. The RRSM is appropriate for analyzing survey data that were collected using static rating scale categories. According to the model the probability of a person n responding in category x to item i, is given by:

$$P_{xni} = \frac{\exp \sum_{j=0}^{x} [\beta_n - (\delta_i + \tau_j)]}{\sum_{k=0}^{m} \exp \sum_{j=0}^{k} [\beta_n - (\delta_i + \tau_j)]} \qquad x = 0,1,\ldots, m$$

where $\tau o = 0$ so that $\exp \sum_{j=0}^{0} [\beta_n - (\delta_i + \tau_j)] = 1$

βn is the person's position on the variable, δi is the scale value (difficulty to endorse) estimated for each item i and

$\tau 1, \tau 2, \ldots, \tau m$ are the m response thresholds estimated for the m + 1 rating categories.

Winsteps[17] measurement software estimated the parameters for the model using joint maximum likelihood estimation procedures.[18] Standard errors were estimated for every person, item, and threshold measure as well.

Results

Results of Traditional Statistical Analysis

Results of the traditional survey analysis indicated the items possessed a good bit of variability (Table 2). The Cronbach's alpha reliability estimate was 0.753, indicating a moderate level of score reproducibility. A factor analysis was not performed due to the relatively small sample size. Tabachnick and Fidell[19] state a sample needs to consist of approximately 300 cases in order to provide a "good" sample size appropriate for a traditional factor analysis. Our relatively small sample size (n = 67) would be considered "very poor" for a traditional factor analysis.

Psychometric Properties of the CIFS

The evaluation of the psychometric properties of the CIFS scale focused on six criteria: dimensionality, internal consistency, rating scale quality, item quality, person measure quality, and construct hierarchy. The results for each criterion are presented below.

Dimensionality

A Rasch measurement-based principal components analysis (PCA) of standardized residual correlations was performed to investigate dimensionality. In total, 45.6% of the Rasch dimension was explained. The largest secondary dimension explained 11.4% of the variance. Overall, the variance explained by the items was 32%. This is approximately three times the variance explained from the first contrast, indicating a second dimension may be present. An investigation into the magnitude of the first contrast yielded an eigenvalue of 3.3, indicating the additional dimension consists of three items, at best. Given this evidence, the authors conclude the Rasch dimension is strong enough to assert a significant primary dimension, thus meeting the requirement for sufficient unidimensionality.

Reliability

We produced reliability estimates to evaluate the extent to which the measures were reproducible. Person reliability estimates ranged between 0.75 (worst case estimate) and 0.79 (best case estimate), with item reliability estimates stable at 0.97.

Rating Scale Effectiveness

Rating scale effectiveness refers to the extent that response options were appropriate, the categories functioned as intended, and the participants interpreted the response options in a consistent manner. The distribution of responses per category indicated survey respondents made full use of the rating scale. Infit and outfit mean square fit statistics ranged between 0.85 and 1.29 among the 5 categories, thus indicating rather noise-free categories. Additionally, structure calibrations advanced in a stepwise manner in accordance with the direction of the scale. According to Linacre[20], all of these criteria are hallmarks of a quality rating scale that is functioning properly.

Item Measure Quality

Table 4 reports the item statistics for each of the 16 survey items. A difficulty measure (Di) is provided for each item, as well as an estimate of its standard error. INFIT and OUTFIT mean square fit statistics are also provided to speak to the extent to which each item fit the model's expectations. Wright and Linacre[21] suggested mean square fit statistics should range between 0.60 and 1.40 to ensure noise-free calibrations. Here, these values range from 0.71 to 1.29, indicating these measures are relatively noise-free.

Person Measure Quality

We evaluated person measure quality by investigating fit statistics, stability of measures, and size of associated standard errors. Person measures were quite stable, with an average standard error of 0.27 (SD = 0.04).

According to Wright and Linacre[21], reasonable infit and outfit mean square values should range between 0.6 to 1.4 for surveys, but only values that exceed 2.0 are considered potentially problematic, as they may distort the measurement system. For the present study, 29 participants had mean square values outside the suggested range. However, only four persons were considered grossly misfitting, with values exceeding 2.0. These individuals qualified as candidates for potential removal from the dataset. However, because the sample size was relatively small and overall data-to-model fit was exceptional with mean square values approximating 1.00 (Table 5), the researchers decided to keep all person responses in the sample frame.

