


International Journal of Science Education
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tsed20

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Published online: 18 Dec 2014.

To cite this article: Pey-Tee Oon & R. Subramaniam (2015) University Programme Preferences of High School Science Students in Singapore and Reasons that Matter in their Preferences: A Rasch analysis, International Journal of Science Education, 37:2, 367-388, DOI: 10.1080/09500693.2014.987714

To link to this article: http://dx.doi.org/10.1080/09500693.2014.987714

*International Journal of Science Education*, 2015
Vol. 37, No. 2, 367–388, http://dx.doi.org/10.1080/09500693.2014.987714

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# University Programme Preferences of High School Science Students in Singapore and Reasons that Matter in their Preferences: A Rasch analysis

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This study explored an under-researched area in science education—the university programmes preferred by high school students who take physical science subjects and the reasons that matter in their preferences. A total of 1,071 upper secondary and pre-university students in Singapore, who take physical science subjects among their range of subjects, participated in this study. A survey method was adopted and the Rasch model was used to analyse the data. Overall, Business Studies was ranked as the predominant choice; nonetheless, scientific programmes such as Science, Engineering, and Mathematics are generally still well liked by the students. When gender differences were examined, we found that students largely followed gender-typical programme preferences, in which males tend to incline towards Engineering while females tend to incline towards Arts and Social Sciences. Students prefer a university programme based on their individual interest and ability, with career aspiration and remuneration coming next. Interestingly, females place greater emphasis on career aspiration than males. Some implications of the study are discussed.

Keywords: *Science interest; University programmes; Rasch analysis; Singapore*

## Introduction

It has been widely reported that school students' interest in physics and chemistry is not very positive (e.g. Oon & Subramaniam, 2010; Erlikh, 2013). This has inevitably contributed to the declining enrolment in these subjects at the tertiary level.

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Does the declining number of students in science (or for that matter, the physical sciences) really indicate the declining interest of students in science? It has been reported that students' decision on whether to pursue a subject is a 'prolonged and dynamic process' (Langen, Rekers-Mombarg, & Dekkers, 2006). Whether or not they would study science at university depends also on the career opportunities available (Tai, Liu, Maltese, & Fan, 2006) as well as grades (Oon & Subramaniam, 2013).

There are no studies in the science education literature which have explored whether science students' self-indicated preference for programmes at the university, before having knowledge of their grades at the end of leaving level examinations, matches with what they finally enrol in at the university. Their self-indicated preference can be taken as some indication of their individual interest in the programme—this is because interest is an important factor in such decisions (e.g. Robertson, 2000). Their individual interest could be hidden by grade effect, especially in an examination-oriented education system, as this has been reported to be a significant factor on whether students would choose to pursue a science course, such as physics, at university (Oon & Subramaniam, 2010; 2013). Knowledge of university programmes preferred by science students while in school would obviously be of interest to university administrators and other stakeholders. At the same time, it provides some indication on whether students intend to continue in science at the tertiary level. Such information would also be relevant to schools as they can see whether any interventions can be taken to address this.

It would also be of interest to know if students from an Asian country (Singapore), which has consistently been performing well in international science and mathematics tests such as TIMSS and PISA, and who are taking science in schools, show inclination towards science-based courses at the university. The same holds true for reasons that matter to these students when choosing a programme for study at the university.

This study explored university programme preferences of upper secondary and junior college science students in Singapore, with the focus on those currently doing physical science subjects in school, and the relative influences of various reasons affecting their preferences. It also examines whether there are gender differences in their preferences.

## Literature Review on Higher Education Preferences

As a contribution to the educational administration literature, Maringe (2006) surveyed sixth form students ($N = 387$) in the UK to investigate their intended choice of university and courses in higher education as well as factors influencing their decision. Only 8% of them registered interest in science, with business attracting the highest percentage (18%). The three top reasons for selecting a course include career opportunities, ability, and grade.

Dar and Getz (2007) noted that academically less bright students tend to pursue education and social science degrees, while brighter students tend to pursue science till graduate level. Their sample consisted of 1,538 second- and third-year Bachelor's degree students.

Male and female school students (17–20-year-olds) in the UK exhibited observable differences when it comes to variables affecting their higher education choices (David, Bali, Davies, & Reay, 2003); the study, however, did not explore course choices. In most West European countries, males tend to choose science and technology courses far more frequently than females (Støren & Arnesen, 2007).

In a longitudinal study, Tai et al. (2006) asked eighth graders in the USA whether they expected to be in a science career by age 30; a follow-up study when they were 30 years old confirmed that about half of them who graduated with a degree were in science careers.

A few studies also focused on why university students chose to study science-related courses—for example, STEM programmes in Slovenia (Cerinsek, Hribar, Glodez, & Dolinsek, 2013), physics in the UK (Rodd, Reiss, & Mujtaba, 2013), and physics in Norway (Boe & Henriksen, 2013).



## Research Background

When students consider a programme to pursue at the university, they are likely to use various criteria, which may differ in their importance. This section explores pertinent constructs that need to be taken into consideration in our methodology.

### *Personal*

The perception that a student has in his or her own ability and individual interest in a subject influences school subject choice. Interest as a construct is multidimensional in nature. For the purpose of our study, we restrict it to individual interest, which can be defined as the propensity of the individual to engage with a domain (Ainley & Ainley, 2011). That is, it is intrinsically motivated. Kelly (1988) found that ability and interest were the predominant reasons that drive students in their school subject choices, with no significant gender differences reported. Robertson (2000) used a cohort of university bioscience students and also noticed the interest factor on course choice.

### *Social*

The influence of peers and parents on enrolment choices at school (and by extension, the pathway to university education) has been reported in the literature, but there is no general consensus. For example, peers are said to exert influence on the choice of subject to pursue in science, nonetheless some repudiated such claims (Panizzon & Levins, 1997). Others have reported that the influence of parents on their children's enrolment choices is more significant than that of peers (Kremer & Walberg, 1981, reported in Dalgety & Coll, 2004).

