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Why school students choose and reject science: a study of the factors that students consider when selecting subjects

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ABSTRACT
Student study of science at school has been linked to the need to provide a scientifically capable workforce and a scientifically literate society. Educators, scientists, and policymakers are concerned that too few students are choosing science for study in their final years of school. How and why students choose and reject certain subjects, including science, at this time is unclear. A Best–Worst Scaling (BWS) survey was completed by 333 Year 10 (age 14–17) students to investigate the relative importance of 21 factors thought to impact students' subject-selection decisions. Students ranked enjoyment, interest and ability in a subject, and its perceived need in their future study or career plans as the most important factors in both choosing and rejecting subjects. They considered advice from teachers, parents or peers as relatively less important. These findings indicate that enhancing students' enjoyment, interest, and perceptions of their ability in science, as well as increasing student perceptions of its value in a future career, may result in more students studying science at school.

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Subject choice; science; post-compulsory; best–worst scaling; career; STEM

Introduction

Our modern society is dependent on science to provide new knowledge, technologies, and solutions to pressing world problems (Goodrum, Druhan, & Abbs, 2012; Tytler, 2007). However, many children become disenchanted with science when they enter high school and develop a view that the subject is irrelevant and uninteresting (Goodrum, Hackling, & Rennie, 2001). When given the opportunity to choose subjects for their final years of schooling, almost half of Australian Year 10 (typically age 15–16) students do not choose a science subject for their final two years of schooling and instead choose alternative subjects from the wide range of courses available to them (Kennedy, Lyons, & Quinn, 2014; Lyons & Quinn, 2010, 2015).

The study of science in the final years of school is critical to the flow of the scientifically trained individuals needed for our modern society because the subject-selection decisions that teenagers make influence their potential career paths (Thomson, 2005; Warton & Cooney, 1997). Senior study in science provides a path to not only potential careers in

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science but also a scientifically literate community that is needed for social and economic progress (DeBoer, 2000; Woods-McConney, Oliver, McConney, Schibeci, & Maor, 2014).

The importance of maintaining and enhancing the flow of scientists and increasing the scientific literacy of the general populace means it is critical to study the decision point at which students choose not to continue with science when given the choice at school. Given the widely held view of the importance of science, technology, engineering, and mathematics (STEM) skills to economic prosperity, the fall in enrolments in senior science subjects that has occurred in recent decades is of concern to educators and policymakers in many nations. This research investigates how students are influenced to continue with the study of science by asking the research question, 'What is the relative importance of the factors that students consider in choosing their subjects for their final years of school?'

The remainder of this paper is organised into four sections. The first is a brief literature review that outlines the research into factors influencing choice of science at school. The second section describes the generation of a list of factors students consider when choosing their subjects, and the construction of an online survey that incorporated a Best–Worst Scaling (BWS) task to help quantify the relative importance of these factors. The research findings for the survey are presented in the third section, which is followed by a discussion of these findings, their limitations, and future research opportunities.

Background literature

There has been considerable research conducted on the factors influencing students' choices to continue with science at school or not (e.g. Ainley, Kos, & Nicholas, 2008; Henriksen, 2015; Lyons & Quinn, 2010; Regan & DeWitt, 2015). The factors commonly cited as being major influencers of the decision to choose science at school are: students' engagement in previous school science, their perceptions of the usefulness of science, socio-economic factors, gender preferences for some science subjects, and the decreased relative popularity of science as a subject generally. In order to provide a coherent and brief description of the factors that may impact on students' choice of science, we have classified these factors into two areas: *intrinsic* factors relating to the student themselves and their preferences, and *extrinsic* factors relating to the environment within which subject choice is made.

Intrinsic factors for choice of science

The intrinsic factors impacting on students' choice of science are grouped into four themes for discussion: attitudes; interest and engagement; ability and self-efficacy; and gender.

