CULTURAL DIVERSITY IN STATISTICS EDUCATION: BRIDGING UNIQUENESS

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Learning does not take place in a vacuum. Culture, individual and social background influence how we learn. Differences in learning styles have always existed, but in recent years the emphasis has shifted to the cultural background of these differences. College students with different cultural backgrounds taking introductory statistics face a special challenge: besides employing growing differences in learning styles they also have different entrance levels. This results from a diversity in mathematics preparation during high school; it puts an extra burden on teachers taking into account these differences. Besides giving an overview of the current state of literature on this topic, this paper describes the results of an analysis of a recent Dutch study aiming to provide an insight in cultural differences in learning styles, attitudes and goal setting.

INTRODUCTION

When Vere-Jones (1995) discussed his view on the future of statistics teaching, he questioned whether an international organization such as IASE would be capable of serving the needs of such a diversity of teachers all over the world. He, however, did not specifically mention the cultural diversity in classrooms that teachers came to face in more recent years. At ICOTS7 the number of papers discussing any topics concerning *internationalization* (not cultural diversity) only mounted to 17% (Smith, Reid & Petocz, 2009). Although research on *cultural diversity* in statistics education is still in its infancy, a growing body of literature discusses aspects of the cultural diverse statistics classroom. This paper gives an overview of recent studies on cultural diversity in the statistics classroom (mainly emerging from similar research in mathematics education), focusing on learning styles, learning attitudes, and goal setting, asking the question to what extent these antecedents of learning differ across nationalities. In doing so, our definition of 'culture' is taken from Hofstede's notions: "Culture is the collective programming of the mind that distinguishes the members of one group or category (or nation) of people from others" (Hofstede, 2011). Cultural *diversity* is then defined as the recognition of cultural differences across nations and regions.

As the focus of this study also lies on cultural differences in *learning styles*, - *attitudes*, and *goal setting*, it is defined as the combination of dispositions and activities students deploy, the way in which they structure their learning, their perception of learning and their study-motivation. This is a broader concept than just learning strategy: activities a person deploys to attain, integrate and apply knowledge (Vermunt, 1992).

The Culturally Diverse Statistics Classroom

There is a wealth in educational studies on 'cultural diversity in higher education', with diverse foci on classroom management, teaching- and learning styles, learning strategies and - outcomes (e.g. Campbell, 2000, Joy & Kolb, 2009). Until recent years, studies in statistics education largely ignored the cultural dimensions in the classroom. This focus recently changed due to shifts in the organization of European higher education (Bologna), and the growing international outlook of students on their program. As the first results from studies into the culturally diverse statistics classroom are expected soon, the best way to start the description of developments in this area is to look at mathematics education. Studies on cultural diversity in mathematics education focus on a variety in topics, such as teaching mathematics in multicultural elementary classrooms (Esmonde & Caswell, 2010), teaching practices in Latin America (Sorto, 2010), curricular issues in China and the United States (Cai & Ni, 2011) and theoretical notions on culturally situated knowledge (and the problem of knowledge transfer; Lerman, 1999).

In statistics education, research results with regard to cultural differences are scarce, with contributions from Clark (2006), Davidovitch et al. (2012), Maizam (2009), Mvududu (2003), Sisto (2009), Smith, Reid & Petocz (2009), Tempelaar, Rienties, Giesbers, & Schim van der Loeff

(2012), and Wagler & Lesser (2011). It seems as though most teachers have adapted to cultural diversity in their statistics classroom, without so much adding the concept to their research models.

Studies on cultural diversity in statistics education cover a wide range of topics, from teacher teaching programs for indigenous and migrant students (Clark, 2006) to learning styles and differences in high school preparation for university (Tempelaar et al., 2012). As Smith et al. (2009) notice, most papers focus on curriculum or justice issues. As papers from more developed countries have a tendency to discuss international issues, papers from less-developed countries more likely discuss intra-national problems or advocate local initiatives. Another distinction found is the one between European and global developments, pointing at the recent European developments in higher education (Bologna). Sisto (2009) discusses the implementation and evaluation of statistics group projects as a teaching method in a multicultural context, thereby focusing on recommendations for teachers. Cultural diversity is mainly addressed as differences in expectations among students doing group work. Wagler & Lesser (2011) emphasize the aspect of enabling students with a diverse background to enter the statistics courses. They describe different types of diversity that both students and teachers face, among which ethnicity, gender and native versus immigrant students. Their recommendations focus on adapting teaching methods to this diversity, especially for English language learners. However, they refrain from using Hofstede's distinction. Already at the start of the century, Mvududu (2003) recognized the need to study attitudes toward statistics and learning environments across cultures, in order to gain insight in statistical pedagogy. He, however, only compared two countries (Zimbabwe and the United States), using a constructivist approach.

