European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.2609193 Volume 5 | Issue 12 | 2019

ACADEMIC SELF-EFFICACY, ATTITUDES AND KNOWLEDGE AMONG UNDERGRADUATE BIOSTATISTICS STUDENTS

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Abstract:
Objective: The objectives of the present study were to evaluate the academic self-efficacy, content knowledge and confidence in their responses to knowledge questions, as well as attitudes of students in an undergraduate biostatistics course. **Design:** The study was a cross-sectional analytical design. **Setting:** The study was carried out in Masinde Muliro University of science and technology **Sample:** Sampling frame consisting of 114 students who had at least taken a biostatistics course. Probability sampling technique of purposive sampling method was applied to select the students. (*n = 103*) **Analysis:** Data were analyzed through path analysis and confirmatory factor analysis. **Main measures:** Self-efficacy, confidence, attitude and knowledge **Results:** The estimation of this hypothesized structural model yielded an acceptable fit to the data, $\chi 2$ =45.9, *df* = 2; χ^2/df *ratio* =22.123 (good), CFI = .933; RMSEA = .071, with 90% C.I. = .044 - .083, SRMR = .078. Attitude was a direct predictor of self-efficacy (β = .490, p < .001), confidence was a direct predictor of self-efficacy (β = .400, p < .001), self-efficacy was a direct predictor of knowledge (β = .515, p < .001). **Conclusion:** The study concludes that academic self-efficacy and optimism were strongly related to performance. Therefore, this study supports previous literature that found academic self-efficacy affects the success of students in the sciences. **Recommendation:** Educators should be aware of students' personality antecedents in order to improve their students' beliefs about their capabilities to master different areas of coursework.

Keywords: self-efficacy, attitude, undergraduate students, biostatistics, Kenya

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1. Background

Academic difficulties may lead to long-term patterns of school drop-out, academic failure, and problems entering a successful career in adulthood (Alexander, Entwisle, & Kabbani, 2001). A meta-analysis of the relationship between perceived self-efficacy with respect to academic subjects and achievements showed that self-efficacy appraisals make a positive contribution to academic achievements (Multon, Brown, & Lent, 1991). Previous research has also shown that expectancy of future grades is both based on previous academic achievement and related to actual subsequent achievement (Vollmer, 1984). research has shown that both self-efficacy and goal orientations predict achievement relevant outcomes, such as deep/surface learning strategies and examination grade (Greene et al., 2004; Liem et al., 2008; Walker, Greene, & Mansell, 2006). Academic self-efficacy researchers, Schunk and his colleagues in particular (Schunk, 1984a, 1984b; Schunk & Hanson, 1985; Schunk, Hanson, & Cox, 1987; Schunk & Swartz, 1993), have successfully established the causal role of efficacy beliefs in enhancing students' achievement-related behaviors. Students with various academic deficits participated in instructional programs that were designed to enhance their competence by resorting to one or more of the diverse instructional strategies such as modeling, strategy training, goal setting, and providing rewards, attributional feedback, or progress feedback to students. After successful completion of the programs, participants demonstrated significantly enhanced self-efficacy toward the tasks of interest which, in turn, resulted in improved performance on similar tasks

Bandura (1997) described self-efficacy as "*the belief in one's capabilities to organize and execute courses of action required to produce given attainments*". Efficacy beliefs influence the particular courses of action a person chooses to pursue, the amount of effort that will be expended, perseverance in the face of challenges and failures, resilience, and the ability to cope with the demands associated with the chosen course. we do not know the nature of the direct effects of academic self-efficacy on academic performance, but we do know that confident students work harder, persist longer, and use better learning and problem-solving strategies (e.g., Bouffard-Bouchard, 1990; Bouffard-Bouchard et al., 1991; Cervone & Peake, 1986) and that efficacious students manage the learning environment more efficiently (e.g., Pintrich & Schrauben, 1992; Zimmerman & Martinez-Pons, 1988).

