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"Tell them it's easy": Framing incentives in learning basic statistical problems

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ABSTRACT

Learning quantitative subjects is perceived as a difficult process; congruently, students are often concerned about academic courses involving statistics. Simultaneously, there are a number of tools in psychology and behavioral economics, i.e. framing stimuli, which can increase the efficiency of knowledge transfer processes and level of solving new problems in a simple manner. During a basic statistics test on a group of 284 economics students, it was shown that the method of informing students that a specific problem was very simple, increased their efficiency to solve problems, compared to those who were informed that the problem was very difficult. Using 4 × 2 ANCOVA, with the level of prior knowledge in statistics as the covariant and including gender analysis into the homogeneity-of-slopes model, it was also revealed that the impact of individual framing stimuli is universal and does not depend on the level of prior knowledge of statistics.

1. Introduction

Contemporary economics uses a broad range of quantitative tools, and quantitative skills, especially mathematical ones, which supposedly are key factors to enabling students to follow a logical and systematic sequence and, eventually, lead to success in economics taught at university (Schoeffler, 1956; Mallik and Varua, 2008; Mallik and Basu, 2009; Lagerlof and Seltzer, 2008; Birch and Miller, 2006; Ballard and Johnson, 2004; Mallik and Shankar, 2016). However, quantitative methods taught at universities, in particular statistics, are perceived as difficult and arouse anxiety among students (Birenbaum and Eylath, 1994; Schau et al., 1995; Baloğlu, 2003). Statistics anxiety, as defined by Onwuegbuzie et al. (1997), occurs when an individual experiences anxiety as a result of encountering statistics in any form and at any level. There are several main factors that mediate the influence of statistics anxiety on the learning of statistics (Forte, 1995; Onwuegbuzie et al., 2000; Onwuegbuzie and Wilson, 2003; Baloğlu et al., 2011; Vahedi, 2011). Onwuegbuzie (2003) found statistics anxiety had a direct impact on achievement and both statistics anxiety and expectation mediate the relationship between statistics achievement and other cognitive, affective, and demographic variables. On the other hand, some educators suggest that statistical thinking at the elementary level of academic statistics is mostly intuitive and non-mathematical and, therefore, there is no residual mathematics knowledge effect on elementary statistics performance. Furthermore, students may find it easier to learn statistics, if at the outset they can be assured that there is no reason to fear it (Woodward and Galagedera, 2006).

Giving instructions and learning are two elements of knowledge transfer. The successful transfer of knowledge allows us to use knowledge acquired in past situations or tasks to solve new problems (Barnett and Ceci, 2002; Bransford and Schwartz, 1999; Cormier and Hagman, 1987; Detterman and Sternberg, 1993; Elis, 1965; Lobato, 2006; Reeves and Weissberg, 1994; Royer, 1979; Salomon and Perkins, 1989; Singley and Anderson, 1989). According to Kock and Davison (2003), knowledge transfer is defined as the transfer of mental schemas that can be used to process information, where information can be represented as facts (e.g. today is sunny) and knowledge that can be represented as a production rule (e.g. if today is sunny, then the probability of rain is low).

Learning quantitative subjects might not be easy for students. However, educators try to aid learning by teaching new concepts using concrete examples. It seems to be an effective instructional approach (Belenky and Nokes, 2009) because it reduces memory load (Sweller, 2006; Sweller et al., 1998), facilitates understanding by grounding new information in meaningful prior knowledge (Brown et al., 1989), and may increase students' motivation to learn and understand an instruction, task, or problem (Cordova and Lepper, 1996; Schraw et al., 2001). The particular profile of transfer processes triggered for a given situation depends on the type of knowledge to be transferred and how it is represented (Nokes, 2009). Moreover, the effectiveness of learning and knowledge transfer seems to be a result of direct factors such as prior knowledge, motivation, a native language, and learning strategies

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(Dochy, 1992; Brückner et al., 2015; Mallik and Shankar, 2016; Dochy et al., 1999; Schultz et al., 1998). However, it is the state of prior knowledge that is supposed to play a major role in such processes (Dochy et al., 1992). Belenky and Nokes-Malach (2016), using an example from basic statistics, showed how the manner in which presenting instructions to students could promote the adoption of desired educational goals and, consequently, increase the likelihood of positive transfer outcomes. According to the prospect theory (Kahneman and Tversky, 1979), the way in which people react to a particular situation depends on how it is presented. This is a basis for the framing effect analysis and a behavioral approach in economics. In some instances, functionally equivalent situations, problems, and outcomes can be framed differently, emphasizing either positive or negative information. A surgical technique, for example, can be described as resulting in a "80 percent cure rate" or "20 percent mortality rate". In other instances, situation framing can be used to emphasize positive or negative consequences associated with an alternative course of action. Meyerowitz and Chaiken (1987) and Maheswaran and Meyers-Levy (1990), for example, framed health outcomes and actions positively (i.e., "if you do [action] you will be better off because…") and negatively (i.e., "if you do not do [action] you will be worse off because…").