Attitudes

Students' attitudes to different aspects of science are important in understanding the decline in students choosing science (Osborne, Simon, & Collins, 2003). Tytler and Osborne's (2012) review of student attitudes and aspirations towards science illustrates the extensive research in this area over many years. This research shows that students' attitudes towards school science are typically positive, although these decline through adolescence. School science is also less popular than other subjects. There is some agreement among academics that students' attitudes towards doing school science is declining in

Western societies. However, Lyons and Quinn (2010) note that Australian students' attitudes towards science and scientists and their enjoyment of the subject are not significantly different from those expressed by students two decades ago when science enrolments were high. Further, a longitudinal study in England found the majority of the 5600 children surveyed enjoyed science in secondary school and had a positive view of scientists (DeWitt, Archer, & Osborne, 2014).

Interest and engagement

According to Ainley and Ainley (2011), students' interest in and enjoyment of science are closely related. Their analysis of 2006 data from the Program for International Student Assessment (PISA) shows that individual interest and engagement in science are important in the formation of adolescents' intentions to continue with learning about science. The development of personal interests (defined as the motivation to pursue an objective) is believed to be strongly related to subject choice and subsequent vocational choice (Elsworth, Harvey-Beavis, Ainley, & Fabris, 1999). By mid-to-late adolescence, students are likely to have formed an enduring interest in activities in which they see themselves as competent and from which they expect to receive valued outcomes.

Ability and self-efficacy

Academic success in a subject (ability) is linked to students' attitudes, self-efficacy and interest in a subject. The beliefs adolescents have about their abilities influence their choices as well as their lives (Bandura, 2006). Interest and achievement in a subject are related to a students' academic success in that subject and are likely to lead to even further interest in it (Brown & Lent, 2006; Kidman, 2009). Students who are successful in science in their earlier years are generally those who are encouraged to continue with the science when it becomes an elective (Smith & Gorard, 2011). Students who perceive that they lack ability in science state this is a reason for not choosing to study post-compulsory science (Lyons & Quinn, 2010). There is evidence that students may not choose physics and chemistry in particular, as they believe it is more difficult to achieve high marks in these subjects (Ainley et al., 2008; Lyons & Quinn, 2010).

Gender

Gender-based preferencing of some science subjects has been suggested as an important factor affecting choice of science at school, particularly with respect to the underrepresentation of girls in science (Ceci & Williams, 2007; Kessels & Taconis, 2012). According to Regan and DeWitt (2015), important factors contributing to fewer girls choosing science are that girls consistently show less positive attitudes to it than boys, display lower self-efficacy in it, and may identify science as being a 'masculine' pursuit. Blickenstaff's (2005) review of 30 years of research into explanations for the underrepresentation of women in STEM suggests that the problem is complex and unresolved, but he argues that genetic differences between the sexes are not the reason for lower participation. He suggests that improvements in the teaching of science may improve female participation rates. A meta-analysis study on gender and science research conducted by the European Commission on gender segregation in research careers states that a change in culture of science and research will be required to encourage more women to study science (Caprile, 2012).

Extrinsic factors for choice of science

Factors within the immediate school and home environments of students have been found to be associated with the decline in choice of science for further study (Cleaves, 2005). We group the impact of extrinsic factors on the choice of science into five themes for discussion: socio-economic factors; persons of influence; teaching and curriculum; careers; and logistics of choice.

Socio-economic factors

The socio-economic status (SES) of a student and the socio-economic composition of their school are associated with a student's choice of, and performance in, science (Ainley et al., 2008; Anderhag, Emanuelsson, Wickman, & Hamza, 2013; McConney & Perry, 2010; Smith & Gorard, 2011). Students from poorer socio-economic and non-English speaking backgrounds are less likely to choose science than those from more affluent families and those where English is a first language (Ainley et al., 2008).

Persons of influence

Teachers, parents, and peers are believed to influence a students' interest and achievement in science. Students who have parents with better educations are more likely to choose science (Anderhag et al., 2013). Henriksen, Jensen, and Sjaastad (2015) found in their study of 5007 Norwegian students that parents who were engaged in STEM make the choice of STEM likely for children and that teachers can influence science choice by giving pupils positive experiences with the subject. The impact that peers have on choice of science is not clear; although during the period in which subjects are chosen, the influence of peers on other aspects of an adolescent's life is considerable (Ryan, 2000; Santrock, 2010).

