Statistical reasoning and its relationship to attitudes towards statistics and achievement

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1. Introduction

This research is motivated by 'new' methods of learning statistics that emphasize active learning, and the need for research on the effects of the introduction of these new methods on student learning, their reasoning abilities and attitudes towards learning statistics (Chance & Garfield, 2002). In order to contribute to this research, we will develop a structural equation model (SEM) that relates learning achievement, attitudes and reasoning abilities amongst a large group of about 1000 students that participate in three quantitative methods courses in the first year programs of the studies economics and business of the University of Maastricht. These programs are problem-based.

2. Attitudes and beliefs

Several reasons exist to consider the role of attitudes and beliefs about statistics in statistics education (Gal et al, 1997): their influence on the learning and teaching of statistics (process consideration), their role in influencing students' statistical behaviour after leaving university (outcome considerations) and the willingness of students to elect statistics courses (access considerations). To assess students' attitudes, we applied Schau et al's (1995) Survey of Attitudes Towards Statistics, SATS, that contains four scales: Affect, Cognitive Competence, Value, and Difficulty (Dauphinee et al, 1997).

3. Statistical reasoning

Researchers of the NSF-funded ChancePlus Project developed an objective instrument for assessing the reasoning abilities statistical of students: the SRA (Garfield 1998). The SRA is a multiple-choice test consisting of 20 items. Each item describes a statistics or probability problem and offers several choices of responses, both correct and incorrect. Most responses include a statement of reasoning, explaining the rationale for a particular choice. Both types of correct reasoning are included in the SRA, such as reasoning about data, about representations of data, about statistical measures, about uncertainty of samples, and about association, as types of incorrect reasoning are identified, such as misconceptions involving averages, 'outcome orientation', 'good samples have to represent a high percentage of the population', the 'Law of small numbers', the 'representativeness misconception', and the 'Equiprobability bias'.

4. Structural equation model

SRA and SATS were both administered in the first week of the first of three quantitative methods courses, covering most of the first year program. Of these courses introducing students into mathematics and statistics, different achievements were collected: final exam results, bonus achieved for homework and bonus for participating in quizzes. For both attitudes data, reasoning data and achievements, measurement models were developed, and subsequently a full structural model relating all types of data was estimated (see figure 1). Main conclusions of this research are: the complete absence of any relation between attitudes and reasoning abilities; a very weak relationship between these variables and achievements; and: although the impact is not strong, whilst attitudes towards statistics has its strongest relation with achievements on statistics, statistical reasoning abilities are stronger tied to math outcomes than to statistics outcomes.

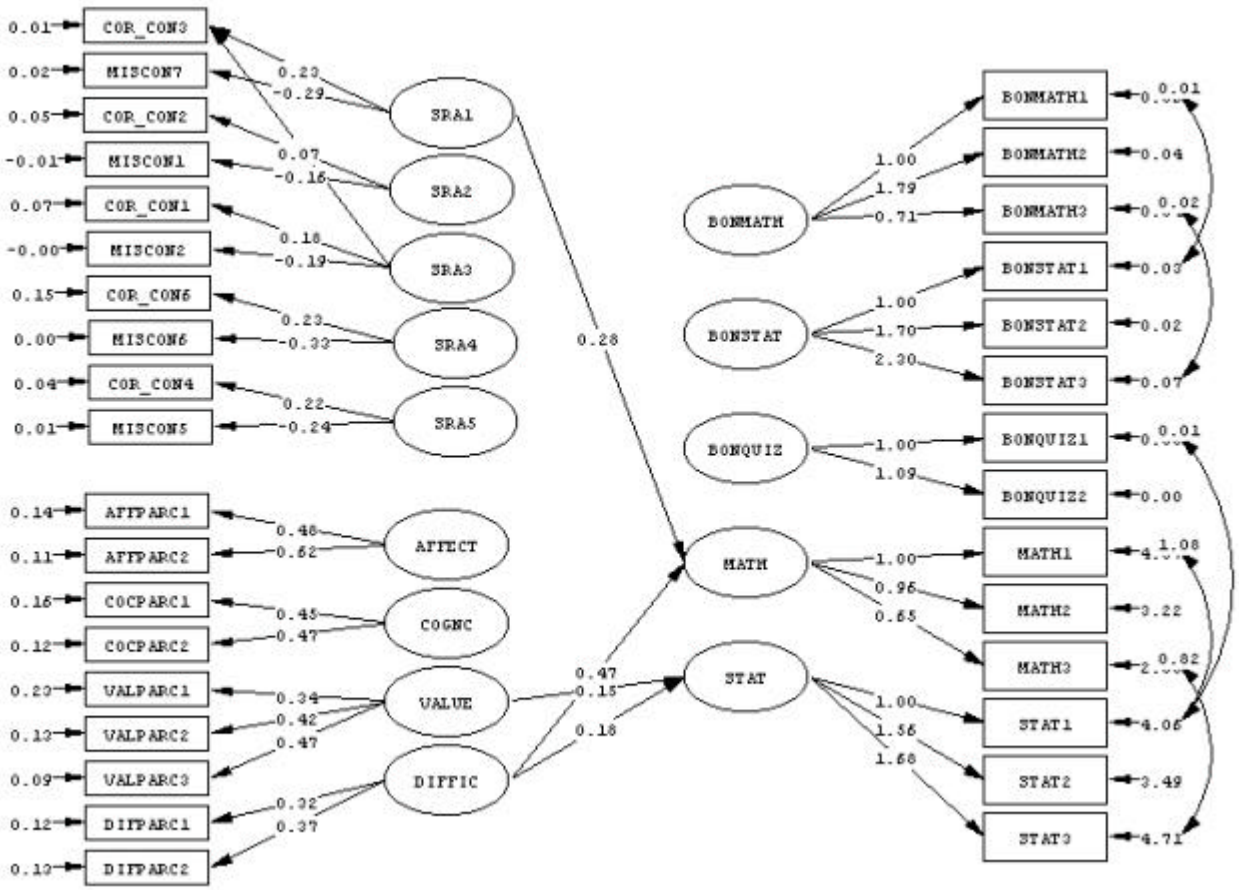

Figure 1. Structural equation model relating Attitudes, Reasoning abilities and achievements

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RÉSUMÉ

La présente étude examine la relation entre les attitudes des étudiants envers statistiques, leur capacités de raisonnement et leur performance dans un cours d'introduction en statistiques.