Considered together, studies involving personal beliefs suggest convincingly that individuals with positive views of themselves strive to succeed and overcome even the greatest obstacles in life. Those people with weak or negative self-conceptions seem, on the other hand, to fail to reach their fullest potential and fall short of their expected performance in light of their objective capacity. Constructs of self-beliefs, therefore, are not mere reflections of one's past performances but are active and agentic producers of human attainments (Bandura, 1986; Markus & Nurius, 1986). In academic motivation research, this distinction between self-concept and self-efficacy often becomes blurred. This is because although the conceptual definitions of academic self-concept often include both cognitive and affective components, its measures tend to concentrate on

one's perception of competence over other self-relevant information. This renders academic self-concept (as measured) and self-efficacy more analogous than the theoretical analysis suggests. Still, there is some evidence indicating the relative compositional complexity of self-concept. Pajares and Miller (1994) demonstrated that math self-efficacy was able to predict students' math self-concept scores, suggesting that self-concept may include a self-efficacy component. They also found that math anxiety was highly correlated with math self-concept (r = .87), whereas it showed only a moderate correlation with math self-efficacy (r = .56). Skaalvik and Rankin (1995a) reported similar results. For both sixth and ninth graders who participated in their study, math and verbal self-concepts displayed higher correlations with anxiety measures (r = .82 [.72] in math and r = .77 [.59] in verbal areas for sixth [ninth] graders) than self-efficacy (r = .40 [.54] in math and r = .35 [.44] in verbal areas for sixth [ninth] graders). It is worthwhile to note that academic self-concept in both studies was measured with the Self-Description Questionnaire (SDQ), items which include students' perceived competence and their feelings about it at school subject levels

In sum, theoretical assumptions and previous research findings provide a basis for the investigation of a structural model and the following hypotheses are put forward: Attitude will predict self-efficacy and subsequent knowledge, Self-efficacy will at least partially mediate the effect of confidence on knowledge, Self-efficacy will predict knowledge. The objectives of the present study were to evaluate the academic self-efficacy, content knowledge and confidence in these responses, as well as attitudes of students in an undergraduate biostatistics course.

2. Methods

2.1 Participants and Context

The study design was cross-sectional analytical design was used due to time factor available for the study to be conducted hence requiring data to be collected in a point in time. The descriptive study design was ideal as the study was carried out in a limited geographical scope and hence it was logistically easier and simpler to conduct considering the limitations of this study (Mugenda & Mugenda, 2008). 103 students enrolled in an undergraduate statistics course participated in the present study. (66 male and 37 female) students with a mean age of 21.21 years (range 19–25 years, standard deviation. 3.08). Informed and voluntary Consent was obtained from the participants before they participated in the study to allow for their freedom in participation. Confidentiality was maintained at all levels for the data and information obtained by ensuring no names included in the questionnaires. Privacy for the participants was ensured through anonymity by ensuring no names appear on the questionnaires and that information does not identify directly to an individual. There was the protection of the individuals from harassment, harm, discomfort or distress.

2.2 Procedure

The students were given a specific time to complete an inventory during one of the final lectures approximately one month before the exam. At this point of the semester, they had sufficient study experience to assess how they were confident, knowledgeable and had a positive attitude towards the biostatistics course. It took about 15min administer the inventory. The course lecturer was present during this administration. The survey and its use were approved by the institutional instructional review board (IRB)

2.3 Questionnaire

Questionnaires were selected as data collection instruments. It took 15 minutes to administer the questionnaire. This questionnaire was adapted from the works of Woolcock, Creevy, Coleman, Moore, and Scott (2016). The reliability of the scale of the items was found to be: Internal consistency = (Cronbach's α = 0.73). The analysis showed that deleting selected items would not increase the Cronbach's alpha coefficient.

2.4 Demographic Information

Information about the participants including gender, age, and year in college was collected. In addition, participants were asked if they had previously completed any biostatistics course. This final question had only "yes" or "no" as possible responses, so participants were not able to specify at what point in their education they took such courses.

2.5 Academic Self-Efficacy

A 5-item measure was developed for the present study. Participants were asked to rate, on a 5-point Likert scale, their agreement with statements reflecting their level of confidence in their ability to explain certain concepts to their classmates. A sample item is as follows; "How confident are you that you could explain descriptive and inferential statistics to your classmates?" The response scale ranged from 5 (totally confident) to 1 (not at all confident). The participants were not asked to anticipate their performance in comparison to their classmates, only to rate their confidence in explaining a concept to their classmates. A confirmatory factor analysis (CFA) indicated good fit for a one-factor solution (chi-square [χ^2]=6.22, degrees of freedom [df]=3, χ2 /df ratio=2.09, RMSEA=.07, and CFI=0.99).

2.6 Content Knowledge

Five multiple-choice questions related to basic biostatistics were included in each survey. These questions were intended to reflect pertinent content that could appear on a formal examination for the biostatistics course. The lecturer for this course was not involved in the creation of these questions, nor did he have access to them prior to the course lectures or survey administration. The lecturer also was not present in the classroom when the students were completing the survey. The survey contained two memory/recall questions and three higher-order thinking skills questions. Students

were presented with four possible responses to each question, with one correct response and three distractors per question. Because completion of the survey was voluntary, these questions had no impact on the participants' course grade.

