Obtaining and Interpreting Students' Attitudes – Some Methodological Considerations and a Case Study

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Abstract

Obtaining students' attitudes, opinions, feedback, etc., plays an essential role in the higher educational process because it makes it more bidirectional and engaging for the students. Including larger populations in surveys often calls for informational structuring/standardization for subsequent statistical post-processing. Moreover, it brings along some well-known methodological issues (e.g., the central tendency in Likert scale-based surveys). Here we build upon a relatively large student survey case previously presented more extensively in [1]. That survey was devoted to various aspects of economics and business-related education offered on an elective basis to electrical engineering and computer science students. Here we focus on the interference between the intrinsic information (that is, the "true type" student responses) and the processing method that, if not designed carefully, can increase incentives for students to conceal their true type and recourse to the neutral ("central") answers. We also discuss our new practical approach currently tested in a similar population.

Keywords: *Student surveys, data processing, central tendency bias.*

1. Introduction

Universities play a critical role in developing the intellectual capabilities of students and providing the educational foundation necessary for economic development in knowledge-intensive societies [2,3]. For students to make the most of the opportunities provided by university education, professors and programs attempt to offer courses that capture student attitudes and interests as motivational variables that promote positive attitudes and performance in the classroom [4]. In the case of engineering students, promoting a greater interest in business can help ensure that students not only understand the technical skills needed to acquire and build a career but that they also learn about business and the economic context in which they apply those skills. Students who find relevance and interest in a subject are often seen to develop greater mastery in their chosen field. This has been demonstrated in studies examining the technological literacy of students [5]. Thus, understanding student preferences and the factors that distinguish those preferences allow professors and programs to not only promote certain courses, but also student success.

To proceed with the main topic of this article, first, it is necessary to briefly explain the Case Study it is based on. For more details, please refer to [1], while the complete set of relevant (anonymized) data and analyses can be obtained from the corresponding author.

The survey sampled students from the Faculty of Electrical Engineering and Computing (abbrev. FER; https://www.fer.unizg.hr/en), which is a part of the University of Zagreb, Croatia (http://www.unizg.hr/homepage/). FER offers research-oriented undergraduate, graduate, and post-graduate programs (specializations and doctoral) in electrical engineering and computer science/engineering. Although the programs at FER are concentrated on engineering/computing topics, the students must take, each semester, at least one of the elective, so-called "transversal courses," outside the school's mainstream. Within the undergraduate programs, there are currently three economics and/or business-oriented elective courses called Management in Engineering (2nd and 4th semester), Engineering Economics 1 (3rd and 5th semester), and Engineering Economics 2 (4th and 6th semester). The latter is also offered to the graduate students (2nd and 4th semester). The basic contents of these courses can be found at the following web addresses: https://www.fer.unizg.hr/en/course/mui_a (Mgmt. in Eng.),

https://www.fer.unizg.hr/en/course/engeco1 (Eng. Econ. 1), and https://www.fer.unizg.hr/en/course/engeco2 (Engineering Economics 2). The survey was organized in June 2020 for the students enrolled in Engineering Economics 2.

Besides these courses, the students at FER are offered numerous other optional business-related activity-based contents, such as regular weekly business workshops (meetings with prominent business people and academia members), a startup incubator established as an organizational unit of the FER, massive events with meeting opportunities with prospective employers, etc. Furthermore, recognizing the importance of early exposure of STEM students to the local business eco-system and educational content, FER has developed a variety of side activities available to the interested students over time. However, students' feedback, attitudes, and opinions related to the business topics are essential to make everything more meaningful and efficient. Therefore, the surveying initiatives, which may or may not be (and certainly do not need to be) planned much in advance or structured in a formalized framework, can be viewed as a part of continuing organizational learning and adapting.

Considering that, the *quality* of information gathered through surveys is very relevant.

The survey in our Case Study had the following main parts:

- A brief introductory letter from teachers to students.

- Quick instructions on how to fill out the form.

- A set of 53 questions out of which only the first 32 were analyzed for the purpose of this study:

  - Q01 – Q02: General demographic information (age and whether they were enrolled in the course Engineering Economics 1).

  - Q03 – Q17: Student's previous knowledge and experience in finance, economics, business, and similar.

  - Q18 – Q32: Students' attitudes about Engineering Economics, similar courses, and related additional learning resources.

