A comparative analysis of students' satisfaction with teaching on STEM vs. non-STEM programmes

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Recent Higher Education Funding Council research echoes previous findings that student satisfaction scores differ between subject areas (HEFCE, 2011). However, there remains a paucity of research attempting to account for this, and these differences have only been reported for final-year student satisfaction. It is unclear at what stage during a study programme differences in satisfaction might emerge, and satisfaction of first-year students is of particular interest because of its association with student progression and retention (Tinto, 2007). Exploratory analyses of first-year students' responses to National Student Survey (NSS) questions (N=1180) revealed that there were significant differences in students' perception of teaching and available resources depending on whether they were enrolled on a STEM subject course or not. Perhaps unsurprisingly (given funding council bands) the STEM students were more likely to agree that they had access to adequate resources. However, the non-STEM students were more likely to agree that their teachers were good at explaining material and were enthusiastic about their topic. Furthermore, the differences in the perceptions of teaching experienced by STEM versus non-STEM students varied as a function of sex of the student. The implications of these findings are that although the experience of STEM students may be bolstered by access to resources, their experience of teaching and learning (and particularly that experienced by males on STEM courses) is less satisfactory than that of non-STEM students. This finding is of particular interest in light of the increasing use of student satisfaction data to inform league tables and students' degree choice. Furthermore, these data challenge stereotypes of the experiences of males and females in STEM disciplines and have implications for how STEM teaching practitioners approach the learning experience of their students.

Keywords: *Student experience; satisfaction; NSS; retention; sex differences.*

A NUMBER of Government initiatives have recently been implemented in attempts to increase uptake in the study of STEM subjects in schools and universities, for example, National curriculum changes in 2008, and the *Science So What? So Everything* campaign launched by the Department for Innovation, Universities and Skills (DIUS, 2009). Despite the attempts of successive governments to attend to this issue, there is considerable evidence that the STEM subjects remain relatively unappealing to young people. Recent studies have found that secondary school pupils report that they are put off of studying science by the lack of clear application of their subject to professional practice and employment (Archer et al., 2010). Furthermore, there is evidence that children drop STEM subjects before post-compulsory education due to a perceived tendency toward transmissive pedagogy and unappealing teaching approaches (Lyons, 2006; Osborne, 2007).

Dwindling numbers of secondary school STEM students is a key priority in addressing the issue of a STEM graduate shortfall (CBI, 2011). However, the author argues that HE institutions (HEIs) need to ensure that they do not further contribute to the attrition of numbers of STEM graduates. There is some evidence to suggest that HE students opt out of STEM for reasons that may to some extent be in the control of HEIs. For example, Seymour and Hewitt (1997) reported that the leading reasons cited by students for switching out of undergraduate study of STEM subjects were: (1) non-STEM degrees offer a better education; (2) loss of interest in science; and (3) rejection of STEM careers. Furthermore, there is evidence from research within STEM subject fields that suggests that pedagogical issues are influential in poor retention of STEM students (Hewitt & Seymour, 1991; Olds & Miller, 2004).

One approach to identifying whether, and how, STEM teaching practices in HE might influence retention is to compare student's experiences and perceptions of STEM vs. non-STEM degree programmes via analysis of satisfaction surveys. There are large and stable satisfaction differences evident between subject groups (HEFCE, 2010). Interestingly, Surridge (2009) found that course characteristics (e.g. mode of study, RAE profile), and specifically subject area, exert larger effects on satisfaction than the characteristics of students (e.g. age, sex, ethnicity), or the institution (e.g. UCAS entry scores, size). However, to the author's knowledge there has been a lack of comparative analysis of UK students' satisfaction with STEM vs. non-STEM courses.

