# International issues in education

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**Abstract**

*Anxiety, negative attitudes, and attrition are all issues presented in the teaching of statistics to undergraduates in research-based degrees regardless of location. Previous works have looked at these obstacles, but none have consolidated a multilingual, multinational effort using a consistent method. Over 400 Spanish-, English-, and German-speaking undergraduate students enrolled in introductory psychology statistics courses were given the Composite Survey of Statistics Anxiety and Attitudes to determine the precursors and effects of existing problems. Results indicated that student background was heavily linked to attitudes and anxieties. The measure was supported as a viable method for more than one class or university in addressing issues in statistics education, developing interventions to improve students' experiences, and then determining the success of those changes.*

WITH THE growing importance of statistics education in various academic programs of all types (Bandalos, Finney & Geske, 2003), it is necessary to examine the issues surrounding the teaching and learning of statistics (Batanero, 2004). Specifically at the post-secondary level, where universities now have the obligation both to educate students and prepare them for professional work (Bakker, Chance, Jun & Watson, 2004), obstacles preventing students from achieving statistical literacy, obstacles like anxiety, cognitive deficits, poor attitudes, should be addressed (Ben-Zvi & Garfield, 2004).

While a range of anecdotal solutions to obstacles have been presented by long-time statistics educators (i.e. Gelman & Nolan, 2002; Wainer, 2005), they are generally presented based on beliefs of the teacher that certain methods will better assist their students and not on any empirical data (Bartsch, 2006). Other attempts have targeted overall appeal, by implementing presumptively engaging activities on the first day of the course (Henslee et al., Burgess & Buskist, 2006). Yet, all of these attempts have been based on impressions instructors have taken from students and were not built to address known problems in teaching statistics. While the impression educators have taken from student sentiment may, in fact, be accurate (Gal & Ginsburg, 1994), a specific issue must be targeted for interventions to work beyond a single classroom.

Two commonly addressed issues in statistics education are statistics anxiety and attitudes toward statistics, noted as the most pertinent issues to address in teaching statistics (Blalock, 1987) These have been linked to negative outcomes, such as poor performance and avoidance of statistics (Zeidner, 1991).

Statistics anxiety is a unique construct from mathematical anxiety (Baloğlu, 1999). It has been linked with a variety of negative outcomes in various degree programmes (Onwuegbuzie & Wilson, 2003), particularly research-based areas such as psychology (Tremblay et al., 2000). Though it may be linked with other anxieties, it is specifically the negative reaction to anything involving statistical information, computation, or interpretation in both academic and practical situations (Cruise et al., 1985; Onwuegbuzie & Daly, 1999).

Attitudes toward statistics have generally been noted by reactions of both students and educators in the subject (Garfield et al., 2002). These attitudes are the response to

how individuals experience statistics (Gal et al., 1997). Like statistics anxiety, a variety of measures exist to gauge these feelings.

While tests for statistics anxiety exist, the Statistics Anxiety Rating Scale (STARS; Cruise & Wilkins, 1980) was the first created solely to address this particular phenomenon. Other measures, such as the Revised Mathematics Anxiety Rating Scale (Plake & Parker, 1982) and the Statistics Anxiety Inventory (Zeidner, 1991), were developed either as a link to mathematical anxiety or as single-use measures for a particular study. Furthermore, validity scores of the STARS have shown the six subscales (worth of statistics, interpretation anxiety, test and class anxiety, computation self-concept, fear of asking for help, fear of statistics teachers) are best suited to address the potential aspects of the problem (Baloğlu, 2002).

The Survey of Attitudes Toward Statistics (SATS; Schau et al., 1997) has demonstrated that the multi-dimensional (four) model it provides (affect, cognitive competence, value, difficulty) is the most reliable measure available (Schau, 2003). While the Attitudes Toward Statistics Questionnaire and Statistics Attitude Survey do address similar topics, the lack of unique factors means they do not cover all necessary variables in their assessment (Gal et al., 1997). This addresses more possible factors, whereas others only focus on single or two-dimensional approaches.

Many previous studies have utilised both STARS and SATS – some even concurrently (Nasser, 2004) – but few potential antecedents, externalities, or personal characteristics (aside from gender and previous mathematics experience) which may contribute to the issues in developing statistical literacy are addressed in either. Many untested suggestions of likely causes of negative attitudes and statistics anxiety exist (i.e. Haynes, Mullins & Stein, 2004), such as family background, previous statistics experience, workload, and expectations.