Teaching and curriculum

While both science and non-science teachers can advise and influence students in their decision-making about subjects for study, it is in the classroom where much of the experiences around a subject occur. Teaching quality has therefore been suggested as an important factor in student's choices of particular school subjects, and their engagement and success in them (Tytler, 2007; Tytler & Osborne, 2012). However, science teaching has been criticised for remaining unchanged for decades – utilising transmissive, traditional teaching techniques that conflict with the needs of modern students (Goodrum et al., 2001; Tytler, 2007). If students see classroom science as uninteresting and difficult, this can negatively affect their interest, self-efficacy and attitude towards the field and, in turn, reduce the likelihood of choosing a science subject (Christidou, 2011; Goodrum et al., 2012).

Careers

The subjects students choose to study in their final years influence the career and study options open to them (Bøe, Henriksen, Lyons, & Schreiner, 2011; Thomson, 2005). Senior students have reported that they chose science to meet university prerequisites and to maintain their career options (Goodrum et al., 2012). The choice of science is an important decision on the path to a STEM-related career (Thomson, 2005; Warton &

Cooney, 1997). In a study of physics choice in secondary education, Stokking (2000) found that the future relevance of the subject for further study or for entering a profession were the main predictors of students deciding to study physics. In addition, there is concern that school students may not choose science because they are unaware of the diversity and nature of science-related careers (Goodrum et al., 2012). The conceptions that students have of science as being difficult, isolating, and uncreative, as well as stereotypical images of scientists (in laboratory coats and safety glasses), also influence the science subject choice decision (Regan & DeWitt, 2015). Several authors have argued that increased knowledge of the relevance of a science degree, and a more authentic understanding of the nature and practicalities of being a scientist, may improve the perception of science as a career (Cleaves, 2005; Rodrigues et al., 2007; Tytler & Osborne, 2012).

Logistics of choice

Students often choose subjects from an extensive range of subjects available and this has led to the suggestion that competition among these subjects may result in fewer students choosing science (Lyons & Quinn, 2010). Restrictions in the timetabling of subjects for senior students can also mean that some subjects may be unavailable to students. Goodrum et al. (2012) provides evidence of students who did not choose science mentioning timetable limitations as a reason for their choice. Further, not all schools make all science subjects available. Harris, Baldwin, and Jensz (2005) conducted a study of 219 Australian schools and found that 20% of the schools did not offer a senior subject in either biology, chemistry or physics and 4% did not offer any of these three subjects.

In summary, the literature suggests many interrelated factors influence student choices to continue studies in science. The impact of individual factors is difficult to determine, and their relative importance to student's decisions is not fully understood. This makes it difficult to formulate strategies that might remedy the problem of lower than desirable enrolments in science. To address this gap in our knowledge, we used a BWS methodology (Louviere, Flynn, & Marley, 2015) to quantify and rank the importance of factors students consider in their subject-selection decision.

Methodology

In order to determine the relative importance of the factors students consider in choosing or rejecting a subject at school, a survey was conducted with 378 Year 10 (ages 14–17) students from five schools in metropolitan Sydney, Australia. We now provide background for the BWS methodology used, along with details of the development of the survey instrument and sampling strategy.

BWS instrument

The BWS method is a well-validated technique that allows factors identified as impacting a decision-making process to be ranked according to their importance (Louviere et al., 2015). The BWS method was first described by Finn and Louviere (1992) and is based on random utility theory and discrete choice modelling (McFadden, 1974; Thurstone, 1927). The BWS instrument used in this study was an online survey that presented students with sets of factors believed to influence their subject-selection decisions. These sets presented the factors multiple times to students in different combinations. By comparing the choices respondents made within each set, a hierarchy of the average relative importance of all factors was created and quantified. A BWS task such as this is similar to a traditional choice task where respondents make a free choice from a set of options, but it utilises additional information about respondents' most and least preferred options. A 'Case 1 BWS Task', as is utilised here, presents objects as being described by just a single factor that may influence subject choice, such as the difficulty of the subject or the perception that the subject will be enjoyable.