As far as we know, Tempelaar et al. (2012) are the first to investigate the role of cultural dimensions in regards with a range of learning dispositions and achievement. Using Hofstede's cultural dimensions they offer an insight in high school preparation, transition - and adjustment problems, motivation, attitude and achievement of students from a diverse cultural background, thereby focusing on blended learning as a tool to adapt to this diverse inflow of students. They discuss the overall concern that students entering university with a different cultural background are ill prepared for academic life and as a result their academic performance is affected. In a similar tradition, this study aims to investigate cultural variability in a range of learning dispositions, all known to be important antecedents for achievement in statistics education.

Hofstede's Cultural Dimensions

While the original aim of Hofstede's research was to investigate the impact of cultural differences on leadership styles, the cultural dimensions identified by Hofstede appeared to impact learning- and teaching styles as well: see e.g. Hofstede (1980, 1986), Hofstede, Hofstede & Minkov (2010), Joy and Kolb (2009). Cultural dimensions distinguished by Hofstede are power distance, indicating the extent to which an unequal division of power is accepted; Individualism vs. collectivism, indicating the looseness of ties, or the degree of integration; Masculinity vs. femininity, where gender roles are distinct or overlapping; Uncertainty avoidance, referring to tolerance to uncertainty and ambiguity; and long-term vs. short-term orientation, indicating the degree to which one is directed towards future rewards or more present needs and wants.

In particular, the masculinity – femininity difference happens to play a strong role in regard with learning- and teaching styles. Where in strongly masculine countries - like Germany and Japan - education is characterized by competition, openly striving for excellence, taking the best students as the norm and regarding failure as a disaster, in feminine countries - like the Netherlands and Nordic European countries - the average student is the norm, excellence is something one keeps to oneself and failure is at most an unlucky incident, but better useful feedback for a next step in learning (Hofstede et al., 2010). Other cultural aspects play less pronounced roles. Long-term orientation is a general virtue that also pays off in educational situations: using international comparative studies into the state of educational affairs, Hofstede et al. (2010) conclude that long-term orientation most and for all impacts performance in mathematics education (of which statistics forms part of). In collectivist societies, learning is seen as a onetime process for young people who learn primarily how to do things in order to participate in society, with diplomas and certificates being of great importance, in contrast to individualistic societies, where learning is more focused on learning how to learn (Hofstede et al., 2010). Moreover, students from strong uncertainty-

avoidance countries - like Germany - prefer structured learning situations with precise objectives, detailed assignments, and teachers in the role of experts. In contrast, in weak uncertainty-avoidance countries - as again the Netherlands and the Nordic European countries - the teacher may say 'I do not know', learning situations tend to be open-ended, assignments more broad, and objectives more vague (Hofstede et al., 2010).

        Recently, Hofstede's framework for cultural differences has been refined in a series of studies of the GLOBE (Global Leadership and Organizational Effectiveness) research program: House, Hanges, Javidan, Dorfman, and Gupta (2004). The GLOBE project identified culture clustering into the *ten* cultural regions: Germanic Europe, Nordic Europe, Eastern Europe, Latin Europe, Anglo, Middle East, Southern Asia, Confucian Asia, Latin America, and Sub-Saharan Africa.

Vermunt's Learning Styles

        The Inventory of Learning Styles (ILS; Vermunt 1998) has been used to assess preferred learning approaches. In his learning styles model, Vermunt distinguishes four domains or components of learning: *cognitive processing strategies,* metacognitive regulation strategies, learning conceptions or mental models of learning, and learning orientations, of which we apply the first domain. Using the sub-strategies, three main cognitive processing strategies of learning were composed: the Deep Learning strategy (sub-strategies Relating & Structuring and Critical Processing), the Stepwise Learning strategy (sub-strategies Memorizing & Rehearsing, and Analyzing; also sometimes referred to as surface learning) and the Concrete Learning strategy (also called strategic learning).