Empirical Construct Hierarchy

In psychometrics, a construct is thought of as a hierarchy that can be placed along a psychometric ruler. The person/item map presented in Figure 1 illustrates the construct hierarchy for factors deemed important (or not) in influencing the decision to become a veterinarian as determined by participants' willingness to endorse each item. The map can be thought of as a psychometric ruler that possesses many of the same properties as a physical ruler (e.g., equidistant scaling, etc.). Briefly, the map is divided into two halves, with persons appearing on the left and items on the right, all placed along the same logit scale. Symbols "M", "S", and "T" indicate the mean, standard deviation, and two standard deviation marks for both distributions of people and items, respectively. Persons (symbolized as #) appearing at the top of the map are persons who had the highest logit value, indicating they were the most likely to endorse each item. Items appearing at the top of the map are the most difficult items to endorse. Conversely, people appearing at the bottom of the map had the most difficult time endorsing each of the items, and items at the bottom of the map are the easiest to endorse. Readers are encouraged to read Royal[8] for a detailed

Table 2. Means and Standard Deviations for Each Item

Item	Mean	SD
Q1 Experience with a particular animal or family pets	4.10	1.03
Q2 Love of animals	4.64	0.67
Q3 Desire to work with animals	4.74	0.51
Q4 Desire to improve animal health	4.71	0.61
Q5 Desire to work on food production issues	2.55	1.26
Q6 Desire to work on environmental issues	3.09	1.18
Q7 Desire to improve human health	3.08	1.16
Q8 Mentor's influence	3.12	1.39
Q9 Family's influence	3.33	1.35
Q10 Intellectual stimulation or challenge	4.42	0.86
Q11 Opportunity for service	3.96	1.15
Q12 Earning potential	3.02	1.15
Q13 Opportunity to work with people	3.10	1.18
Q14 Research opportunities	3.24	1.17
Q15 Teaching opportunities	3.15	1.10
Q16 Prestige	3.25	1.22

Table 3. Summary of Rating Scale Diagnostics

Rating Category	n	%	INFIT MnSq	OUTFIT MnSq	Structure Calibration	Category Measure
(1) Not Important	89	8%	1 01	0.99	NONE	-2.25
(2)	147	14%	1.07	1.05	-0.81	-0.89
(3)	216	20%	1.13	1.29	-0.37	-0.03
(4)	278	26%	1.05	0.85	0.20	0.87
(5) Very Important	339	32%	0.96	0.96	0.98	2.35

Table 4. Item Quality Indicators

Item	Di	Error	INFIT Mean Square	OUTFIT Mean Square
Q1 Experience with a particular animal or family pets	-0.41	0.14	1.24	1.22
Q2 Love of animals	-1.43	0.21	1.24	1.29
Q3 Desire to work with animals	-1.77	0.25	0.95	1.16
Q4 Desire to improve animal health	-1.65	0.23	0.97	0.76
Q5 Desire to work on food production issues	1.13	0.12	1.11	1.10
Q6 Desire to work on environmental issues	0.64	0.12	1.11	1.09
Q7 Desire to improve human health	0.65	0.12	0.85	0.85
Q8 Mentor's influence	0.61	0.12	0.98	0.95
Q9 Family's influence	0.42	0.12	1.10	1.06
Q10 Intellectual stimulation or challenge	-0.91	0.17	0.91	0.71
Q11 Opportunity for service	-0.22	0.13	1.10	1.14
Q12 Earning potential	0.71	0.12	0.89	0.89
Q13 Opportunity to work with people	0.63	0.12	0.99	0.97
Q14 Research opportunities	0.51	0.12	0.95	0.91
Q15 Teaching opportunities	0.59	0.12	0.98	0 .97
Q16 Prestige	0.49	0.12	1.11	1.09

explanation for interpreting the map.

The map indicates item Q5, Desire to work on food production issues, is the most difficult item to endorse, and item Q3, Desire to work with animals, is the easiest item for respondents to endorse. When calculating the probability that the average person in the sample (someone with a mean logit value of 0.70) would rate items Q5 (logit value of 1.13) and Q3 (logit value of -1.77) as important factors in their decision to become a veterinarian, the probabilies were 39.4% and 92.2%, respectively.

Discussion

Psychometric Properties of the CIFS

In 1989, renowned measurement scholar Samuel Messick introduced the notion of construct validity as a uniform concept. According to Messick, construct validity is the integration of any evidence that impacts the interpretation or meaning of a score.[22] His framework for construct validity consisted of the following six aspects: content, substantive, structural, generalizability, external, and consequential. Because the vast majority of measurement, assessment, and evaluation scholars have adopted Messick's framework, we feel it is helpful to also use this framework to evaluate the construct validity of the CIFS.