2.7 Attitudes

A five-item measure of student attitudes was designed for the present study. Participants were asked to rate on a 5-point Likert scale their agreement with statements regarding biostatistics. The response scale ranged from 5 (strongly agree) to 1 (strongly disagree). Sample items are as follows: "Biostatistics is particularly important to the current society." A CFA indicated good fit for a three-factor solution (chi-square [χ^2] =36.68, degrees of freedom [df]=23, χ2 /df ratio=1.60, RMSEA=.05, and CFI=.98).

2.8 Confidence

After each Biostatistics content question, participants were asked to rate, on a 5-point Likert scale, their confidence in their responses to the previous questions. Thus, each survey contained a five-item measure of post-question confidence. The response scale included the following choices: 5 (very confident; I am sure that I chose the correct answer), 4 (somewhat confident; It is very likely that I chose the correct answer), 3 (slightly confident; I made an educated guess when choosing an answer), 2 (somewhat unconfident; I was able to eliminate a few choices, but ultimately had to guess); 1 (very unconfident; My answer was a complete guess). For each respondent, confidence scores for each question were averaged to provide a single score for post-question confidence for that individual respondent.

2.9 Data Analysis

Confirmatory factor analysis was performed to test the adequacy of the measurement models (cf. Marsh, Byrne, & Yeung, 1999). We used structural equation modeling (SEM) framework using AMOS 20.0 (Arbuckle, 2007) to explore the hypothesized relations among the variables. Given that obtaining a non-significant χ2 becomes increasingly unlikely with large sample sizes (Kline, 1998), the following criteria were employed to evaluate the goodness of fit: To interpret these indices the following criteria were used: $\chi^2/df\ ratio < 2$ (excellent); $\chi^2/df < 3$ (good); $\chi^2/df < 5$(acceptable). However, because the goodness of fit test is problematic with large samples (Hayduk, 1996), the adequacy of the models was described with some additional statistics. The overall model fit was evaluated using the root mean square error of approximation (RMSEA), the standardized root mean square residual (SRMR) and the comparative fit index (CFI). The RMSEA and SRMR indices measure the discrepancy between the predicted model and the observed model; values lower than 0.08 are interpreted as acceptable fit, with lower values indicating better fit (Hu & Bentler, 1999). The CFI measures the extent to which the model of interest is better than an alternative model where measured variables are uncorrelated; values closer to 1 are considered acceptable fit (Hu & Bentler, 1999). For this study, RMSEA values lower than 0.06, SRMR values lower than

0.08, CFI values greater than 0.95, normalized fit index (NFI) values above .90; values of incremental fit index (IFI) above .90 were considered as indicative of good model fit. Statistical significance was set at α = 0.05. The pattern of missingness was tested by using the missing values option in SPSS 25. The Little (1988) test for MCAR was not statistically significant ($\chi 2(16)$ = 61.906, p =.101), indicating that the variables in our analysis met the strict assumption of MCAR.

3. Results

103 questionnaires were correctly filled and returned which represented a response rate of ninety percent. According to Mugenda and Mugenda (2003), a response rate of 50 percent is adequate, a response rate of 60 percent is good, and a response rate of 70 percent is very good. While we should not expect a full response in studies where responding is voluntary, scholars utilizing questionnaires should aim for a high response rate (Baruch & Holtom, 2008).

3.1 Structural Model

A structural model was designed to estimate the relationships between the measured constructs. The cross-sectional inter-correlations between attitude, confidence, self-efficacy, and knowledge were tested. The estimation of this hypothesized structural model yielded an acceptable fit to the data, $\chi 2$ =45.9, *df* = 2; χ^2/df *ratio* =22.123(acceptable), CFI = .933; RMSEA = .071, with 90% C.I. = .044 - .083, SRMR = .078. The conceptual links are displayed in Figure 1. As the figure shows, attitude was a direct predictor of self-efficacy (β = .490, p < .001), confidence was a direct predictor of self-efficacy (β = .400, p < .001), self-efficacy was a direct predictor of knowledge (β = .515, p < .001). All variables explained 77% of the variance on self-efficacy and 43% on knowledge. The indirect effects of confidence (p=.206) and attitude (p=.253) on knowledge was not statistically significant, meaning self-efficacy mediated the relationship between confidence and knowledge. The final model with significant pathways and standardized coefficients is shown in Figure. 1