Schau's Attitudes Towards Statistics

        Attitudes or achievement motivations toward the subject statistics based on Eccles' expectancy-value theory (Eccles, 2005), are measured with the instrument Survey of Attitudes Toward Statistics (SATS) developed by Schau and colleagues (1995; also see Dauphinee, Schau, & Stevens, 1997; Hilton, Schau, & Olsen, 2004). Expectancy-value models take their name from the key role of two components in the motivation to perform on an achievement task: students' expectancies for success, and the task value, that is the value they attribute to succeeding the task. The SATS instrument measures five aspects of post-secondary students' subject attitudes: two expectancy factors that deal with students' beliefs about their own ability and perceived task difficulty: Cognitive Competence and Difficulty (in fact: lack of…), and three subjective task-value constructs that encompass students' feelings toward and attitudes about the value of the subject: Affect, value and interest. A sixth scale, effort, is hypothesized to represent the outcome of the interplay of expectancy and value constructs in the model.

Elliot's Achievement Goals

        In the 2*2 achievement goal model, different facets of goal setting are distinguished based on different definitions (mastery versus performance) and different valence dimensions (approach versus avoidance; Elliot & Murayama, 2008). Combining these two facets leads to four different types of achievement goals: mastery-approach (attaining task-based or intrapersonal competence), performance-approach (attaining normative competence), mastery-avoidance (avoiding task-based or intrapersonal incompetence), and performance- avoidance (avoiding normative incompetence).

DESIGN AND PROCEDURE

        For this empirical study, data from a student survey held in 2012/2013 and 2013/2014 at a Dutch University (Maastricht) were used ($N = 1,985$). Business and economics students enrolled in introductory statistics courses filled in a range of surveys, among which the SATS (Schau et al., 1995), the ILS (Vermunt, 1998), and AGQ (Elliot & Murayama, 2008). For all these learning dispositions, scale scores were computed and validated using Cronbach's alpha. Then the computed learning dispositions were compared (using univariate GLM) across nationality's using the GLOBE clustering of countries (House et al., 2004), whereby regions with $n<20$ were excluded, and two additional regions were introduced: Netherlands and Belgium. Eta-values were computed for effect size.

RESULTS

Attitudes toward statistics exhibit patterns amongst cultural regions. Dutch and Scandinavian students score high in Affect, Cognitive Competence, and especially, lack of difficulty: see Figure 1, where relative positions of each of the cultural regions on any learning disposition is expressed as a z-score. Confucian students take the opposite position: low in most attitudes, except for their willingness to exert a lot of Effort in learning statistics.
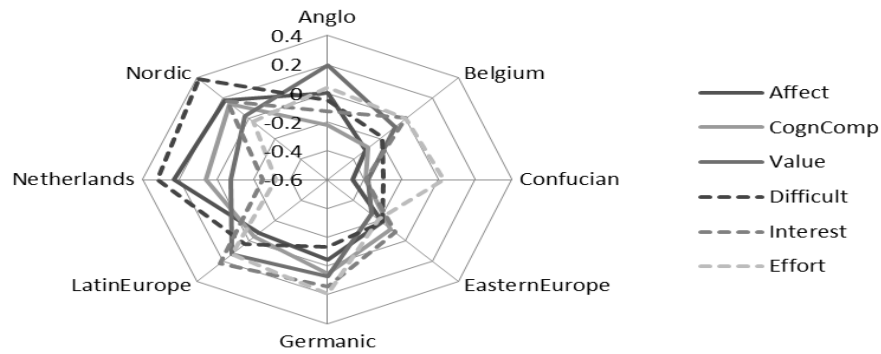
Figure 1. Attitudes towards statistics (SATS) by cultural region