To begin, a principal components analysis (PCA) of standardized residual correlations provided sufficient evidence of unidimensionality (the notion that one attribute primarily is being measured at a time). This evidence supports the substantive aspect of validity. Item quality measures were evidenced to be very sound, lending support for the content aspect of validity. An evaluation of the rating scale's effectiveness concluded the rating was psychometrically sound and functioning appropriately, thus presenting evidence of both the communicative[23] and the structural aspects of validity. Reliability estimates exceeded values of 0.70, indicating the scores were quite reproducible. This evidence speaks to the generalizability aspect of validity. Substantive findings from this study

Table 5. Summary Statistics

	Measure	Model Error	INFIT Mean Square	OUTFIT Mean Square
Persons				
Mean	0.70	0.27	1.00	1.01
S.D.	0.60	0.04	0.49	0.57
Items				
Mean	0.00	0.14	1.03	1.01
S.D.	0.91	0.04	0.11	0.16

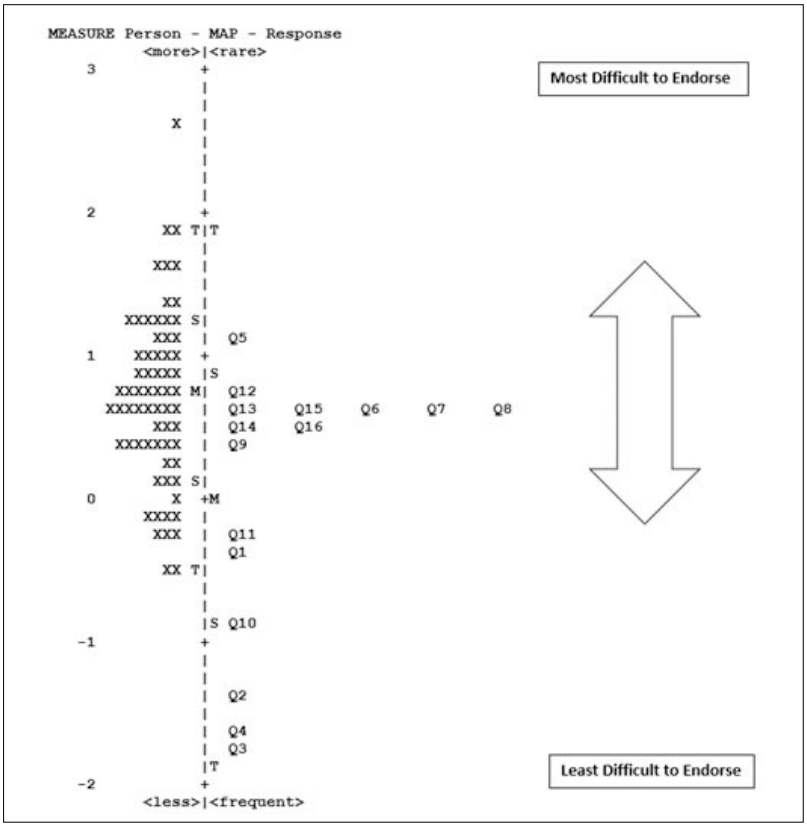

Figure 1. Construct Map

seemed to corroborate previously published research regarding students' motivations for becoming a veterinarian. This provides evidence that speaks to the external aspect of validity. Finally, we present no evidence of the consequential aspect of validity. The primary reason is due to non-applicability, as no decisions were made based on the study's findings that could have any potential repercussions for the students. Collectively, there is a wealth of evidence to support the quality of the CIFS and the likelihood that it will generate valid and reliable findings when administered to a sample of veterinary medical students.

Discussion of Substantive Findings

One of the goals of this study was to produce a measure of the importance of various factors that influence the decision to become a veterinarian. Results suggest students find factors relating to animals and animal welfare, such as love of animals, desire to work with animals, and desire to improve animal health, to be the most important in making the decision to become a veterinarian. This is not surprising, as one of the most commonly-recognized roles of DVMs is to support animal health and wellbeing.[24] This finding is also consistent with data from Daly and Erickson[7], showing that 95.3% (183/192) of students enrolled in undergraduate agriculture and biomedical sciences courses indicated an enjoyment of working with animals as a major reason for wanting to pursue a career in veterinary medicine.

