ATTITUDES TOWARD STATISTICS AND THEIR RELATIONSHIP WITH SHORT- AND LONG-TERM EXAM RESULTS

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This paper presents an empirical study that used the Attitudes Toward Statistics (ATS) scale (Wise, 1985) to investigate the relationship between attitudes toward statistics and short- and long-term exam results for Flemish university students taking statistics courses in a five year Educational Sciences curriculum. The aim was to examine whether the previously reported relationship between attitudes toward statistics and first year statistics exam results also exists for later statistics and general exam results. The results indicate that there indeed exists a relationship between attitudes toward statistics (at the beginning of the curriculum) and later statistics performance (indicated by the dissertation grade), but that this relation between attitudes and results is content-specific.

INTRODUCTION

According to Gal, Ginsburg, and Schau (1997) students' attitudes toward statistics may affect the extent to which they will develop useful statistical thinking skills and apply what they have learned outside the classroom. Presumably, poor attitude will lead to poor skills. Therefore, it is important, for statistics instructors and educational researchers, to thoroughly study the attitudes students have toward statistics and their relationship with performance. Several authors have investigated the relationship between students' attitudes toward statistics and short term statistics performance with Wise's (1985) Attitudes Toward Statistics scale (ATS) (e.g., Rhoads and Hubele, 2000; Shultz and Koshino, 1998; Waters *et al*. 1988; Wise, 1985). The ATS is of 29 Likert-type scale items, each with five response possibilities. The questionnaire consists of two subscales – *Field* (20 items) and *Course* (9 items) – that respectively aim to measure attitudes toward the use of statistics in the students' field of study and attitudes toward the particular statistics course in which they are enrolled. In most of previous studies the test was administered twice: once at the beginning of the course and once at the end (before the exam results). Table 1 presents an overview of the previously reported correlations between ATS and first year statistics exam results.

Table 1: Previously reported correlations between ATS scores and first year statistics exam results

Study	Course subscale		Field subscale	
	Adm. 1	Adm. 2	Adm. 1	Adm. 2
Rhoads and Hubele, 2000	0.29*	0.29*	Not sign.	Not sign.
Shultz and Koshino, 1998 (sample 1)	0.06	0.45*	0.16	0.43*
Shultz and Koshino, 1998 (sample 2)	0.13	0.34*	0.13	0.08
Waters *et al*. 1988	0.20*	0.42*	0.07	0.17*
Wise, 1985	0.27*		-0.04	

* Correlation is significant at the 0.05 level

Aside from the significance of the correlations, we will refer to effect sizes. Cohen (1992) provides a classification of effect sizes for correlations in terms of small (r = 0.1), medium (r = 0.3), and large (r = 0.5) effects as compared to the effects typically found in the social, educational and behavioral sciences. Except for Shultz and Koshino (1998, a study that contains two different samples), these studies show a statistically significant positive correlation between the first administration (Adm.) of the *Course* subscale and the first year statistics exam results (first column). In terms of effect sizes (Cohen 1992), these correlations are small or medium. The correlations of the second administration (second column) are considerably higher (effect sizes ranging from medium to large). None of the previous studies shows a statistically significant correlation between the *Field* subscale scores and the exam results for the first administration

(third column). Two studies (Shultz and Koshino, 1998, first sample; Waters *et al*., 1988) yield a statistically significant correlation for the second administration for the Field subscale (fourth column), but for all studies, the correlation at the second administration is smaller for the *Field* subscale than for the *Course* subscale (although not necessarily significantly smaller). The data in Table 1 are in line with the conclusion of Waters *et al*. (1988) and Harvey *et al*. (in Mvududu, 2003) that especially the *Course* subscale scores are related to the exam results. The latter authors suggested that a supportive atmosphere in the course could help performance, regardless of the attitudes toward the field.

The present paper presents data from a large study which aims at exploring the relationship between students' attitudes toward statistics and performance further. Whereas previous studies merely addressed the relationship with their first year statistics grades (which is also our first research question), the present longitudinal study additionally addresses two complementary questions: What is the relationship between students' attitudes toward statistics and (1) long term statistics exam results and (2) general exam results (short- and long-term).

RESEARCH METHODOLOGY

Participants

Participants were 264 first year students (218 female, 46 male) of an introductory undergraduate statistics course at the Department of Educational Sciences of the Katholieke Universiteit Leuven. Since not all students passed the exams, the sample sizes of the correlations become smaller and more selected each year (see Table 2). Therefore, the conclusions of the relationship between the attitudes and long-term exam results only pertain to students who actually passed the exams.

Instrumentation

Attitudes toward statistics were assessed with a Dutch version of the Attitudes Toward Statistics (ATS) scale (Wise, 1985). Two administrations of the ATS took place with the same students: one at the beginning of the first year (when most students have limited or no knowledge of statistics) and one at the beginning of the second year after they knew their exam results. To relate the attitude scores to statistics performance, we recorded students' statistics exam results and their dissertation grades. Because of the major role methodology and statistics play in making a dissertation, this can also be considered as a content-specific statistics exam. The students have no statistics course in the fourth year. To relate the attitude scores to general performance, we recorded students' general exam results for the five years of the curriculum.

RESULTS

The test-retest reliability analyses (correlations between ATS subscale scores on the first and second administration) showed a test-retest correlation of .62 for the *Field* subscale and .76 for the *Course* subscale. Table 2 presents the correlations of the ATS subscale scores with all statistics exam results and the correlations between the first year exam results and later exam results. We remark that due to the different numbers of observations, not all direct comparisons are meaningful and hence we will focus mainly on a comparison of correlations where the same students are involved.