The extent to which students respond to parental pressure in their higher education choices or career pursuits appears to differ across cultures. This factor does not appear to have a large influence on science students' enrolment in high school physics in the USA (Crawley & Black, 1992). However, an intervention study in the USA focusing on parents has been helpful—mailing them brochures reinforcing the value of STEM education led to a good number of their children taking up an extra semester of science and mathematics in preparation for tertiary education (Harackiewicz, Rozek, Hulleman, & Hyde, 2012). In Korea, parents' influence play an important role in students' decision on whether or not to pursue science (Myeong & Crawley, 1993). This could be due to cultural factors as youngsters are generally expected to be obedient to their parents in Asian societies. Such parental exertion is not very pronounced in Western societies as they are generally supportive of their children's educational choices (Dalgety & Coll, 2004). Females are more likely to be influenced by parental views, especially their mothers' (Dawson & O'Connor, 1991; Sleet & Stern, 1980, as reported in Dawson & O'Connor, 1991) when choosing school subjects, which will set them on a particular pathway if they proceed to university.

The impact of peer influence on science attitudes among adolescent students is significant (Gogolin & Swartz, 1992; Talton & Simpson, 1985). It is noted that the strength of the relationship between peers and personal attitudes towards science increases over grades 6–8 before peaking in grade 9 (Talton & Simpson, 1985). Eccles (2007) also reported that students' psychological need for a social identity (relatedness) has a bearing on what choices they make in educational settings. In other words, students' relationship with their peers grows stronger and they tend to develop deeper social connections with those who share similar attitudes towards science as the school year progresses. Contradictory results have also been reported that while inputs from peers are valued, their opinions regarding future career choices do not directly influence students' enrolment choices (Dalgety & Coll, 2004; Panizzon & Levins, 1997), or that it just appears to be slightly influential (Robertson, 2000). A study has also reported that young people rarely recognize the influence of peers (Brooks, 2003).

*School Environment*

Teacher variables as well as career advice students receive in school (Young, Fraser, & Woolnough, 1997) are important. The influence of teachers (e.g. personal encouragement outside of class) is noted to be important in influencing students' intention to be a scientist, that is, choosing science at the tertiary level (Woolnough, 1994). Another study reported that teachers' influence on enrolment choices is insignificant when compared to other variables, such as future relevance and parental influence (Myeong & Crawley, 1993). High school students reported that they would seek teachers' and school admission officers' views on enrolment choices or career decisions (Koballa, 1988; Rennie & Dunne, 1994). Also, advices provided by universities about courses being offered are important on course choice, particularly for females (Robertson, 2000).

*Nature of Subject*

Science has often been stereotyped as being a 'hard, cold and analytical discipline' (Kahle, Parker, Rennie, & Riley, 1993). Even within science, subjects are viewed differently. For example, physical science subjects are perceived to have an image that is not personal and not caring (Kelly, 1987) while biology is regarded as projecting an image that is nurturing and people-centric (Jones, 1987). The image of physics and chemistry as being difficult and irrelevant has also contributed towards students' negative attitudes towards these subjects (Erlikh, 2013; Kessels, Rau, & Hannover, 2006; Panizzon & Levins, 1997). Transforming negative attitudes of students towards science learning into positive ones is important for stakeholders (United Nations Educational Scientific and Cultural Organization [UNESCO], 2010).

*Career Choice*

Students' decision on choosing a university programme will be driven by career aspirations. Even at school, students would choose a subject based on its career value in the future (Barnes, McInerney & Marsh, 2005; Reid & Skryabina, 2002; Stokking, 2000). It has a particularly strong effect even among students in Years 8–9, and is expected to be greater in Year 10 (Dawson & O'Connor, 1991). Students choosing a technical subject such as physics usually believe that it will open up viable career options (Lyons, 2006; Reid & Skryabina, 2002; Stokking, 2000).

## Rationale for Present Study

This study aims to contribute to the sparse literature on university programme choices of high school (physical) science students, thus helping to address a gap in the science education literature. Such a study can serve two purposes. Firstly, if science is not their intended choice at the tertiary level, it would be prudent for the school to explore interventions that can address this issue earlier. Secondly, reasons that matter in their choice of programme can provide university stakeholders useful information of the popularity of a programme—if science is not their intended choice, they can even consider how to work closely with schools to address it. As it is, interest in science among students is declining and approaches to explore this complex discourse need to embrace multiple approaches so that further perspectives can be obtained. Most of the reviewed studies focused on reasons that matter in the subject choice at school level, with only a few at the university level. Only a few focused on reasons that matter in programme preferences at the university and that, too, in limited contexts (for example, Dar & Getz, 2007; Davidet al., 2003; Maringe, 2006; Myeong & Crawley, 1993; Young et al. 1997). Where surveys were used, the scales were incorrectly assumed to be interval when these were actually ordinal (e.g. Maringe 2006). There is thus a need to use more robust methodologies to address the issue.

Besides the scarcity of studies on programme choices, the very few limited studies in this area have been drawn from Western settings. Very little research has focused on

Asian students, who are known to regularly shine in international science and mathematics assessments. A study from a different cultural perspective can address a gap in the literature in this area.

In the context of the foregoing, the present study explores the university programme preferences of secondary and junior college science students in an Asian country and the reasons that matter in their choices. More specifically, the research questions that guided our study are as follows:

(1) What are the popular programmes that upper secondary and pre-university students who take physical science subjects are likely to consider for study at the university?
(2) What reasons matter to the students when considering a programme to study at the university?
(3) Do male and female students show significant differences with regard to programme preferences at the university and, if so, what are the important reasons that influence this preference?

## Methodology

### *Instruments*

In deciding on tertiary programme choices, care was taken to ensure that these were available in the three publicly funded universities in Singapore. There were 14 programmes included in this study (Table 2).

The survey items on reasons that are likely to matter in programme preferences are framed on the basis of the research background advanced earlier. These are as follows:

(1) Personal: a. Interest in subject (Is it interesting?), b. Own ability (Am I good at it?)
(2) Social: a. Influence from peers (What your friends say about it?), b. Influence from parents (What your parents say about it?), c. Gender stereotyping (Is it mainly taken by boys or girls?)
(3) School: a. Influence from teachers (What your teachers say about it?), b. Influence from senior students (What senior students say about it?), c. Career talks (What they say at career talks?)
(4) Nature of the subject: a. Relevance of the curriculum (Is it relevant to daily life?), b. Difficulty of the programme (Is it difficult to study?)
(5) Career choice: a. Career aspirations (Is it helpful to be what I want to be?), b. Market demand (Is it easy to get a job?), c. Salary (How much I can earn?)