The BWS method has a strong mathematical basis and is well validated (Louviere, Lings, Islam, Gudergan, & Flynn, 2013; Marley & Louviere, 2005). It has been utilised to understand how choices are being made in a variety of areas, including health (Lancsar, Louviere, Donaldson, Currie, & Burgess, 2013), public food safety (Finn & Louviere, 1992), and ethical consumption (e.g. Burke, Eckert, & Davis , 2014). At the time of writing, BWS had been used in a single education study on the effective retention of early career teachers (Burke et al., 2013). This paper presents the first study to use BWS as a methodology to understand student subject choices.

Factors for BWS

To generate the list of factors believed to impact subject choice, extensive prior research was conducted in four schools in metropolitan Sydney. This included: (a) 10 focus groups each with five upper-secondary students; (b) interviews with 15 adult subject-selection stakeholders within schools; (c) observations conducted at seven subject-selection events; and (d) a review of the literature relating to subject choice (Palmer, 2015). A list of 21 factors that students considered in their subject-selection process was created. This list was presented at a conference of science education researchers for discussion to obtain further feedback.

The focus groups conducted to generate the list of factors involved students describing their subject choice decision-making process. The focus groups revealed that students appeared to use one set of reasons that were positive and supportive for choosing a subject (e.g. enjoyment; likelihood of getting good marks) and another set of reasons for not studying a particular subject (e.g. they were already taking too many subjects). This is consistent with work by Shafir (1993) on choosing and rejecting choices. Thus, the survey instrument reflected this phenomenon by expressing the 21 factors as attribute statements that approached the decision-making process in terms of choosing a subject (BWS-Choose) and also rejecting a subject (BWS-Reject). Table 1 shows the list of factors and two versions of the attribute statements produced.

To determine which factors to show in which particular set in the BWS task, a Balanced Incomplete Block Design (BIBD) was used to maximise statistical efficiency (Street & Burgess, 2007). BIBD is an experimental design that allowed the 21 attribute statements to be arranged into sets, such that each statement could be assessed against every other statement with the number of sets minimised. The statistical design resulted in 21 sets that each contained five attribute statements. Each of the 21 statements appeared five times in the survey and co-appeared with each other statement once. Within each

Table 1. BWS-Choose and BWS-Reject subject-selection attribute statement pairs.

Grouping	Factor #	Factor title	Attribute statement for BWS-Choose	Attribute statement for BWS-Reject
Advice	1	Parent advice	My parent(s) suggested doing the subject	My parent(s) suggested not to do the subject
	2	Older peer advice	Older students or sibling suggested doing the subject	Older students or sibling suggested not to do the subject
	3	Peer advice	A friend in my year suggested doing the subject	A friend in my year suggested not doing subject
	4	Teacher advice	My teacher suggested doing the subject	My teacher suggested not to do the subject
Enjoyment and Interest	5	Interest expectation	I will find the subject interesting	I will find the subject boring
	6	Enjoyment experience	I enjoyed the subject (or similar subject) in middle school	I did not enjoy the subject (or similar subjects) in middle school
Logistics	7	Number of units	I needed extra units	I had too many units
	8	Timetable fit	The subject fitted with my timetable	The subject did not fit my timetable
	9	Information	I had plenty of information about the subject	I did not have enough information about the subject
Ability (marks)	10	Ability	I received good marks in this subject (or similar subject) in middle school	I received poor marks in this subject (or similar subject) in middle school
	11	ATAR[a] scaling	The subject will scale well for my ATAR	The subject will not scale well for my ATAR
	12	Mark expectation	I think I can get good marks in the subject	I think it will be hard to get good marks in the subject
Subject characteristics	13	Assessment type	I like the type of assessment	I do not like the type of assessment
	14	Classwork style	I will enjoy the classwork for this subject	I won't enjoy the classwork for this subject
	15	Difficulty	I will find the subject easy compared to other subjects	I will find the subject difficult compared to other subjects
Teaching	16	Teacher quality	I think the subject's teachers can help me get a good mark	I don't think the subject's teachers can help me get a good mark
	17	Teaching style	I like how the subject is taught	I do not like how the subject is taught
	18	Teacher like/dislike	I like a teacher or teachers I might get	I dislike a teacher or teachers I might get
Usefulness	19	Need for future study	I probably need the subject for my future study	I probably do not need the subject for my future study
	20	Need for personal life	The subject will be useful in my personal life	The subject will not be useful for my personal life
	21	Need for career	The subject could be useful for my career	The subject is unlikely to be useful for my career

[a]ATAR is Australian Tertiary Admission Rank, the primary measure for undergraduate entry into university in Australia.

question, students chose the statement they found most important (best) and least important (worst). Students were shown either the BWS-Choose or the BWS-Reject statement sets but not both. The benefit of the BIBD design is that respondents compare every statement with every other statement in the fewest number of sets possible, balancing both appearance and co-appearance.