Relationship Between Students' Attitudes Toward Statistics and Short-term Exam Results

Correlations between students' attitudes toward statistics and first and second year exam results are positive and statistically significant for both administrations, with effect sizes (Cohen, 1992) between small and medium. The *Course* subscale scores showed the highest correlations.

As expected, the correlation between the first and second year statistics exam results (r = .45, p < .05) was higher than the correlations between the ATS scores and the second year statistics exam results (respectively .23, .14, .31 and .20; see Table 2). This means that for the included sample the first year statistics exam result (a cognitive characteristic) was a better predictor of the second year exam result than the attitude scores (an affective characteristic).

Table 2: Correlations between ATS Course and Field scores and statistics exam results

Statistics exam	1st administration			2nd administration			Statistics exam	
	N	Course	Field	N	Course	Field	N	1st year
1st year	234	0.33*	0.15*	127	0.47*	0.20*	127	1*
2nd year	102	0.23*	0.14*	115	0.31*	0.20*	115	0.45*
3rd year	78	-0.03	-0.01	88	0.22*	0.07	88	0.26*
5th year (dissertation)	72	0.09	0.04	83	0.03	0.23*	83	0.19

* Correlation is significant at the 0.05 level

Relationship Between Students' Attitudes Toward Statistics and Long-Term Performance

The *Course* subscale scores of the second administration showed a statistically significant correlation with the third year statistics exam results ($r = .22$, $p = .04$), whereas the *Field* subscale scores did not show such a correlation ($r = .07$, $p > .05$). It is important to notice that we have to be careful with the data from the third year statistics exam results because this course involves group work as evaluation and each member of a group gets the same grade. Concerning the dissertation grade the *Course* subscale scores of the second administration did not show a significant correlation ($r = .03$, $p = .53$) but The *Field* subscale scores did show a statistically significant correlation with the dissertation grades in the fifth year ($r = .23$, $p = .04$).

Contrary to what happens in the short-term results, the correlation of the *Field* subscale scores with the dissertations grades at the second administration ($r = .23$, $p = .04$) was higher than the correlation between the first year exam results and the dissertation grade ($r = .19$, $p = .08$). In other words, the affective measure was a better predictor of the dissertation grade than the cognitive measure. However, the test for comparing correlated correlation coefficients provided by Meng, Rosenthal and Rubin (1992) shows that this difference between the correlations was not significant ($Z = 0.31$, $p = 0.48$).

Relationship Between Students' Attitudes Toward Statistics and General Exam Results

Except for the first administration of the *Course* subscale and the first year total grade ($r = .16$, $p = .02$), this study did not yield a statistically significant correlation between the ATS scores and the short- and long-term general exam results. The first year general exam result, however, correlated significantly with most of the following general exam results.

DISCUSSION

The analysis of the relationship between the ATS scores and short-term statistics exam results complemented findings obtained by other authors (see Table 1), namely that especially attitudes toward the course are related to short-term exam results. This relationship was higher for the second administration, showing that the attitudes after experiencing the statistics course are more strongly related to exam results. Harvey *et al*. (in Mvududu, 2003) suggested as an explanation that a supportive atmosphere in the course could help performance, regardless of the attitudes toward the field. Besides, an inspection of the items of the ATS reveals that a feeling of self-confidence toward the course plays an important role for the *Course* subscale items. Especially in the beginning of the curriculum, we expect this feeling of self-confidence to have an important impact on the performance and thus on the observed correlation.

The most important findings emerged from the comparison of the influence of the different attitudes on exam results at the beginning and the end of the curriculum. Whereas for short-term exam results, attitudes toward the course (always) yielded a better prediction than the attitudes toward the field, attitudes toward the field yielded a better prediction of the fifth year dissertation grade than the attitudes toward the course (at the second administration). In our opinion, this only happened for the second administration because the course in the first year consists of a statistical and a methodological component. In the beginning of their first year, students may spontaneously ignore the methodological component when thinking intuitively about the course, and they were not explicitly instructed to think of this methodological component when fulfilling the ATS. This study showed that students who value the importance of methodology and statistics for the field of education will in general do a better dissertation. This

implies that it is important for teachers to focus in their education on the relevance of statistics and methodology for their field of research.

Furthermore, the data showed that the relationship between the attitudes toward the field after experiencing a statistics course (affective measure) and second year statistics exam results were smaller than between first year exam results (cognitive measure) and those second year exam results. This finding was similar to the results of Roberts and Bilderback (1980), who found that the measure of attitudes toward quantitative concepts was the most valid affective predictor of statistics performance (r = .35), even though a cognitive measure predicted the outcome (r = .40) with slightly higher accuracy than that afforded by the affective measure. However, the affective and cognitive measures were equally related to the dissertation grade in the fifth year, although the relationship for the affective measure was slightly (but not statistically significant) higher than the relationship for the cognitive measure. These results emphasize the important role of attitudes toward the field of statistics for long-term statistics performance and are thus in line with the Gal, Ginsburg and Shau (1997) who emphasize the important role that attitudes play in statistics education.

Results from this study also revealed that this important relationship between attitudes toward statistics and statistics performance was content-specific. The relationship between attitudes toward statistics and total exam results was not statistically significant. Therefore, further research should investigate how the attitudes measured by the ATS can be distinguished from 'general study attitudes' and how different attitude scales are related to different kinds of performance.

We are aware that some authors caution against the indiscriminate use of paper-and-pencil Likert-type scales, like the ATS, to study attitudes (e.g., Gal *et al*., 1997). Further research should extend the use of the questionnaire with other methods, focused on the description as well as the deep understanding of the underlying processes.

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