In an initial pilot study, Pawson (2012) compared the 2011 National Student Survey (NSS) data from STEM vs. non-STEM degree courses at 18 UK universities. Specifically, Pawson compared the mean NSS ratings for the following STEM courses at each university: psychology; electrical engineering; chemistry and maths (or maths & statistics), with the mean NSS ratings for English; History; Sociology and Law (non-STEM) at the same university. The data revealed that, in terms of students' ratings of the ability of staff to explain things and make the subject interesting, the mean non-STEM satisfaction ratings were consistently higher than those for STEM degree courses.

The current study aimed to further explore the findings reported by Pawson (2012). Specifically, it aimed to control for the possibility that the average class sizes in STEM vs. non-STEM degree courses was related to satisfaction ratings, and to explore at what stage in the degree course STEM vs non-STEM differences in student satisfaction were identifiable. Finally, the longstanding under-representation of females within STEM degree courses and careers (Ceci, Williams & Barnett, 2009) prompted an additional exploration of the potential different experiences and satisfaction of males and females studying STEM subjects.

Method

Participants

1180 undergraduate home students from a post-1992 London university completed a student satisfaction survey in the second semester of their first year of study. Biographical characteristics of the sample are presented in Figure 1 below. STEM students (*N*=583) were studying programmes in faculties of Health and Bioscience (e.g. Biomedical Science; Pharmacology); Computing and Engineering (e.g. Civil Engineering; Technology & E-Commerce) and Psychology (e.g. Psychology; Forensic Psychology).

Figure 1: Frequencies and proportions of participants by sex, age and ethnicity.

		Sex		Age Group (years)			Ethnicity			
		M	*F*	*<20*	*21–25*	*>25*	*White*	*Black*	*Asian*	*Other*
STEM	*N*=	268	315	134	204	245	163	198	122	100
	(%)	(46)	(54)	(23)	(35)	(42)	(28)	(34)	(21)	(17)
Non-STEM	*N*=	227	370	161	197	239	209	215	83	90
	(%)	(38)	(62)	(27)	(33)	(40)	(35)	(36)	(14)	(15)

Non-STEM students (*N*=597) were studying programmes in faculties of Law (e.g. Criminology and Criminal Justice; LLB); Humanities (e.g. Anthropology; Sociology) and Arts (e.g. Fine Art; Fashion Design).

Materials

The survey administered in this study was based on the National Student Survey (NSS) developed by the Higher Education Statistics Agency. The survey consisted of all 22 items deployed in the NSS, with the addition of five items pertaining to institution-specific issues (e.g. helpdesk guidance and virtual learning environment provision). Each item was scored in the same way as the NSS on a five point likert scale ranging from 1=Definitely Disagree to 5=Definitely Agree (with the inclusion of a 'Not Applicable' option). As with the NSS, questionnaire responses provided scores on six sub-dimensions: Teaching (reliability Cronbach's α=.90); Assessment (α=.82); Academic Support (α=.85); Organisation (α=.87); Learning Resources (α=.84) and Personal Development (α=.87).

Procedure

An online approach to survey distribution was adopted. All first-year students were initially emailed an invitation with an individual link to the online survey after the commencement of their second semester of study (February). Four email reminders and a further SMS message were sent to all those that hadn't completed the survey at the end of March. There was also a poster campaign across the university advertising the questionnaire, and there was an incentive of entry to a prize draw for all participants. This approach provided a 22 per cent response rate. Participants' data was fully anonymised for the purposes of this study.

Results

For the purposes of more meaningful analysis, and in a departure from the typical NSS analysis, the mean scores of the items in each sub-dimension were calculated for each individual, so that each participant provided a mean satisfaction score on each of the sub-dimensions. Mean scores for each sub-dimension by sex and STEM vs non-STEM status are presented below in Figure 2.