Whilst statistics anxiety and attitude literature has been produced from all over the world, a joint effort of educators from different universities, nationalities, and languages in a single, extrapolatory study is lacking. For any intervention to be applicable beyond a situational context, broad measurement must first take place. Given that much of the previous work in the area has been undertaken in English- and Spanish-speaking locations, American, British, and Spanish universities might provide an appropriate first sample. German-speaking universities also highlight the importance of statistics in the social sciences while providing diverse populations of students.

Potential cultural differences were expected to vary the results somewhat, it is still important to compare these findings in order to address the problem from a perspective that all may benefit. Due to diversity within and between universities of students and educators alike, all research in the area of statistics education will face the predicament of lacking homogeneity (Ben-Zvi & Garfield, 2004). To address this, analyses will take into account the specific items relating to student background when determining differences and similarities are presented.

Based on the issues in teaching statistics to undergraduate psychology students, the lack of an internationally consistent measure, and the need for changes to improve the course, the goals of this particular work were fourfold:

1. Create an internationally reliable testing measure to address issues in statistics education.
2. Identify similarities and differences in statistics education between multiple locations.
3. Find potential causes for the obstacles found in statistics education.
4. Encourage other research-based institutions to consider issues in their own curriculum in order to improvement the development of future researchers.

## Method

*Instrument*

The Composite Survey of Statistics Anxiety and Attitudes (COSSAA) is a combination of the previously developed Survey of Attitudes Toward Statistics (SATS) and Statistics Anxi-

ety Rating Scale along with questions to tap into a range of demographic factors, previous experiences, and expectations of statistics. It includes:

- academic level;
- age;
- gender;
- first language;
- awareness of statistics in degree programme;
- expectation of success;
- family background in degree subject;
- non-traditional student (i.e. mature, international);
- class size preference;
- statistical relevance to subject;
- secondary school mathematics;
- confidence in statistical thinking;
- expectations of statistics course; and
- professor influence.

The original language of both the STARS and SATS is English, as was the completed COSSAA. The composite tool was translated by a bilingual native Spanish speaker and then checked for fidelity by the first author (bilingual, English) and distributor (bilingual, Spanish). A similar process was used for the German version, using two bilingual (German-English, one native speaker of each) academic interpreters.

*Participants*

Undergraduate psychology students from a medium public university in Spain, large universities in both the United Kingdom and Austria, and a small private college in the United States were asked to complete the Composite Study of Statistics Anxiety and Attitudes. In total, 463 participants (73.2 per cent female) ranging in age from 17 to 52 ($M = 20.9$) from all undergraduate levels took part. All students were asked to take part during their statistics lectures or tutorials. Of the entire sample, only five students were not enrolled in courses taught in their native language.

*Procedure*

In order to assess if issues in teaching statistics were prevalent regardless of the location, timing, and educator, students from each location completed the COSSAA at different points in their academic calendar. English-speaking collections were done at the beginning of the term, before any statistics teaching was undertaken. German and Spanish versions were collected in the middle of the academic year, immediately before and after winter vacation periods, respectively. All students were instructed to answer every question honestly and were given no time constraints to do so, though most needed between 15 and 20 minutes to complete the 103 questions.

## Results

*Personal background*

Family background in research did not heavily influence even with 15.4 per cent of participants fitting that category, it was not a

| Nationality (participants*) | % Female | Mean age |
|---|---|---|
| Spanish (85) | 79.3 | 21.63 |
| British (196) | 71.9 | 20.66 |
| American (42) | 66.7 | 20.35 |
| Austrian (104) | 82.7 | 20.86 |
| German (27) | 51.9 | 21.15 |
| Other** (5) | 100.0 | 21.20 |

**Table 1:** Participant information: Sample size, nationality, gender and age. Note: *Some students did not complete the demographic section. **One participant from each Italy, Romania, Pakistan, Norway and Bosnia-Herzegovina

significant predictor of any of the scales of statistics anxiety or attitudes. Age was an equally insignificant factor, accounting for no significant results in any of the ten subscales.