The detailed table of questions was omitted here for brevity. The survey was offered to 197 students (81.73% male, 18,27% female). The participation rate was very high (92.55% male, 100% female), so 185 completed surveys were received and processed. The multiple-choice answers offered to students were organized on a standard Likert scale [6] with 5 points. The obtained data set was analyzed using the following methods and techniques:

- Computing basic descriptive statistics across questions and students (mean, standard deviation, skewness, kurtosis, median, adjusted median[1], and other selected relations between these parameters).

- Statistical analysis of gender differences in answers to all the questions and their interpretation.

The answers to most of the survey questions were distributed non-symmetrically and non-normally. In most cases, they could not be regarded as similar enough to the Gaussian distribution, nor to any other standard one. Therefore, the usual parametric tests for the equality of means could not have been used. In general, the reasons for non-normality can be sought in either too small samples (probably not the case here), the non-Gaussian nature of the responses, or both. The student's answers to each question were tested for equality of medians using the Mann-Whitney U-test for two independent groups [7-10]. As it is not our intention to comment on the same results here (for that, please refer to [1]), we shall only comment that, perhaps contrary to usual expectations, we did not find important gender differences in the responses. However, we did notice that, in general, the female participation in business-related activities was considerably lower and that the central tendency bias is more

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[1] Because of the coarse raster of answers offered in the Likert scale, the median can take only five discrete values. However, as the number of participants was pretty high, the median could be too rough a measure of central tendency. Thus, the notion of "adjusted median" was devised in the following way: Suppose that the median obtained from the population responses equals 4 and that the answer 4 was returned by R responders out of the total of N. Next, say that L responders returned a valuation lower than 4. Let "adjusted mean" be somewhere between 3.50 and 4.50 so that the value 3.50 is assigned to the ordinal number of L, and 4.50 is assigned to the ordinal number of $L+R$. The "adjusted mean" then simply equals $3.50 + [(N/2) – L]/R$. For example, if the sample size N was 137, the response 4 was given by $R = 32$ people, and the response lower than 4 was returned by $L = 43$ persons, the adjusted median would equal 4.30, which is higher than the actual value of 4. That indicates that the true median position is considerably closer to the next-higher class than to the next-lower one, giving a *somewhat better* signal of the average response. The details and the rationale are available from the authors upon request.

prominent in the female part of the population. Both effects must be connected with cultural preferences and deserve further and more deliberate investigation.

2. Methodological considerations

One of the most frequently used tools for gathering responses in surveys is the Likert scale [6]. With it comes the common problem of *central tendency bias* – the occurrence of response grouping around the most neutral degree of the scale, which is usually the middle. For instance, if the degree of supporting a specific assertion in a survey can be expressed in five steps, from 1 (strongly disagree) to 5 (strongly agree), a commonplace answer may turn out to be the 3 (neither agree, nor disagree). If the central tendency were especially (or unexpectedly) prominent, one would naturally suspect the truthfulness of many of the responders. There can be many reasons for that, for example (not listed in any particular order):

- The responders actually express their *true type*, which happens to be neutral. – In this case, it is *not* the central tendency. Still, *we often cannot know that for sure, so the suspicion may stay if we cannot* identify the reason (perhaps a poorly formulated survey question).

    - As a variation on the above theme, if a question has an obviously "correct" answer (e.g., "I would never embezzle money from the company I manage." – everyone in the right mind would answer that with "Strongly agree," even if having a diametrically opposite intention/opinion).

- The responders fear that someone could learn their preference and that it could harm their interests (for example, if the students express criticism towards the professors while anonymity is not guaranteed or trusted).

- The responders try to guess what the "right answer" could be but cannot do it, so they pick the safe option.

- The cultural prejudice induces the responders to be neutral (e.g., polite or not confronting).

- The responders share a widely accepted "common wisdom" that the "truth must be lying somewhere in the middle."

- The entire survey, or some parts, is made in a way that suggests insufficient preparation or even incompetence of the survey designer. This can lead to a "resentment" of (possibly many) respondents who feel undervalued or even offended by such material and just look to complete it as quickly as possible or even give it up.

- The responders are lazy and do not want to spend more time on the survey than they have to (in which case, the easiest and safest way is to mark the neutral answer). – This can be the case, e.g., with students that must fill out a survey as a requirement, but (fill that they) get nothing as a reward for the effort.

Douven [11] offers a Bayesian perspective on the central tendency bias, explaining it as a natural outcome of participants providing point estimates of probability distributions over the items on a Likert scale. The bias would still exist even if the questionnaire was indisputably correct and well thought out. Therefore, it is a question of interpreting it rather than trying to eliminate it. This finding, however, should not give rise to recklessness in designing the Likert scales because a bad design will undoubtedly inflate the problem.