For the BWS-Choose survey, the instructions to students read: 'Please think about how you chose your subjects for Year 11. For each of the sets of features below, please choose the feature that you find most important and least important in choosing a subject to study.' The BWS-Reject version replaced the word choosing with rejecting. An example of a set of statements presented to students from the BWS-Choose survey is presented in Figure 1.

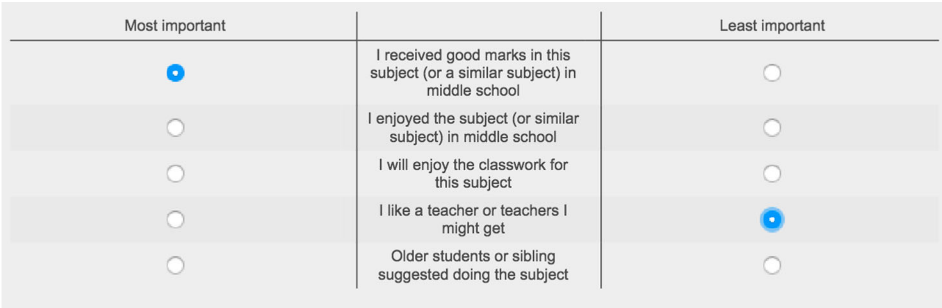

Figure 1. Example of BWS-Choose statement set.

Instrument testing

To validate the questions in the survey, three 16-year-olds from one of the participating schools were asked to explain their understanding of the meaning of each question. Feedback from these students led to refinement of the statements to achieve coherence between the intended meaning and interpretation of the teenagers. The survey was also reviewed by university academic experts in the fields of education, BWS and statistics.

The online survey was constructed and trialled by a further three students from a participating school who were statistically similar to the students in the school sample. These students completed the survey and provided feedback on their understanding of the survey and the difficulty or ease of its completion. The survey was then submitted to the schools for review and no changes to it were suggested by school representatives. The survey was conducted in the final term of the school year after the Year 10 students had chosen their subjects for Year 11.

Participants

The survey was made available to all Year 10 students at five schools in metropolitan Sydney, Australia, chosen using the Australian Government's *My School* directory (www.myschool.edu.au). The schools were of similar, above average SES. These schools were selected in an attempt to control for SES as a variable that is reported to be a key factor in a student's choice to participate in science (Ainley et al., 2008). The average number of enrolled students at the five schools was 1203 (SD = 255), although two of the schools included primary school students in their enrolment figures. The schools chosen had differing gender mixes and were within a geographic range that made it practicable for them to be visited repeatedly by a single researcher.

Each school chose how it would administer the survey to their students. Two schools allocated class time to complete the survey and a researcher supervised its administration. Two schools informed students about the survey and invited them to complete the survey in their own time, and then sent students a follow-up email reminder. One school emailed students an invitation to complete the survey.

A total of 386 students opened the online survey and 379 students (98%) commenced it. The BWS-Choose and BWS-Reject versions of the survey were allocated randomly to

Table 2. Number and percentage of respondents to the BWS survey by gender and school sector.

	BWS-Choose		BWS-Reject	
Students	Number	Percent	Number	Percent
Boys	93	59	89	51
Girls	64	41	87	49
Government schools	22	14	24	14
Non-government schools	135	86	152	86
Age 14	3	2	0	0
Age 15	54	34	53	30
Age 16	100	64	120	68
Age 17	0	0	3	2
Total	157	100	176	100

respondents by the survey software. Of the 333 students who completed be BWS survey in full, 157 (47%) completed the BWS-Choose version of the survey and 176 (53%) completed the BWS-Reject version of the survey. The median time to complete the survey was 13 minutes.