A survey method was adopted because it provides a channel for a large population to be reached. It is also time-efficient (Robertson, 2000). Panizzon and Levins (1997) used a ranking scale to survey reasons why a subject is chosen—students were required to rank only four reasons in order of importance, using ‘1’ (most important) to ‘4’ (least important). We opted not to use this type of ranking scale because such an approach does not flesh out the precise distance between the ranks; for example, the distance between 'Important' and 'Very Important' is not accurately known. Inferential statistics cannot be done on such scores because the ranking scale is not linear (Wright, 1999a, 1999b). As a result, information will be lost and only limited statistical analyses are possible (Alreck & Settle, 1985; Nardi, 2006). Since we wished to know the precise distance between the reasons as well as why a reason is more important than another, a Likert scale anchoring on the Rasch framework was chosen, with students being asked to *rate* rather than *rank* (e.g. Oon & Subramaniam, 2013). Students need to rate all the reasons provided in the survey instead of only four as in the study by Panizzon and Levins (1997). The raw scores can then be converted into linear measures in unit logit (e g. Career consideration is four logits more important than parental influence). In this way, we can know the distance between the differences accurately in relation to the reasons that matter to students. However, a ranking scale is unavoidable when it comes to considering university programmes because it allows students to choose the top three programmes that they are interested to study in a hierarchical manner. A Likert scale is not necessary for this because we do not intend to survey the relative popularity of each of the programmes, but only the three most popular programmes—a ranking scale serves this purpose adequately. We deliberately wanted students to rank three programmes rather than rank all 14 because it would not only be overwhelming for them to rank all 14 in preferential order, but it would also be cognitively taxing for them. Also, at the educational level students are in, they are more likely to have some idea of the few key programmes that appeal to them.

In addition, Kelly (1988) used a three-point rating scale, whereby students were asked to indicate how important each reason is in their programme choice decision (Kelly, 1988). We opted for a four-point rating scale so that students are given more choices in selecting their views: 1 as 'Very unimportant', 2 as 'Unimportant', 3 as 'Important', and 4 as 'Very important'.

Space was provided in the survey form for students to specify programmes and reasons that did not feature in it. There was also space to indicate demographic information such as gender, class level, and science subjects pursued in school.

The instrument was sent for validation to two academic staff in the university. They agreed unanimously on the content of the instrument.

The instrument was piloted on 192 upper secondary school students. Analyses using the Rasch model indicated an item reliability of 0.91 for programme preference and 0.99 for reasons that affect programme preference. All items stayed within the acceptable ranges of MnSq and Zstd infit and outfit statistics (MnSq ranges from 0.60 to 1.40; Zstd ranges from $-2$ to 2) (Bond & Fox, 2007).

For the revised instrument, a 'salary' reason was added as students in the pilot study mentioned about it. The instrument was then sent to two subject heads (from secondary school and junior college) for further validation. They agreed on the appropriateness of the instrument for testing on local students. Expert judgement can be sought at multiple points during instrument development (Wolfe & Smith, 2007).

*Data Collection*

A cluster sampling method was employed, whereby schools were randomly chosen from the four zones (South, East, West, and North) in Singapore. A total of eight secondary schools and eight junior colleges participated in this study. Students were given 20 minutes to complete the survey form and were assured that the individual information provided will be kept confidential and that it will be pooled for analysis. It was ascertained earlier in the pilot study that this time duration was adequate.

*Sample*

A total of 1,071 upper secondary (grades 9–10) and junior college students (grades 11–12) participated in the main study (Table 1). Thus, they are equivalent to high school students. The upper secondary school students take physics either as a pure subject or as a combined science subject (along with chemistry). Those at junior college take Physics as a separate subject along with Chemistry. Of course, they do take other subjects as well before they sit for the Singapore–Cambridge GCE Examination, either at 'O' or at 'A' level—for example, mathematics. It is to be noted that science students can apply for not only the hard sciences programmes at the university but also for any other programmes. Those who take Arts subjects in junior college cannot apply for the hard sciences programmes at the university.

Whilst it would be prudent to recruit only junior college students for this study, since they are at a stage where university progression is a possible next step, we also wanted upper secondary school students in our study as we wished to see if there are any patterns of differences in programme preferences and reasons of interest in



Table 1. Demographic information of the sample, $N = 1071$ (728 secondary, 343 junior college)

| Aspect | | | Number | % |
|---|---|---|---|---|
| Secondary | Gender | Male | 355 | 48.8 |
| | | Female | 371 | 51.0 |
| | Level | Secondary 3 | 320 | 44.0 |
| | | Secondary 4 | 246 | 33.8 |
| | | Secondary 5 | 158 | 21.7 |
| | Subject | Combined science | 204 | 28.0 |
| | | Pure science (Physics and Chemistry) | 417 | 57.3 |
| Junior college | Gender | Male | 204 | 59.5 |
| | | Female | 138 | 40.2 |
| | Level | Junior college 1 | 168 | 49.0 |
| | | Junior college 2 | 170 | 49.6 |

Note: Two secondary students did not specify their gender, four did not specify their school level, and 107 (52 from Secondary 3; 31 from Secondary 4; and 24 from Secondary 5) did not specify the subjects they are taking. One junior college student did not specify the gender, and five did not specify their junior college level. Percentages are computed with respect to secondary and junior college levels respectively.

these two groups. It is of interest to note that the former would need to make a decision on university programme preference sooner than the latter.

### *Data Analyses*

Rasch model, using WINSTEPS version 3.68.1 (Linacre, 2009), was used to analyse the data.

## Results

The likelihood of a school student choosing a programme for possible study at the university can be expressed in terms of how easy that programme is for the student to endorse. If a programme is easier to endorse than others, it can be judged to be of individual interest for that student.