One could list more possible explanations of the phenomenon. There have been discussions, for example, on using or not the midpoint in the scale. The initial idea was that the even number of answering options would not allow for choosing the central option. As Chyung et al. [12] put in a short sentence, "*Respondents may use a midpoint as a dumping ground when they are responding to survey items that are unfamiliar to them or to items that are ambiguous or socially undesirable.*" They also argue that "*The potential misuse of a midpoint as an "N/A proxy" or "dumping ground" can be reduced by first improving the clarity of survey items and presenting other options such as* Not applicable, I don't know, *or* It depends." Further, their research led to the conclusion that the missing midpoint lead to a great increase in non-answered questions, while the other "centrally oriented" responders apparently picked one of the neighboring options at random. Thus, it is more to the overall quality of a survey than the appearance.

In our approach, when designing the survey questionnaires, we were not primarily interested in dwelling over theory but rather coming up with a practical scheme that would *incentivize students* to at least *think more carefully* about the answers they choose.

In the Case Study mentioned above with FER students, one can note a large number of questions to answer: 53. Yet, we obtained an excellent participation rate. The reason for that was that the students were promised to get 5 points for this extra-curricular activity regardless of the answers they gave, as long as they filled out correctly the entire form. That way, they could obtain 5% of the total possible points, which probably seemed quite attractive as the end of the semester was approaching. However, it obviously could have led to the central tendency bias because there were no associated risks. To cope with that, we tried the approach by using many questions as a "distraction." At the same time, the students were motivated by an explanation that their answers would be valuable for improving the teaching quality, so it would be appreciated if they approached seriously. The survey questions were grouped in three macro-groups, as explained above in Sec. 1, but within those groups, they were not listed in any particular order. Moreover, we deliberately devised questions that were very diverse in the overall importance of the topics they covered.

Question #53, unlike the others, called students to write, if they wanted, their opinions in a free form on whatever topics from the previous questions or anything else they deemed necessary. It was used as a "control question" to establish who was "mentally present and engaged" enough to "bother" with writing an additional piece of text. Surprisingly, as much as 30% of the students did write down their thoughts, although everyone knew that it would not get any benefit in terms of additional points.

The overall idea was that we would be able to spot the individuals who found this kind of survey too heavy or tiresome and chose mainly midpoint answers just to get their 5 points and simply rule them out of our statistical analysis. However, after the entire population, and then only the subgroup of those who did not respond to question #53, were analyzed, we could not find any *hard proof* of central tendency (which, of course, does not mean that there was not any). Note that the central tendency bias can be very different across that many diverse questions.

2.1. A methodological discussion on group sizes and central tendency in the Case Study

In the Case Study described in [1], at least two methodological concerns – one technical and one more fundamental – had relevance. First, suppose a significant number of students did not reveal their true type in their answers but just succumbed to the dare of a swift run through the web form. The number of those could not be known because there was still a possibility that some of the students who did reveal their true types happened to have very neutral attitudes.

The technical concern would be: Given the unknown number of faked types in each survey question, could it have happened that the relevant groups were, in fact, smaller than 8 so that the normal distribution of U-test statistic could not have been applied? However, given the relatively big groups (36 women and 149 men), it was assessed that this was probably not the issue, so the z-tests were applied.

The fundamental concern is: to what extent does a notable existence of central tendency distort the results? On the one hand, since the number of students who revealed their true types is smaller than the total number, the groups appear to be more representative than they genuinely are. But, on the other hand, in the presence of a potentially significant number of faked types, concentrated about the neutral position in the Likert scale, the overall deviation is dimmed so that any differences in answers among the gender groups are presumably harder to detect from the available observations.

Therefore, it seems safe to conclude that in the cases where the null hypothesis of the non-existence of gender differences was rejected with particular statistical significance, this rejection was, in reality, *even more, justified* because the *central tendency phenomenon partially shadowed the actual information*. It is quite possible that there would be more survey questions with observed gender differences if the "non-honest" answers were somehow recognized and removed. For that reason, it was decided to report in [1] the survey questions in which the null hypothesis was rejected with 5% significance and 10%, too. The latter could be possible candidates for rejection (in another, more detailed research) now hidden in the shadow of the central tendency problem.

3. Further ideas about reducing the central tendency bias in student surveys

In the continuation of our work, we wanted to analyze the student attitudes about quite a few topics from the critical area of business ethics. To that end, we devised a set of questions to be answered by various groups of students to perform a comparative analysis of their prevalent ethical points of view while they are still at the "innocence" stage in their professional development. At the same time, they still have some "blurred" information about what goes on in the "real business world."