Table 2 shows that of the 333 students who participated in the survey, 55% were boys and 45% were girls. The majority of students were aged 15 (32%) and 16 (66%).

Survey analysis

BWS analysis (also called 'MaxDiff' analysis) was used to determine a score of relative importance for each of the factors that impacts the decision process being investigated (Marley & Louviere, 2005). In the current setting, scores ranged from a minimum of −5 (where a factor was always as chosen as worst) to a maximum of 5 (where a factor was always chosen as best). Ordered probit or logit models were used to estimate linearly equivalent importance scores for each statement, at the aggregate level. The advantage of the best–worst scoring method is that scores can be calculated for each individual. BWS scores are presented as means and 95% confidence intervals. Inferential statistics were conducted using two samples (independent) *t*-tests of unequal variance to compare pairs of BWS scores.

Results

BWS-Choose

The BWS-Choose survey allowed the factors that students considered in choosing their subjects to be scored using BWS analysis and thus compared. Figure 2 shows the mean BWS score, with corresponding 95% confidence intervals for the 21 factors students considered when choosing which subjects to study in Year 11 at school. These results were sorted to reflect the ranking of factors for choosing a subject, from the most important at the top to the least important at the bottom.

Analysis revealed that seven factors were relatively more important to students in choosing a subject for future study: (1) expectations about how interesting the subject will be; (2) the subject requirement in pursuing a career; (3) expectations about marks; (4) whether it is a requirement for future study; (5) how enjoyable the subject will be; (6) the students' perceived abilities in this area of study; and (7) the style of classwork

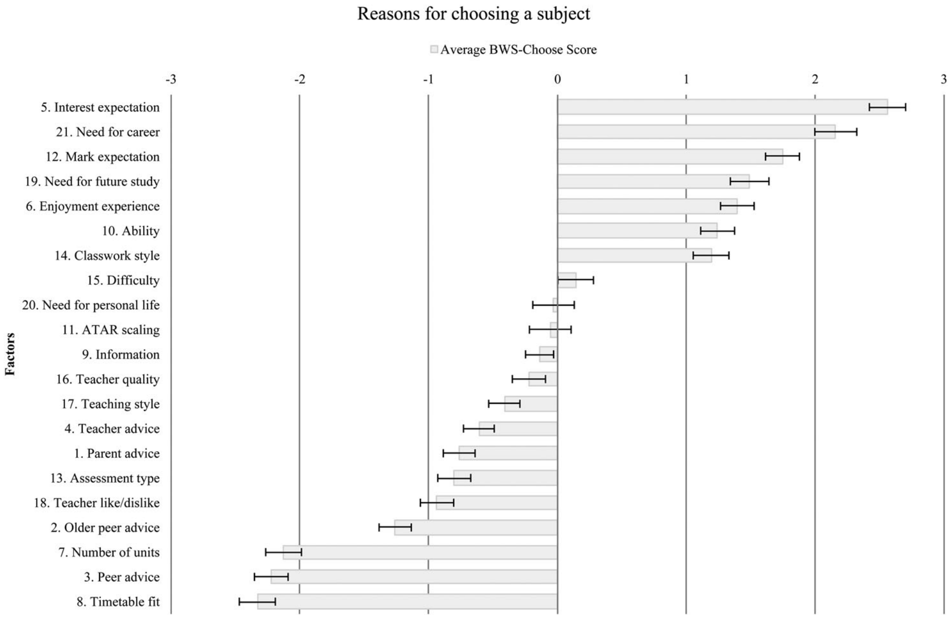

Figure 2. BWS-Choose: Reasons for choosing a subject.

relating to the subject. The first two ranking items –'interest expectation' and 'need for career' – were most important in terms of their impact on decision-making, with the next five items being of similar importance to adjoining ranked factors.

Factors that were considered relatively less important in students' subject choice decisions relate to the constraints about the number of units a student is required to study, peer advice, and timetable constraints. There were no significant differences between these three factors. There is a significant difference ($p < .001$) between these lowest three items and the factor 'older peer advice'.

BWS-Reject

The BWS-Reject survey allowed ranking of the factors that students considered in rejecting a subject for study in Year 11. Figure 3 shows the mean BWS score and corresponding 95% confidence interval for the 21 factors students considered when choosing which subjects they did not want to study in Year 11 at school.