Table 2 reveals that Business degree programme (estimate = 0.45 logits) is easier for upper secondary students to agree with than Dentistry (estimate = 1.59 logits). Students are thus likely to choose Business over Dentistry at the university. The same holds true for reasons that affect programme choice at the university. For example, interest in a subject (estimate = −2.60 logits) (Table 3) is easier to endorse than gender stereotyping (estimate = 1.54 logits) for secondary students. Each item estimate is accompanied by an error statistic showing the precision of the estimate (Table 2).

Fit statistics are reported as MnSq (meansquare) and Zstd (standardized $z$ values). Infit/outfit MnSq range of 0.6 to 1.4 and Zstd of −2 to 2 are regarded as acceptable in assessing if the items measure an underlying latent trait (Bond & Fox, 2007). All the items (Table 2) conform to the Rasch measurement model. A few items misfit the Zstd statistics; these ranged from −6.99 to 5.12 for upper secondary students and −3.64 to 3.29 for junior college students (Table 3). Nonetheless, items displaying misfit in only one form of statistics can be retained (Bond & Fox, 2007). Recent literature suggests that Zstd statistics should be interpreted with caution when judging item fit for polytomous data as it can be substantially influenced by sample size (Smith, Rush, Fallowfield, Velikova, & Sharpe, 2008). In fact, some studies even exclude it from scale assessment (e.g. Cervellione, Lee, & Bonanno, 2009).

Upper secondary students are likely to consider Business, Medicine, Science, and Engineering programmes, while junior college students are likely to choose Business, Engineering, Medicine, and Banking programmes at the university (in decreasing sequence, Figure 1). Computing and Dentistry programmes could hardly interest students—both stayed at the bottom of the scale. Interestingly, upper secondary school students showed higher interest in Science and Mathematics, with Mathematics recording a sharper difference. The contrary is true for Engineering, for which junior college students showed greater inclination.

Figure 2 displays the reasons affecting programme preference. It is arranged in the order of perceived importance. There are few differences between secondary and junior college students on reasons affecting programme preference. The two groups

Table 2. Rasch item estimates (easiness to endorse) for all secondary and junior college students (with error) on programme preferences

| | Secondary students ($N = 728$) | | | | | | Junior college students ($N = 343$) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Infit | | Outfit | | | | Infit | | Outfit | |
| Item | Estimate *logits* | Error | MnSq | Zstd | MnSq | Zstd | Estimate *logits* | Error | MnSq | Zstd | MnSq | Zstd |
| Business | 0.45 | .03 | 0.94 | −1.33 | 0.93 | −1.63 | 0.41 | .05 | 0.90 | −1.92 | 0.90 | −1.78 |
| Medicine | 0.62 | .04 | 1.06 | 1.1 | 1.07 | 1.19 | 0.66 | .05 | 1.08 | 0.93 | 1.10 | 1.07 |
| Science | 0.66 | .04 | 1.00 | 0.05 | 0.98 | −0.23 | 0.74 | .06 | 0.97 | −0.25 | 0.97 | −0.27 |
| Engineering | 0.67 | .04 | 1.04 | 0.71 | 1.04 | 0.66 | 0.46 | .05 | 0.98 | −0.25 | 0.98 | −0.34 |
| Banking | 0.79 | .04 | 0.94 | −0.85 | 0.92 | −1.03 | 0.72 | .06 | 0.92 | −0.85 | 0.91 | −0.93 |
| Mathematics | 0.80 | .04 | 0.99 | −0.09 | 0.98 | −0.23 | 1.02 | .07 | 1.00 | 0.06 | 1.03 | 0.23 |
| Finance | 0.81 | .04 | 0.97 | −0.39 | 0.97 | −0.31 | 0.77 | .06 | 0.91 | −0.87 | 0.90 | −0.88 |
| Arts & Social Sciences | 0.89 | .04 | 1.06 | 0.75 | 1.11 | 1.19 | 0.74 | .06 | 1.08 | 0.77 | 1.07 | 0.74 |
| Law | 0.93 | .05 | 0.95 | −0.50 | 0.94 | −0.67 | 1.05 | .07 | 1.09 | 0.61 | 1.07 | 0.50 |
| Music | 0.97 | .05 | 1.02 | 0.29 | 1.07 | 0.73 | 1.26 | .09 | 1.11 | 0.60 | 1.11 | 0.59 |
| Design & Environment | 0.99 | .05 | 1.04 | 0.43 | 1.07 | 0.73 | 1.19 | .08 | 1.13 | 0.75 | 1.1 | 0.58 |
| Education | 1.05 | .05 | 1.07 | 0.68 | 1.12 | 1.12 | 1.10 | .08 | 1.05 | 0.36 | 1.08 | 0.55 |
| Computing | 1.05 | .05 | 1.01 | 0.10 | 1.04 | 0.37 | 1.22 | .09 | 1.12 | 0.67 | 1.09 | 0.51 |
| Dentistry | 1.59 | .08 | 0.94 | −0.28 | 0.95 | −0.20 | 1.55 | .12 | 1.16 | 0.70 | 1.14 | 0.62 |

Table 3. Rasch item estimates (easiness to endorse) for all secondary and junior college students (with error) on reasons affecting programme preferences