This time our approach was to construct something that resembles the Likert scale questionnaire but systematically reduces possibilities to exhibit the central tendency. We relied more on the design of the survey questions and the rules of engagement than on the very form.

We believed that the system of balanced, proper, and just incentives for students was essential to attract their attention to this new research. Therefore, besides classical motivation by the teacher, the plan was to give additional points for the extra activity they are to perform. Consequently, they were offered to get:

- 5 points only if they submit the *correctly and fully filled form* consisting of 15 complex questions, regardless of the answers they give,

- some more points if they explain in a *meaningful* (*non-trivial, coherent, etc.) way* their answers to the 15 questions mentioned above, whereby each meaningful explanation brings 1 point. Still, the total number of those points cannot exceed 5.

Thus, a student who provided answers to all 15 questions could get 5 at least points, possibly up to 5 more for the reasoned explanations.

This point-awarding scheme may vary from school to school, subject to the local rules. It is here just to attract a sufficient number of students.

As regards the very survey questions, they were formulated in the following way:

Each of the questions was comprised of two obligatory parts to answer:

1. Five statements that students must rank uniquely and exclusively (without repetitions of the same rank). Each statement briefly describes a business practice that almost everyone deems unethical. The task is to rank those five statements by the perceived degree of unethicality so that rank 1 means the least unethical practice, and rank 5 represents the most unethical practice.

2. An assessment of the overall severity of the group of the five unethical practices in three stages: A: Not particularly problematic. B: Moderately to sincerely problematic. C: Heavily or extremely harmful. (Naturally, all five statements belonged to the same "type" of business-unethical behavior.)

The optional third part of each question was the free-style explanation of the ranking.

Table 1 gives an example of the first two parts of the survey questions.

As one can observe, the statements to be ranked in relative terms are not really simple, and the students would have to think them through. Then, there is a risk of filling out the form incorrectly because, according to the rules, any entry with repeated ranks would automatically be dismissed as irregular, and the student would lose all the points. Possible automatic repetition of the same rank sequence (for example, 1 2 3 4 5 in each question) would be easily detected, too. Choose always the same answer to the Part 2 would also be easily spotted. Therefore, we assessed that the risks are high enough to induce students to take due care of the process. Since they already have to pay attention, why not just fill out the form honestly? Namely, inventing fake sequences not easy to detect would (hopefully) require as much time and effort as simply giving their true answers. Last but not least, in this particular case, we thought we could count on the young people's general sensibility for ethical topics.

Before completing this article, the survey was already carried out at FER. Of 316 enrolled in the Engineering Economics 2, 231 complete forms were received, all entirely correct as required by the rules[2]. The plan is to

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[2] The data could not be retrieved and processed in such a short time. However, we expect to have at least preliminary results available for the presentation at the conference.

extend the same (or similar, adequately improved) survey to the students at other institutions in the international context.

Table 1. An example of a two-part question in our new survey designed to reduce the central tendency bias.

Question #12, Part 1 Unethical practice in making decisions on the senior level of management in a business organization	Degree of unethicality (1-5)		
Meddling with the technical or commercial conditions for procuring strategic materials or raw products so that the job goes to a predetermined vendor, otherwise reliable and with quality goods, but somewhat more expensive than the other competitors.			
Adjusting the accounting practices so that the financial reports send better-looking signals about the company's financial condition, that can be good for the stock price and hence for the shareholders.			
Making a decision on a very large and risky investment without prior detailed investment studies of the project and the possibilities to hedge against the project-associated risks.			
Meddling with the technical or commercial conditions for the procurement of strategic materials or raw products so that the job goes to a predetermined vendor in exchange for a monetary kickback, a small fraction of the total procurement value.			
Diminishing the significance of possible environmental pollution from the newly planned factory so that the necessary consent and permits from the local community where the factory is to be built.			
Question #12, Part 2	Your assessment of the overall severity of the group of the above five unethical practices (mark one of the answers)		
	A	B	C

4. Conclusion

We analyzed in more depth the methodological issues encountered in our research published in [1], where the effects of central tendency bias, connected with the use of the Likert scale in student surveys, were noticed. As obtaining the attitudes, opinions, and feedback from students is gaining importance from the standpoint of quality and relevance of the education process in business-related areas, methods to reduce the extent and negative consequences of central tendency are worth investigating. Here we propose yet another possible method (please refer to Sec. 3) with a combination of incentives for students and a design of survey questions that could lead to better avoidance of bias.

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