Exposure to a particular animal or family pet was only moderately influential in students' decision to pursue a career in veterinary medicine. Given the makeup of this sample, the finding is not surprising. Amass et al.[25] found that 40% (14/35) of veterinary applicants from under-represented minority groups cited pet ownership as an impetus for pursuing a career in veterinary medicine, while only 20.1% (42/209) of Caucasian applicants listed pet ownership as an important reason for their career choice.

Factors such as a desire to work on food production issues and anticipated earning potential tended to be of lesser importance to incoming students. The lack of interest in food production issues has been documented since 2003, when Ilgen et al. asked students to rate the attractiveness of 9 areas of veterinary practice. Activities dealing with animal reproductive health were rated as least attractive. However, this finding can also be correlated with the background of our admitted student population, as 59.9% of (115/192) pre-veterinary students in Daly's study indicated a desire to help livestock producers in their operations as a major reason for pursuing a career in veterinary medicine.

The lower ratings for earning potential may be due to either a realistic understanding of average starting salaries (i.e., people motivated by money choose to enter other professions) or could also be a reason why veterinary salaries are low (new graduates are not motivated by money, so the market is able to get away with lower rates). Ilgen et al.[24] inferred that students who were more familiar with the field had lower salary expectations at the same time that practicing veterinarians were moderately satisfied with the income they were earning. This finding supports both our assertions – incoming veterinary students have realistic salary expectations and are willing to live within those constraints.

The lower level of interest in working with people, improving human health, and research opportunities seems to indicate a rather narrow mindset regarding areas of practice for the veterinary profession. It appears as though most students enter the profession with a well-defined focus on improving the health and wellbeing of animals, and this mindset persists throughout the DVM program (as evidenced by focus area choice) and subsequent choices of employment. This is a historical trend and can be traced back as far as 2003, when Ilgen et al. noted that students admitted to veterinary programs found research activities much less attractive than those who applied for but were not admitted to DVM programs. It is worth noting that our study only surveyed students who were admitted to the NCSU DVM program.

Implications and Future Research

We believe this research has both methodological and substantive implications for veterinary medical education and medical education as a whole. With regard to methodological implications, this study provides a roadmap for other researchers to utilize the Rasch Rating Scale Model for evaluating the psychometric properties of a survey instrument. Utilizing Messick's framework for validity may be particularly helpful for researchers to present cumulative validity evidence, as opposed to conducting studies that investigate only one aspect of validity (e.g., content validity, reliability, etc.).

With regard to substantive implications, this study provides a modern perspective on the factors that currently motivate many incoming veterinary medical students to pursue a career in veterinary medicine. Further, this study provides a tool with desirable psychometric properties that can assess students' motivations for attending veterinary school. Finally, this study may be helpful for generating ideas for intervening at appropriate times and marketing the profession to increase/diversify the applicant pool.

Four potential areas for future research are identified below. Future research might investigate: (1) students' motivations at institutions based in urban vs. rural areas, as it is possible that this factor could be significant in determining why a student chose to attend veterinary medical school; (2) whether related animal science students (e.g., students in veterinary technician programs and various undergraduate and graduate programs) share similar motivations; (3) the correlation between motivating factors and focus area or track specialization chosen by students; and (4) differences in motivating factors between DVM and MD students.

Limitations

Although the sample size of 67 incoming DVM students was more than sufficient for a Rasch measurement analysis given respondents made full use of the rating scale, a larger sample size would result in greater statistical precision

and smaller error estimates. This limitation has some implications on our ability to conduct robust inferential statistical analyses involving demographic subgroups. Although students appeared to have taken the survey seriously and provided honest responses, the extent to which students may have provided socially-desirable responses given the nature of this instrument is a possibility. We tried to combat this possibility by collecting data without asking students to provide much demographic information, but the extent to which our efforts were successful remain somewhat unknown.

Conclusions

The purpose of the present study was to (1) evaluate the psychometric properties of a newly-developed instrument designed to measure factors incoming veterinary students indicated were important (or not) in their decision to become a veterinarian and (2) produce a measure of these factors by utilizing state-of-the-art psychometric modeling techniques to produce an empirical hierarchy that illustrates the construct of interest. Results indicated the instrument possesses desirable psychometric properties and is capable of producing valid and reliable measures. Substantive results essentially corroborated previous findings in the veterinary medical education field regarding students' motivations. We encourage others to utilize the CIFS to measure the importance of various factors leading to students' decision to become a veterinarian.

Ethical issues

None to be declared.

Competing interests

The authors declare that there is no conflict of interest.

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