While academic level did was a predictor four of the STARS subscales, it did not account for even 4 per cent of the variation in any, and was not a significant predictor in any SATS factors.

| University | Percent aware |
|---|---|
| Austria | 71.4 |
| Spain | 14.1 |
| USA | 57.1 |
| UK/Ireland | 46.4 |

**Table 2:** Student awareness of statistics in psychology

| | Relevance | N | Mean | Mean difference | SD | t | df | p (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| Daily statistics confidence | Yes | 424 | 3.03 | .804 | .904 | 5.031 | 457 | <.001 |
| | No | 35 | 2.23 | | .973 | | | |
| Statistics are useful | Yes | 425 | 3.08 | .835 | .907 | 5.329 | 459 | <.001 |
| | No | 36 | 2.25 | | .841 | | | |
| Statistics are enjoyable | Yes | 425 | 2.40 | .535 | 1.126 | 2.799 | 460 | .005 |
| | No | 37 | 1.86 | | .976 | | | |
| Statistics are difficult | Yes | 425 | 3.60 | −.341 | .941 | −2.110 | 460 | .035 |
| | No | 37 | 3.95 | | .970 | | | |
| Confidence in mastery | Yes | 419 | 4.75 | .997 | 1.509 | 3.856 | 454 | <.001 |
| | No | 37 | 3.76 | | 1.498 | | | |
| Worth of statistics | Yes | 425 | 37.49 | −12.533 | 11.391 | −6.456 | 460 | <.001 |
| | No | 37 | 50.03 | | 10.516 | | | |
| Interpretation anxiety | Yes | 425 | 27.36 | −4.716 | 8.617 | −3.249 | 460 | .001 |
| | No | 37 | 32.08 | | 6.487 | | | |
| Test and class anxiety | Yes | 425 | 24.70 | −4.655 | 6.961 | −3.977 | 460 | <.001 |
| | No | 37 | 29.35 | | 5.023 | | | |
| Computation self-concept | Yes | 425 | 18.00 | −3.160 | 6.296 | −2.970 | 460 | .003 |
| | No | 37 | 21.16 | | 5.053 | | | |
| Fear of asking for help | Yes | 425 | 8.84 | −1.507 | 3.759 | −2.322 | 460 | .021 |
| | No | 37 | 10.35 | | 4.098 | | | |
| Affect | Yes | 425 | 24.59 | −3.545 | 7.493 | −2.773 | 460 | .006 |
| | No | 37 | 28.14 | | 7.020 | | | |
| Cognitive competence | Yes | 425 | 20.70 | −2.893 | 6.807 | −2.512 | 460 | .012 |
| | No | 37 | 23.59 | | 5.595 | | | |
| Value | Yes | 425 | 29.38 | −11.567 | 8.894 | −7.504 | 460 | <.001 |
| | No | 37 | 40.95 | | 10.088 | | | |

**Table 3:** Impact of finding statistics relevant to psychology

Though 63.7 per cent of students did indicate they would have preferred a smaller class size for instruction, this was not a significant factor in 8 of the ten subscales, and accounted for less than 2 per cent of the variation in fear of statistics teachers and difficulty.

*Expectations*

On the whole, many students did not anticipate doing statistics in their course, with only 49.1 per cent indicating an awareness of it. However, 86.3 per cent expected to succeed at introductory statistics, which meant there was an overlap of students who did not anticipate statistics but did not see that as a barrier to success.

Though the overwhelming majority of students did see the relevance of statistics to their area, the 8.0 per cent who did not had equal or lower expectations and confidence, higher anxiety levels, and more negative attitudes toward statistics.

Confidence played a considerable role in both anxiety and attitudes, as it accounted for a significant amount of variance in all ten of the subscales.

*Statistics anxiety*

Aside from the fear of asking for help, subscales varied heavily between countries. However, *post hoc* tests showed these differences were typically between one extreme group per subscale, and not necessarily between the entire group.

*Attitudes toward statistics*

Much like the statistics anxiety subscales, all attitude subscales varied based on location.

Similarly, these variations were consistently traced back to a single extreme location.

*Teacher influence*

The amount of influence a teacher had on the experience of a course varied between universities; $F(2,266) = 3.065$, $p = .05$. Additionally, this was significantly associated with six of the ten anxiety and attitude subscales, generally at a weak to moderate level.