| | Secondary students ($N = 728$) | | | | | | Junior college students ($N = 343$) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Infit | | Outfit | | | | Infit | | Outfit | |
| Item | Estimate *logits* | Error | MnSq | Zstd | MnSq | Zstd | Estimate *logits* | Error | MnSq | Zstd | MnSq | Zstd |
| Interest in subject | −2.60 | .07 | 1.31 | 5.12 | 1.29 | 4.41 | −2.81 | .11 | 1.16 | 2.00 | 1.18 | 2.09 |
| Individual ability | −2.32 | .07 | 1.16 | 2.96 | 1.12 | 2.03 | −2.26 | .10 | 1.10 | 1.30 | 1.08 | 1.08 |
| Career aspirations | −2.25 | .07 | 1.2 | 3.58 | 1.18 | 3.14 | −2.78 | .11 | 1.21 | 2.55 | 1.22 | 2.53 |
| Salary | −1.66 | .06 | 1.28 | 4.95 | 1.21 | 3.77 | −1.72 | .09 | 1.26 | 3.26 | 1.22 | 2.87 |
| Market demand | −1.62 | .06 | 0.98 | −0.34 | 0.98 | −0.31 | −1.67 | .09 | 0.93 | −0.90 | 0.92 | −1.06 |
| Relevance of the programme | −0.31 | .05 | 1.04 | 0.78 | 1.03 | 0.62 | −0.37 | .08 | 1.18 | 2.29 | 1.17 | 2.20 |
| Influence from Parents | −0.25 | .05 | 0.97 | −0.64 | 0.95 | −0.99 | 0.06 | .08 | 0.840 | −2.26 | 0.85 | −2.07 |
| Difficulty of the programme | −0.17 | .05 | 1.02 | 0.50 | 1.02 | 0.40 | 0.02 | .08 | 0.93 | −1.02 | 0.93 | −0.98 |
| Influence from teachers | −0.09 | .05 | 0.71 | −6.46 | 0.71 | −6.54 | 0.31 | .08 | 0.78 | −3.29 | 0.78 | −3.26 |
| Career talks | 0.08 | .05 | 0.97 | −0.68 | 0.96 | −0.84 | 0.57 | .08 | 0.91 | −1.35 | 0.92 | −1.19 |
| Influence from senior students | 0.35 | .05 | 0.75 | −5.72 | 0.76 | −5.46 | 0.55 | .08 | 0.83 | −2.64 | 0.82 | −2.71 |
| Influence from peers | 0.35 | .05 | 0.70 | −6.99 | 0.71 | −6.60 | 0.63 | .08 | 0.77 | −3.64 | 0.78 | −3.30 |
| Gender stereotyping | 1.54 | .05 | 1.17 | 3.34 | 1.25 | 4.50 | 2.00 | .09 | 1.25 | 3.29 | 1.14 | 1.78 |

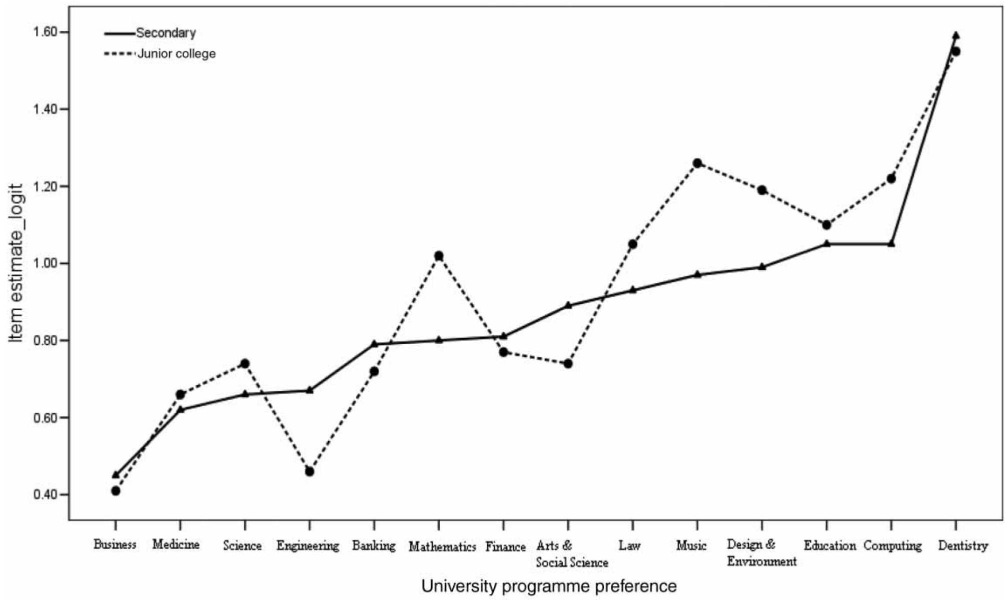


Figure 1. Secondary versus junior college students' item estimates (easiness to endorse) on programme preference

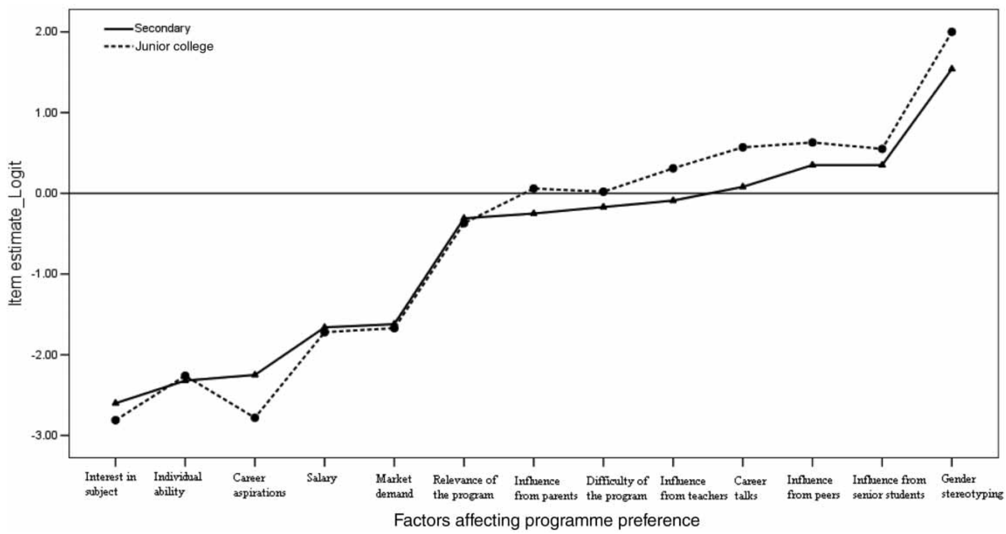


Figure 2. Secondary versus junior college students' item estimates (easiness to endorse) on reasons affecting programme preference

shared identical views on the perceived importance of the various reasons. There is almost close agreement on two reasons: whether a programme is of interest to them and if they are good at it, when considering to pursue it at the university. These two reasons received the highest ratings. Also, career choice reasons do matter to students substantially: whether the programme is helpful in achieving what they want to be, attractiveness of the salary, and ease of getting a job. In brief, these five reasons influence students' decision in selecting a programme of study at the university. Next is the nature of the programme (its relevance and difficulty) as well as advices from parents and teachers—the latter two influence their decision to a lesser extent. The influences from career talks, peers, senior students, and gender stereotyping are least considered by the students.