On the basis of previous analyses of NSS data (Hardman, 2008; HEFCE, 2010) that identified a relationship between UCAS entry points and satisfaction, the author conducted an independent samples *t*-test to identify any UCAS point entry differences between STEM and non-STEM students. UCAS points ranged from 0 to 690 amongst non-STEM students (*M*=76.30, *SD*=136.17), and ranged from 0 to 700 amongst STEM students (*M*=47.72, *SD*=110.09). The *t*-test revealed that the UCAS entry points for students on non-STEM programmes was significantly higher than those for students on STEM programmes (*t*=3.77, *p*=.000). Furthermore, there is some evidence to suggest that class size may impact student engagement, teacher motivation and student satisfaction (Toth & Montagna, 2002), and, therefore, average introductory class size was compared between STEM and non-STEM courses. There was no significant difference in average class size for STEM (*M*=33.76, *SD*=14.04) vs. non-STEM students (*M*=34.51. *SD*=11.40).

A 2 (STEM, non-STEM) x 2 (sex) Multivariate analysis of covariance tested for differences between STEM and non-STEM students on the six subscales of student satisfaction. Due to the association between UCAS entry points and satisfaction, and the significant difference in points between STEM and non-STEM programmes, the analysis was conducted covarying for UCAS points. The MANCOVA revealed that UCAS points covaried with satisfaction on teaching ($F(1,1174)=6.37$, $p=.012$); Assessment and Feedback ($F(1,1174)=5.06$, $p=.025$); Organisation ($F(1,1174)=10.90$, $p=.001$) and Personal Development ($F(1,1174)=8.18$, $p=.004$). When taking in to account the covariance of UCAS points and satisfaction, there was a significant effect of STEM status (Wilks $\Lambda=.97$, $F(6,1169)=5.75$, $p=.000$) indi-

Figure 2: Mean satisfaction rating on each NSS sub-dimension by STEM vs. non-STEM status and sex.

	Non-STEM			STEM		
	Female	Male	Total	Female	Male	Total
Teaching	3.72 (0.94)	3.92 (0.90)	3.80 (0.93)	3.74 (0.82)	3.59 (0.95)	3.67 (0.89)
Assess. and Feedback	3.40 (0.96)	3.61 (1.01)	3.48 (0.98)	3.54 (0.92)	3.44 (0.93)	3.49 (0.93)
Support and Guidance	3.40 (1.01)	3.62 (1.02)	3.48 (1.02)	3.56 (0.95)	3.51 (1.01)	3.54 (0.98)
Organisation	3.53 (1.00)	3.67 (1.01)	3.58 (1.00)	3.69 (0.92)	3.55 (0.99)	3.62 (0.95)
Resources	3.57 (1.02)	3.66 (1.06)	3.60 (1.04)	3.78 (0.96)	3.73 (1.02)	3.76 (0.99)
Personal Development	3.54 (0.99)	3.61 (1.03)	3.57 (1.00)	3.55 (0.89)	3.53 (0.97)	3.54 (0.93)

cating that STEM and non-STEM students differed in their satisfaction. Univariate ANOVAs revealed that STEM students were significantly more satisfied than non-STEM students with resources available to them ($F(1,1174)=5.86$, $p=.016$), but were less satisfied with the teaching on their programme ($F(1,1174)=10.23$, $p=.001$).

The ANCOVA also revealed a significant STEM status x Sex interaction (Wilks $\Lambda=.99$, $F(6,1169)=2.75$, $p=.012$) indicating that differences in the satisfaction of STEM vs non-STEM students differed as a function of the sex of the student. Univariate ANOVAs revealed that the significant interaction effect was found on the satisfaction sub-dimension of Teaching ($F(1,1174)=9.87$, $p=.002$). Post hoc analyses adjusted for multiple testing (Bonferroni) revealed that STEM males were less satisfied with teaching than non-STEM males ($p=.000$) or STEM females ($p=.022$).

This was an interesting result that was further interrogated by exploring the Status and Sex differences on each specific aspect of teaching and assessment (see Figure 3). A 2 (STEM, non-STEM) x 2 (sex) MANCOVA with each of the individual NSS items on the teaching sub-dimension as dependent variables was conducted. Once again the analysis was conducted covarying for UCAS entry points and the MANCOVA revealed that UCAS points covaried with satisfaction on each of the teaching items. When taking in to account the covariance of UCAS points and satisfaction, there was an effect of STEM status that approached significance (Wilks $\Lambda=.99$, $F(4,1167)=2.34$, $p=.05$).