## Discussion

The overall finding of the research indicates that issues – statistics anxiety, negative attitudes, etc. – involving undergraduate students' learning of statistics can be found

| | R | R-square | Adjusted R-square |
|---|---|---|---|
| **Statistics anxiety** | | | |
| Worth of statistics | .614 | .378 | .375 |
| Interpretation anxiety | .519 | .269 | .266 |
| Test and class anxiety | .553 | .306 | .303 |
| Computation self-concept | .676 | .456 | .454 |
| Fear of asking for help | .290 | .084 | .080 |
| Fear of statistics teachers | .355 | .126 | .122 |
| **Attitudes toward statistics** | | | |
| Affect | .656 | .430 | .427 |
| Cognitive competence | .675 | .455 | .453 |
| Value | .571 | .326 | .323 |
| Difficulty | .371 | .138 | .134 |

**Table 4:** Regressions: Confidence

| | F | *p* |
|---|---|---|
| Worth of statistics | 9.071 | <.001 |
| Interpretation anxiety | 49.917 | <.001 |
| Test and class anxiety | 30.337 | <.001 |
| Computation self-concept | 19.234 | <.001 |
| Fear of asking for help | 0.943 | <.05 |
| Fear of statistics teachers | 13.296 | <.001 |

**Table 5:** ANOVA for statistics anxiety between universities

across universities and nationalities. While specific inferences may be made about several of these aspects, the main purpose was not to determine where some areas were strong and others were weak, but to highlight the importance of the issues at hand for all.

The factors related to statistics anxiety and attitudes show quite clearly that students are, probably for a variety of reasons, having quite difficulties and negative experiences in their statistics courses. Furthermore, the background may be the reasons for those issues which need to be addressed within a course. These are both incredibly relevant findings in the light of improving student experiences in statistics education.

In order to address how to go about developing such an intervention, the feedback of the students must be considered. First, unique attention should be paid to the primary areas of concern produced. For example, as many students simply did not consider statistics of value, seeking ways to provide students incentive and motivation to learn statistics may be necessary.

Teacher influence was significantly correlated with the most important statistics anxiety subscales (Onwuegbuzie, 1997) as

| | | | Mean Difference | p |
|---|---|---|---|---|
| Worth | UK/Ireland | Austria | 5.41 | <.001 |
| | | USA | 6.35 | <.01 |
| | | Spain | 5.61 | <.001 |
| Interpretation anxiety | Austria | USA | −6.78 | <.001 |
| | | Spain | −7.47 | <.001 |
| | | UK/Ireland | −9.97 | <.001 |
| | Spain | UK/Ireland | −2.49 | 0.05 |
| Test and class anxiety | Austria | USA | −2.94 | <.05 |
| | | Spain | −6.49 | <.001 |
| | | UK/Ireland | −6.09 | <.001 |
| | USA | Spain | −3.55 | <.05 |
| | | UK/Ireland | −3.15 | <.05 |
| Computation self-concept | UK/Ireland | Austria | 4.29 | <.001 |
| | | USA | 5.38 | <.001 |
| | | Spain | 2.95 | <.01 |
| Fear of statistics teachers | UK/Ireland | Austria | 1.33 | <.01 |
| | | USA | 2.44 | <.001 |
| | | Spain | 2.42 | <.001 |

**Table 6:** *Post hoc* comparisons of statistics anxiety between universities

| | F | *p* |
|---|---|---|
| Affect | 15.691 | <.001 |
| Cognitive competence | 15.52 | <.001 |
| Value | 6.416 | <.001 |
| Difficulty | 9.454 | <.001 |

**Table 7:** ANOVA for attitudes toward statistics between universities

well as four other subscales. Thus, the teaching of the course is clearly something which must be addressed. However, a more focused attempt to determine how teaching influences these constructs is necessary. Also, as the expectations of students clearly played a role in their experience of the course, the role teaching may play in improving these should also be investigated.

If students are actually affected by their awareness – or lack thereof – then this must be addressed immediately. Whether the responsibility for this is upon the university or the secondary school likely depends on the location. As this problem is generally found at the university level, it is likely the first step must come from there. However, if secondary school counsellors are responsible for guiding students as they select tertiary academic degrees, then they automatically qualify as primary sources of providing that awareness. Furthermore, universities have an obligation to admit students who are capable of succeeding in their course, thus they should also be expected to make the statistics requirement known.

Anxiety and attitude improvements have been attempted in the past. While many published interventions to improve statistics education do exist, they primarily address classroom-specific issues. This is a problem in that not all of these strategies are practical for more than a very similar situation (i.e. small class size, social science-only students) which provides a comparable target group. Furthermore, almost none of these studies provided control groups, before and after results, nor standardised testing measures.

*Sample differences*

There was a lack of homogeneity between the groups tested. Each university had very different sizes of students enrolled in the course, thus varying heavily the number of participants from each. This clearly affects the extent to which results can be compared.