### *Male versus Female Comparisons (Secondary and Junior College Students)*

Figures 3–6 show the male versus female comparison graphs for upper secondary and junior college students.

Figures 3–5 show the standardized differences for secondary and junior college males and females on university programmes they are likely to choose. If the programme is easier to be endorsed by males than females, it implies that males are more likely to consider this programme than females (indicated by a downward bar). Coloured bar indicates that the difference is significant ($p < .05$). Figures 4–6 show differences for upper secondary and junior college males and females on reasons that affect programme preference at the university. If the reason is easier to be endorsed by males than females, it implies that males are more likely to consider that reason than females (indicated by a downward bar).

Upper secondary males are more likely to choose Engineering and Mathematics programmes, while females are likely to consider Arts & Social Sciences and Medicine programmes (Figure 3). This pattern of responses is significantly pronounced ($p < .05$) for upper secondary students. In general, Computing, Design & Environment, and Dentistry are the least preferred programmes for the secondary school students

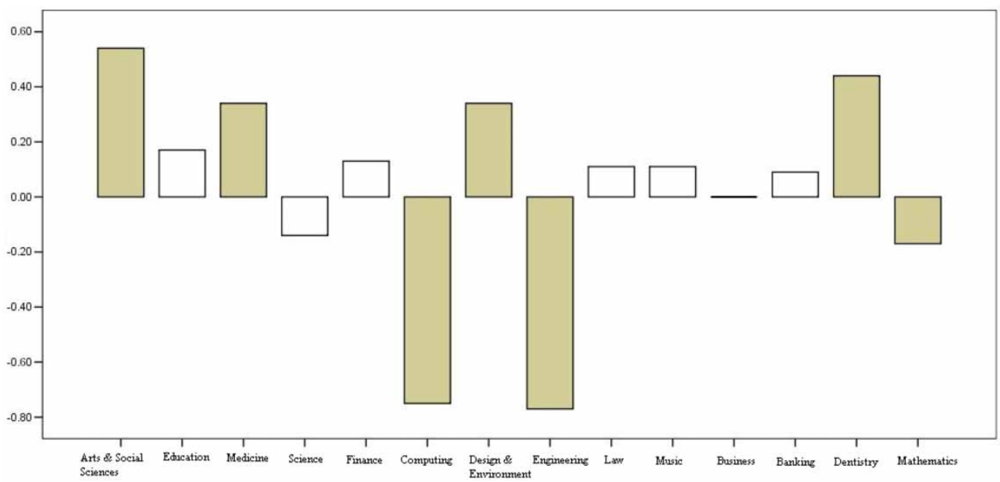


Figure 3. Gender standardized difference graph (coloured bar indicating $p < .05$) on programme preference for secondary students

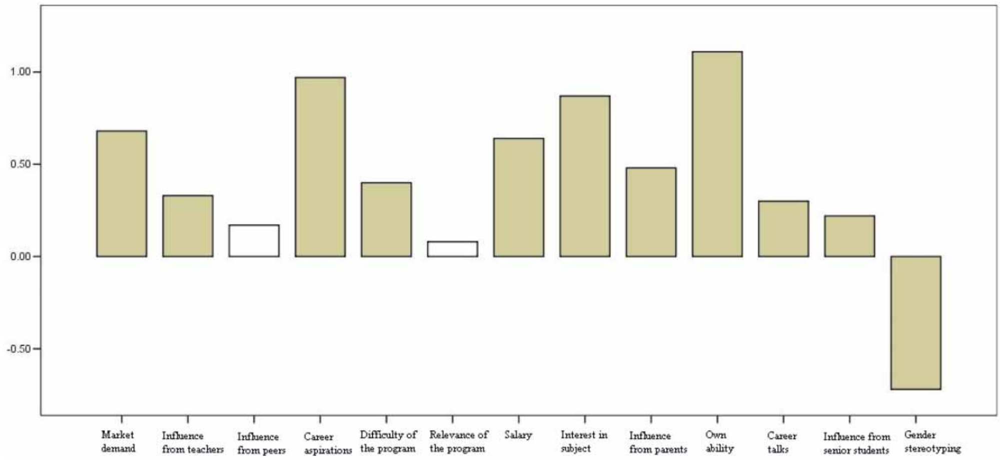


Figure 4. Gender standardized difference graph (coloured bar indicating $p < .05$) on reasons affecting programme preference for secondary students

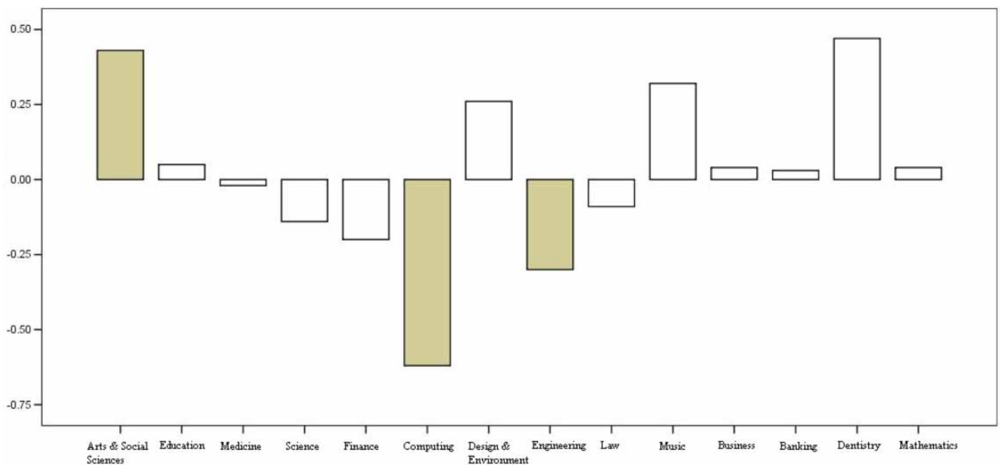


Figure 5. Gender standardized difference graph (coloured bar indicating $p < .05$) on programme preference for junior college students

(Table 2). However, when gender differences are examined, Computing programme appears to be more preferred by males, while Design & Environment and Dentistry programmes are more preferred by females (Figure 3).