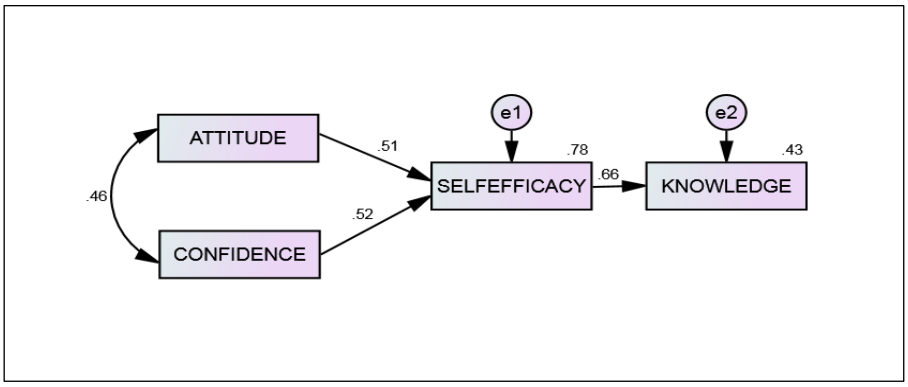

Figure 1: Results of the SEM model

4. Discussion

The objectives of the present study were to evaluate the academic self-efficacy, content knowledge and confidence in these responses, as well as attitudes of students in an undergraduate biostatistics course. In the current study, confidence was a direct predictor of self-efficacy ($\beta = .400$, $p < .001$). In a previous study, students with greater intrinsic motivation generated greater self-efficacy (Liang & Chang, 2014). This is consistent with the findings of this study. The current study also found that self-efficacy was a direct predictor of knowledge ($\beta = .515$, $p < .001$). The results of several previous studies have identified a direct relationship between increased academic self-efficacy and improved academic performance (Chemers, Hu, & Garcia, 2001; Caprara et al., 2008; Di Giunta et al., 2013). Consistent with these findings, previous research (Elliot & Church, 1997; Greene et al., 2004) presupposes competence perceptions (self-efficacy) as antecedents of achievement goal adoption in hierarchical models. In addition, the results of previous studies indicate that expectancy of future grades, which is comparable to academic self-efficacy, is based on previous academic achievement as well as an actual subsequent achievement (Diseth, 2011; Vollmer, 1984).

The indirect effects of confidence (p=.206) and attitude (p=.253) on knowledge was not statistically significant, meaning self-efficacy mediated the relationship between confidence and knowledge. Previous research has shown that more efficacious learners view the demands of their academic workload as more of a challenge than a threat (Chemers, Hu & Garcia, 2001). This finding is also similar to the study by Liem et al. (2008), in which prior achievement primarily predicted self-efficacy and subsequent examination grade. Comparisons between self-efficacy and the theory of self-determination have been made previously (Deci, & Ryan, 1985). This theory also incorporates intrinsic and extrinsic factors that affect motivation and supposes that these have a cumulative effect on one's belief that one will succeed at a given task (Deci & Ryan, 1985; Ryan & Deci, 2000).

5. Conclusion

Future research should further clarify how personality traits and self-esteem predispose individuals to develop and strengthen perceived academic self-efficacy beliefs, and how these personal characteristics interact with learning conditions in improving academic performance. Finally, in agreement with those scholars who established that people may have a different sense of self-worth depending on the specific domain in which they evaluate their self-worth (Hair & Graziano, 2003).

There are also several limitations to the present study. First, basic traits, self-esteem, and confidence were assessed concurrently, and more rigorous longitudinal designs are needed to establish the validity of the relationships between confidence to self-efficacy to academic achievement. Second, it is important to note that the use of self-reports in the assessment of the examined indicators may have introduced response biases (such as social desirability) and inflated the pattern of correlations. Third, caution

should be used in generalizing results from the present study to other populations because participants in this study were students from a specific cohort.

Declarations

Ethics approval

Ethical clearance was obtained from Masinde Muliro University of Science and Technology Ethics Committee.

Competing interest

The authors declare that they have no competing interests.

Authors & contributions

Dr. Maximilla Wanzala and Issah Kweyu conceived, designed and performed the study. Micky Olutende Oloo and Anthony Muchiri analyzed the data. All authors read and approved the final manuscript.

Disclaimer

The findings and conclusions presented in this manuscript are those of the authors and do not necessarily reflect the official position of Masinde Muliro University.

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