Framing can significantly influence how a problem is perceived by decision makers and how alternative options are evaluated (Kahneman and Tversky, 1984). The effects of message framing were also, among others, investigated in particular cases of environmental communication (Davis, 1995), tax policy (Chang et al., 1987), education (Levitt et al., 2012), judgments and decisions (Peters et al., 2006), transfer of knowledge (Belenky and Nokes-Malach, 2016), leaders' performance (Hunter et al., 2009), satisfaction, self-efficacy, performance (van de Ridder, 2015), and intrinsic and extrinsic goals (Vansteenkiste et al., 2007). Jensen (2010) elaborates that message framing and information can benefit the educational process by presenting augmentative motivation to learn and study. How information is presented or who is targeted matters as well (Lavecchia et al., 2014). A question still arises, if one can affect how well students perform not only by presenting the content, but rather the associated elements that have nothing in common with the content, this may affect attitude and decisions of learners with respect to their commitment, motivation, and faith in their own abilities. In one of the best known educational experiments, Aronson et al. (2002) brought about a situation where participants were taught that intelligence is not a finite endowment and that it can grow with effort. This mind-set was predicted to make students' performances less vulnerable to stereotypical threats and help them maintain their psychological engagement with academics, both of which could help bolster their college grades. Results were consistent with predictions. The African American students (and, to some degree, the white students) encouraged to view intelligence as malleable reporting greater enjoyment of the academic process, greater academic engagement, and obtaining higher grade point averages than their counterparts in two control groups.

In this study, I wish to take advantage of observations concerning framing, and more specifically the method of placing additional, or auxiliary, information related to a specific unit of knowledge in statistics, and to check how manipulating such a factor will affect the effectiveness of transferring new knowledge. The planned experiment involves the determination of how students can master new thematic material related to one of quantitative subjects (*t*-Student tests and ANOVA) depending on the manner in which the level of its complication is presented to them. In this manner, I want to build a bridge between, on the one side, personally framed suggestions, current achievements in basic statistics, prior mathematical skills, and students' performance in learning and knowledge transfer on the other. A starting point is the conviction that the proper presentation of level of complication to a problem is an issue will affect how students will master it. A difficulty level may be pre-determined, i.e. stipulated to subjects as additional information (factual or not). I also suspect that what matters is if the information provided will be general or personalized. If information is general, the level of difficulty will be shown objectively and absolutely, providing equal reception by all subjects from the group. If personalized, the same piece of information on the difficulty level may be interpreted differently, depending on emphasizing selected characteristics held, by individual students. Owing to manipulation, it will be possible to examine (in the example of a basic statistical problem), how different framings affect the efficiency of new knowledge transfer and if the potential impact of selected framing stimuli on transfer knowledge efficacy depends on prior knowledge held by students. Hence, two main hypotheses are investigated. I hypothesize that:

H1. The method of presenting the difficulty and the level of understating a basic statistical problem affects the observed efficacy in its solving:

H1a. Presenting a statistical problem as easy/difficult increases/decreases the efficiency of the solution.

H1b. Stressing successes/failures in solving a statistical problem increases/decreases the efficiency of problem solution.

H1c. Introducing a personalized suggestion that refers directly to the situation of an individual will result in the differentiation of efficiency level when solving a statistical problem.

Moreover, I expect that there are combinations of the above-mentioned framing stimuli that will impact the efficiency of knowledge transfer. Finally, I assume that framing has a universal dimension, which means that its efficiency will not be related to the most important predictor within transferring new knowledge of basic statistics, i.e. the level of knowledge available in this area. Therefore, another hypothesis reads as follows:

H2. The impact of variable framing incentives on the efficiency of transferring knowledge of a selected basic statistical problem is not related to the level of prior knowledge of basic statistics.

To the best of my knowledge, no other study has ever investigated the interaction of different ways of framing information and prior knowledge in relation to the transfer of knowledge on the subject of basic statistics. Therefore, previous mathematical experience was entered as an external framing stimulus and the level of prior statistics knowledge as a covariate. Students' performance in the new statistical task was a dependent value whereas various types of framing (difficulty vs. easiness, success vs. failure, and general vs. personalized) were introduced as independent grouping variables.

2. Method

2.1. Participants

In total, 298 persons took part in the study. Due to the conviction that linguistic issues affect the efficiency of knowledge transfer (Brückner et al., 2015; Hambleton, 2005; van de Vijver and Leung, 2000) and due to the ambiguities of converting previous achievements in mathematics, a decision was taken to exclude foreigners (7 persons). Moreover, two test sheets were completed in an unclear way were rejected. Five other respondents did not complete the survey, leaving 284 eligible persons for the study. Subjects of the study were first year students in their second level of study within the Faculty of Economics (University of Gdansk, Poland) majoring in economics (53%) and international economic relations (47%): 185 females (65%) and 99 males (35%). It can be assumed that all the students were of similar age, as more than 95% of them were 22 or 23 years old. The experimentation was a field experiment which, in turn, meant that all students from a given course were examined. The observed predominance of women does not differ significantly from the structure in terms of sex in the