Figure 2 tells the story of learning strategies. First of all, the same three regions call attention, be it that patterns seem to be reverse. Dutch and especially Nordic students stand out by having no clear profile in terms of learning strategies: for all alternative learning strategies, they score below average of the international student body. Confucian students stand out in having a clear learning strategy profile, directed toward stepwise learning. Additionally, students from Latin and Eastern Europe show a clear pattern that points toward concrete learning.
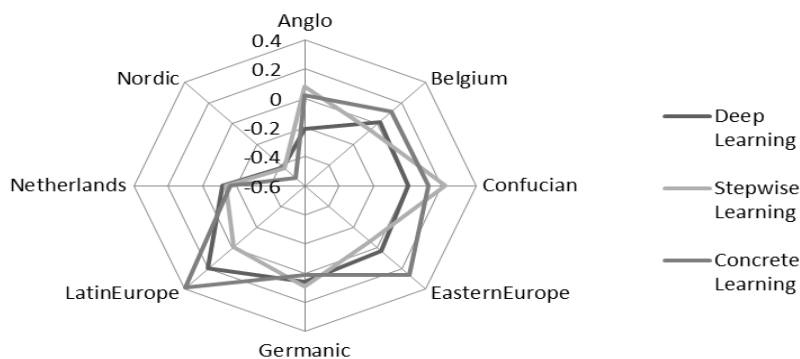
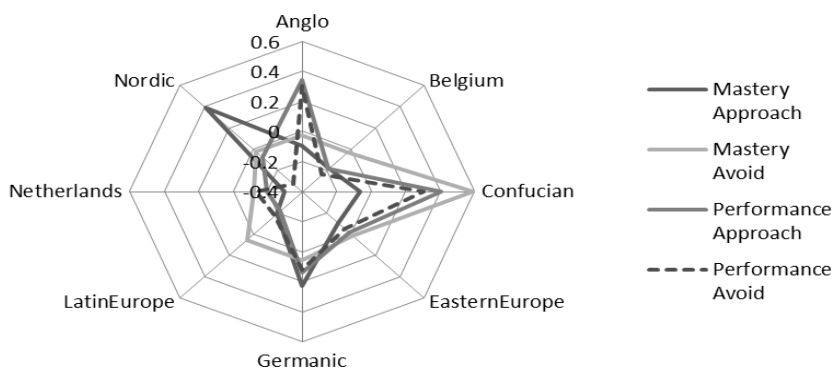Figure 2. Processing strategies for learning (ILS) by cultural region

Figure 3. Achievement goals (AGQ) by cultural region

The largest differences across cultures, both in size and pattern, can be found in goal setting as shown in figure 3. Once more, Nordic and Confucian students seem to be in opposite poles. Nordic students are strong in mastery approach, low on all other approaches. Figure 3 further shows that Confucian students are high in both performance approaches and especially, mastery avoidance. Belgium and (again) Dutch students show no clear goal setting approach. Table 1 provides the outcomes of ANOVA's, at most indicating modest individual effect sizes, stressing the importance of the patterns in dispositions.

Table 1. Results ANOVA for differences in learning dispositions across cultural regions

	F	p	Eta^2
Deep Learning	2.72	0.008	0.010
Step wise Learning	3.22	0.002	0.012
Concrete Learning	5.81	0.000	0.022
Affect	7.77	0.000	0.029
Cognitive Competence	3.56	0.001	0.013
Value	3.19	0.002	0.012
Difficulty	12.16	0.000	0.045
Interest	8.86	0.000	0.033
Effort	13.89	0.000	0.051
Mastery Approach	15.70	0.000	0.057
Mastery Avoidance	2.48	0.016	0.009
Performance Approach	12.66	0.000	0.030
Performance Avoidance	6.21	0.000	0.023

CONCLUSION

Impacts of cultural diversity are modest when looked at from the perspective of individual dispositions. Although these results seem to be in accordance with findings by Joy & Kolb (2009, p. 79), they may explain the circumstance that it attracted little attention in statistics education so far. However, taking all these differences together, strong patterns become visible that deserve our undivided research attention in the near future.

Although many local initiatives shown so far can serve as examples of good practice (e.g. Clark, 2006; Davidovitch et al., 2012; Sorto, 2010), research in statistics education needs to broaden its view to the application of instructional tools that enable students to personalize their learning and, among other things, bridge cultural differences. Centering research around the relation of such tools with learning behavior, motivation and achievement (Tempelaar et al., 2012) will enable statistics teachers (and educational developers) to pay proper attention to cultural differences in their courses.

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