The largest gender difference observed between upper secondary males and females is on individual ability (Figure 4). Upper secondary females are more likely than males to consider their own ability ($p < .05$) as an important reason when it comes to enrolment decisions; it is followed by career aspiration and interest in the subject ($p < .05$) (Table 3). Gender stereotyping is generally unlikely to be considered (Table 3); however, it is in favour of boys when gender differences are examined (Figure 4).

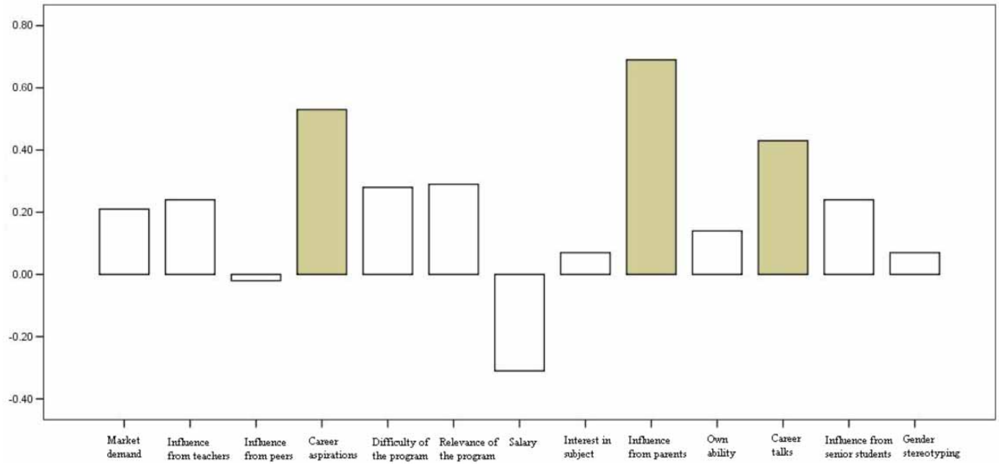


Figure 6. Gender standardized difference graph (coloured bar indicating $p < .05$) on reasons affecting programme preference for junior college students

Junior college males are more likely to consider Engineering programme, whilst females prefer to study Arts & Social Sciences ($p < .05$) (Figure 5). Computing programme is generally least preferred by junior college students (Table 2); however, it appears to be more preferred by males when gender differences are studied (Figure 5).

Junior college females consider career aspirations and parental advice as being more important ($p < .05$) when compared to males when considering a programme to study at the university (Figure 6). Feedback at career talks is generally unimportant to the junior college students (Table 3); nonetheless, females would consider it as more important than males when gender differences are analysed (Figure 6).

## Discussion

It is clear that Business is the most preferred choice of programme for study at the university in that it is attractive to a good majority of both upper secondary and pre-university students who do physical science subjects in school. However, technical programmes (Science, Mathematics, and Engineering) have not been totally neglected; they are generally still well liked by the students. This does indicate that their interest for science before O-level and A-level examinations is high.

Engineering programmes gain better attention and are perceived to be more favourable as compared to science programmes. Engineering graduates are generally perceived to have clearer career paths as they are likely to end up as trained engineers in various areas (e.g. mechanical, electrical, electronics, and communication) as compared to science graduates, who are generally perceived to have lesser career options. On top of that, there are studies which have reported that a bachelor's degree in engineering could open up wider career opportunities with better remuneration than a science degree (e.g. Dar & Getz, 2007). Students who are interested in a science-oriented career would probably opt for Engineering programmes as they are usually perceived to provide better career prospects.

When gender differences are examined, we found that upper secondary and junior college students largely follow gender-typical choice patterns, with males inclining towards Engineering—a finding also reported elsewhere (e.g. Riegle & Moore, 2013). Thus, our findings on gender are consistent with those reported in the literature, even though it is from a different cultural context. Females are likely to choose Arts and Social Sciences. This pattern is also what was recorded in the local universities' enrolment data. From 2004 to 2011, the number of males enrolled in Engineering courses at the local universities outnumbered females by at least half (Yearbook of Statistics Singapore, 2010). Similarly, the number of females enrolled in Humanities and Social Sciences outnumbered males by at least half over this period. A contributing factor for this trend could possibly be the old-school belief that Engineering and Science courses are for males while Arts and Social Sciences are for females.

Upper secondary and junior college students responded in a similar manner in that they are likely to choose a university programme based on personal (own ability and individual interest) and career reasons (career aspirations, market demand, and salary). There were negligible differences between these two groups in this respect. This is in line with Kelly's (1988) as well as Dawson and O'Connor's (1991) findings that personal and career-related reasons are highly considered on enrolment decisions. Similarly, Woods (1979) also reported that liking for a subject and career considerations are two major components that influence enrolment choices among students.

In terms of gender differences, we found that females are more influenced by the 'liking' component (Sleet & Stern, 1980, as reported in Dawson & O'Connor, 1991; Woods, 1979). Also, females are likely to consider career orientation when choosing a university programme far more than their male counterparts. This is unique as studies have reported that males are more concerned (Woods, 1979) or, at least, it is equally important for both genders in this respect (Sleet & Stern, 1980, as reported in Dawson & O'Connor, 1991). This implies that though female students would generally veer towards female-typical programmes, they position their tertiary education as a career platform in which they place this emphasis more than males! It is the culture in Singapore that women prefer to be economically and socially independent. The career opportunities for them in technical and professional areas are equal to that of males. The underrepresentation of females in these areas can be better addressed by providing more incentives and scholarships to them to major in technical sciences at the university, publicizing the diversity of career opportunities available in these fields and highlighting the success stories of females in these professions. Such approaches can help to encourage the entry of more talented females into Science and Engineering professions.