Three concepts which were not addressed specifically by the COSSAA were culture, timing, and educators. The basics of these

| | | | Mean Difference | p |
|---|---|---|---|---|
| Affect | UK/Ireland | Austria | 4.90 | <.001 |
| | | USA | 5.04 | <.001 |
| | | Spain | 3.70 | <.001 |
| Cognitive competence | UK/Ireland | Austria | 3.07 | <.001 |
| | | USA | 5.31 | <.001 |
| | | Spain | 4.58 | <.001 |
| Value | UK/Ireland | USA | 5.79 | <.01 |
| | | Spain | 3.69 | <.01 |
| Difficulty | Austria | USA | 3.88 | <.01 |
| | | Spain | 3.97 | <.001 |
| | UK/Ireland | USA | 3.32 | <.01 |
| | | Spain | 3.40 | <.001 |

**Table 8:** *Post hoc* comparisons of attitudes toward statistics between universities

| | Teacher influence | |
|---|---|---|
| Worth of statistics | Pearson correlation | −.309 |
| | Sig. (2-tailed) | <.001 |
| | N | 267 |
| Interpretation anxiety | Pearson correlation | −.128 |
| | Sig. (2-tailed) | .037 |
| | N | 267 |
| Fear of statistics teachers | Pearson correlation | −.258 |
| | Sig. (2-tailed) | <.001 |
| | N | 267 |
| Affect | Pearson correlation | −.152 |
| | Sig. (2-tailed) | .013 |
| | N | 267 |
| Cognitive competence | Pearson correlation | −.188 |
| | Sig. (2-tailed) | .002 |
| | N | 267 |
| Value | Pearson correlation | −.264 |
| | Sig. (2-tailed) | <.001 |
| | N | 267 |

**Table 9:** Relationship of perception of teacher's influence on experience in statistics and statistics anxiety and attitudes toward statistics

aspects were known (i.e. nationality or time in term), but specifics about exact influences in culture, subjects at the time of collection, and teaching style were not considered. In that these may play as much of a role in the experiences and responses to the teaching of this, or any, course, it is not sufficient to only relate student backgrounds to the result.

For the universities tested, these were three heavily different confounds. American participants each attended a small, private Midwestern college where the teacher was very much involved with students' interaction with material (i.e. teaching all lectures in a small classroom, responsible for all assessment). Students in the United Kingdom also took an English version of the survey, but did so in a very large university, where multiple lecturers handle the teaching of statistics and rarely interact with students. Spanish and Austrian students did take language-appropriate versions, but were in one of multiple statistics courses required of their degree, whereas English-speaking students were tested at the onset of their first course. Any of these could clearly influence differences in the results.

Another possible issue was the question of teacher influence. As the question was not included in the British university edition, many of the possible differences in the way the course was taught could not be examined to determine how it impacted student views of teachers.

The major drawback of this sample problem is the possibility of new biases introduced via the translated testing method. To correct this, future administrations or expansions of this study must first address and test potential biases before implementation. While this issue may not apply to yes-no and background questions, variations may indicate biases, not culture or language, are in fact the cause (Muñiz, 2004).

*Determining the relevance*

One of the main difficulties in understanding issues in statistics education is the lack of a standardised testing measure. While links have been made to poor performance in a course, it is yet to be determined if this is applicable to any type of assessment. In that curricular standards will vary even within a discipline, producing a standardised test may be superfluous. For instance, whereas psychological statistics curricula will likely address the same topics, different universities will vary in the implementation of this teaching. (i.e. handwritten formulae and calculations versus using computerised statistical programs).

Interdisciplinary standards potentially vary to an even greater degree. This may be seen when comparing a sociological course focused on demographic and interpretative learning to a biological course, which would focus heavily on sampling and distribution. In response, future work can identify what specific aspects of learning are affected by the issues presented by statistics anxiety and negative attitudes.

## Conclusion

The importance of understanding statistics to produce appropriate methodologies for research means that statistics education must become a focal point of study. Institutions of higher education must take note of this, as it is now their duty to both prepare students as future researchers and develop skills beyond their immediate focus. Though students may not particularly desire learning the subject, it is something they must do.

Forthcoming work must address negative attitudes, statistics anxiety, and expectations if it is to produce any meaningful effect. Furthermore, it must do so using standardised measures which others can use as a barometer of success for students and educators in all places. As there may be only one opportunity to provide this teaching, these improvements are urgently needed.

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