The ANCOVA also revealed a significant STEM status x Sex interaction (Wilks $\Lambda=.99$, $F(4,1167)=2.86$, $p=.023$) indicating that differences in the satisfaction of STEM vs non-STEM students on the NSS teaching items differed as a function of the sex of the student. Univariate ANOVAs revealed that the significant interaction effect was found on each of the items: the quality of explanations provided by staff ($F(1,1170)=7.85$, $p=.005$); the degree to which staff have made the subject interesting ($F(1,1170)=6.14$, $p=.013$); the enthusiasm of staff for what they are teaching ($F(1,1170)=10.12$, $p=.002$) and the degree to which the programme is intellectually stimulating ($F(1,1170)=7.86$, $p=.005$).

Post hoc analyses adjusted for multiple testing (Bonferroni) revealed that STEM males were less satisfied with every aspect of

Figure 3: Mean satisfaction rating on each NSS item within the Teaching sub-dimension by STEM vs non-STEM status and sex.

	Non-STEM			STEM		
	Female	Male	Total	Female	Male	Total
Teaching staff are good at explaining things	3.72 (0.94)	3.92 (0.90)	3.80 (0.93)	3.74 (0.82)	3.59 (0.95)	3.67 (0.89)
Teaching staff have made the subject interesting	3.40 (0.96)	3.61 (1.01)	3.48 (0.98)	3.54 (0.92)	3.44 (0.93)	3.49 (0.93)
Teaching staff are enthusiastic about what they are teaching	3.40 (1.01)	3.62 (1.02)	3.48 (1.02)	3.56 (0.95)	3.51 (1.01)	3.54 (0.98)
My programme is intellectually stimulating	3.53 (1.00)	3.67 (1.01)	3.58 (1.00)	3.69 (0.92)	3.55 (0.99)	3.62 (0.95)

teaching measured by the NSS than non-STEM males. STEM males were less satisfied than non-STEM males in terms of: the quality of explanations provided by staff (p=.003); the degree to which staff have made the subject interesting (p=.002); the enthusiasm of staff for what they are teaching (p=.001) and the degree to which the programme is intellectually stimulating (p=.003). There were no significant differences in satisfaction between STEM and non-STEM females, or between males and females on STEM courses. However, male students on non-STEM programmes did rate teaching staff as more enthusiastic than female students on the same programmes (p=.005).

Conclusions

The current study sought to compare the student experience of STEM versus non-STEM students as measured by their response to a satisfaction survey. Analyses revealed that STEM students reported greater satisfaction with resources. This is very likely to be due to the resource funding bands set by HEFCE which result in non-STEM subjects receiving between 60 to 75 per cent of the funding received by most STEM subjects. Despite their greater satisfaction with resourcing, STEM students' experience of teaching was less positive than non-STEM students. This has implications for teachers of STEM subjects and the retention of students. However, it is important to note that the data do not point to a simple pedagogical solution for STEM educators, because the lower satisfaction in teaching amongst STEM students was found specifically amongst males.

If dissatisfaction with HE teaching practices is responsible for STEM student attrition rates, then these data suggest that it is male students who will be particularly at risk. Further research is required to replicate this finding amongst other university samples, and to identify whether there are specific variations in teaching practices between STEM and non-STEM courses that are particularly salient to the satisfaction of male students. Furthermore, future research should also explore the possibility that these results could be explained by sex differences in first year student's expectations of STEM and non-STEM disciplines. Females may hold generally lower (or more appropriate expectations) of STEM teaching, and may therefore be satisfied when these expectations are met or exceeded. Whereas males' expectations of STEM teaching may not be being met, or may be less adaptive, which in turn results in lower satisfaction.

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