Peers, parents, senior students, and teachers are not likely to be the key parties students would turn to or listen to, which is in line with the findings from other studies (e.g. Myeong & Crawley, 1993; Stokking, 2000). This finding indicates that

Singapore students are quite independent in making decisions on university programme choices. External parties are unlikely to exert strong influence on their decisions as their individual interests and career aspirations cannot be subordinated to these. However, among these parties, parents are found to exert relatively more influence than others; this finding is in line with the observations of Kremer and Walberg's (1981), as reported in Dalgety and Coll (2004). Also, we found that female students are more likely to be influenced by parental views, thus corroborating the findings of Dawson and O'Connor (1991).

## Implications

It is suggested that the present study has a few implications for science education research. Firstly, students who take physical science subjects in school prefer Business Studies as their predominant choice to pursue at university. Pragmatic considerations must definitely be at work here since graduates in these disciplines have wider career options in a bustling metropolis that Singapore is. Materialistic considerations cannot also be ruled out as these graduates generally command higher starting salaries. It seems that the pursuit of science for its own sake at the tertiary level may have to be subordinated to these considerations—and this means that tertiary enrolment in the sciences, especially physics, would generally be not up to expectations in most countries despite good-intentioned interventions. This is despite the fact that Singapore's education system is highly regarded in the world—the recent McKinsey Report (2010) has ranked it as being among the most competitive in the world. In fact, the preference for business studies is also noted in the study by Maringe (2006), but his sample comprised adolescent students, with no indication of their academic background. Secondly, while a number of studies in the West have suggested that science is generally not of much desire among young students, as shown by the declining enrolment in science, it is not appropriate to generalize it in the Asian context or, at least, in the Singapore context. Though science is unlikely to be the first choice, it is not totally neglected by the youngsters here. It is still perceived to be important by these students, though it may not be considered as the first choice to pursue at the university. A recent study in Korea, however, suggests that interest in science at the secondary level does not necessarily equate to a measure of students' science learning in class (Lin, Lawrenz, Lin, & Hong, 2013). Thirdly, the three most important reasons influencing programme choice are interest, ability, and career aspiration.

What are the possible interventions that could be taken in light of this study if the declining enrolment in technical science programmes is to be arrested? Being interested in science but not wanting to study it at higher education could be due to the perception that career opportunities for science graduates are not promising. A range of employment options or career choices available in science could be actively promoted by schools in collaboration with science-based professional societies and associations. Members in these societies and associations come from a range of professions and they are ideally poised to show that there is no dearth of opportunities for science graduates. Regular career talks, especially from suitable role models in the private sector, are also important as beliefs with regard to enrolment in science are formed in the early secondary school years. In fact, students tend to perceive 'less favourable consequences in science as they progress through the secondary school years' (Crawley & Black, 1992). Teachers should also provide relevant information on various career opportunities in science. This could serve to capture the interest of students who are interested in science as well as further strengthen their beliefs in science till their final years in secondary school or junior college. Also, this can help to enhance students' interest in pursuing science programmes at the university. Some support for this can be found in the work of Eccles (2007) on subjective task value. Whether this translates into a change in individual interest, which is intrinsic by nature, would need further work.

It would be useful to explore cross-cultural studies using the instruments developed in this study. Cross-cultural studies in science education (e.g. Tan et al., 2008) are useful as it helps to see to what extent findings can be generalized and to better understand differences.

## Limitations and Future Work

The sample of students that participated in this study are only a fraction of the students in the country. Requesting students to choose possible tertiary programmes and rate the reasons affecting programme preferences may be somewhat difficult for students at the upper secondary level. The selection hence is merely their preference and may differ from what they eventually select in the future. The interpretation of the results is thus to be viewed in these contexts. Also, the students may not be consciously aware of what really influences them in their decision and may give socially desirable responses (Kelly, 1988), even though there is no evidence to suggest this for our sample. A longitudinal study would be preferable in order to investigate if their final programme choice decision corroborates with their initial intention and if the reasons they mentioned do really matter in their programme choice.

The programme choices included in this study are typical of those being offered at the three public universities in Singapore, with the National University of Singapore (NUS) being taken as the major guide because it is the oldest university in Singapore. In some countries, the programme of Arts & Social Sciences is included in the programme of Music, but they are listed separately in undergraduate courses by NUS. In NUS, under the programme of Arts & Social Science, are included other majors such as Chinese Studies, Communications & New Media Programme, English Language & Literature, Geography, History, Philosophy, Political Science, Psychology, Social Work, and Sociology, but Music is not included as part of the majors—it is listed separately from Arts & Social Sciences programme. Therefore, the inclusion of the programmes is not entirely sufficient to account for all the university programme choices relevant to all countries. However, it can be scaled up for studies in other countries.

## Conclusion

The present study provides a modest contribution to the literature in that the declining enrolment in science does not necessarily indicate declining individual interest of students in learning science. This is likely to be true at least of Singapore, whose students consistently perform well in international science and mathematics assessments. Thus, it is not surprising that the samples in this study also expressed some preference for technical programmes at the university even though these are not their first choice. Most prefer Business programmes. They tend to look at what they like and also consider their own ability in tertiary enrolment decisions. Taking an international perspective, one possible solution to address the issue of declining interest in science at the tertiary level would be to offer science with business at the baccalaureate level—for example, Queen Mary's College in London offers an undergraduate programme called 'physics with finance'. It may well be that rebranding of university programmes via subjects integration may have to be pursued in order to address the declining interest in science, especially physics, as it can cater to the preference of science students. Knowing that business is a popular tertiary programme choice, a hybrid degree course with science may well help to enhance enrolment in the sciences. It is thus important for university administrators to know the current popular university programme preferences of students and the reasons students consider when choosing a programme at a tertiary institution. These could provide them some pointers in formulating strategies to help address the declining enrolment in the sciences, especially physics.

## Acknowledgements

We thank the two reviewers for their detailed reading of our manuscript and for providing several helpful suggestions, which have helped us to significantly improve our manuscript. We thank the Ministry of Education for permission to approach schools for this study and the various schools for allowing their students to participate in this study. We thank the Nanyang Technological University for the award of a Research Scholarship to the first author. (The views expressed in this paper are those of the authors, based on their interpretation of the results from this study, and do not necessarily represent those of any of the national agencies mentioned in this paper.)

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