Analysis revealed that six factors were relatively more important to students in rejecting a subject for future study: (1) enjoyment experience; (2) interest expectation; (3) mark expectation; (4) ability; (5) classwork style; and (6) need for career. The first item – 'enjoying a subject' – is the most important, with the next five items being of similar importance to adjoining ranked factors.

A friend's suggestion not to choose the subject was considered the least important factor in choosing which subjects to reject and was significantly different ($p < .001$) from the penultimate factor, which related to the subject not fitting with a student's timetable.

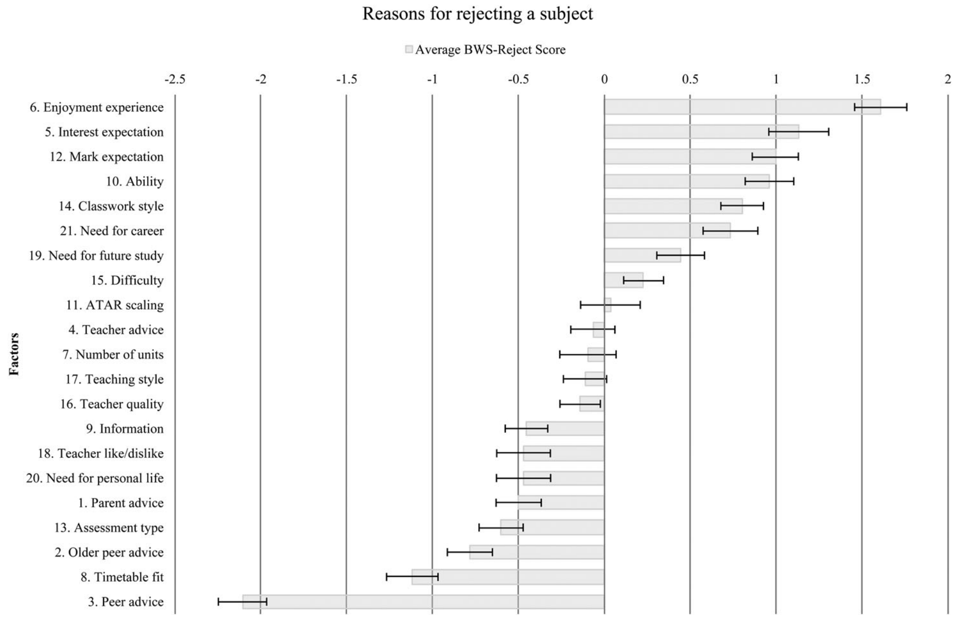

Figure 3. BWS-Reject: Reasons for rejecting a subject.

BWS-Choose and BWS-Reject

Overall, the range in scores for BWS-Choose (Range 4.89, Minimum −2.33, Maximum 2.56) is greater than for BWS-Reject (Range 3.73, Minimum −2.10, Maximum 1.62). Table 3 shows the seven highest ranking factors in students' decisions to choose or reject a subject for their final years of school. The same seven factors appear as most important when either choosing and rejecting subjects. The scores for the factors for BWS-Choose and BWS-Reject versions of the survey are highly correlated ($r = .87$). This supports the idea that students consider these two viewpoints in a similar manner, but there may be some differences in how they rank factors.

Students who chose science versus those that did not

A comparison of students who had indicated that they had chosen science for study to those who had not was conducted. The correlation between the mean scores of students who stated they had chosen a science and those who said they had not chosen a science was .98 and .92 for the choose and reject versions of the survey, respectively. This suggests that students who chose and did not choose science made their subject-selection decisions in a similar way. Further investigation at the individual statement level indicated that for BWS-Choose, the factor 'parental advice' was the only factor that was scored significantly differently at the 95% level ($t(148) = -2.00$; $p = .0477$). Specifically, parental advice was found to be significantly less important for students who chose science ($M = -1.26$) than those who did not choose science ($M = -0.76$).

For BWS-Reject, the factors 'teacher advice' and 'need for personal life' were scored as significantly different ($p < .05$) by students who did and did not choose science. Advice

Table 3. Top seven reasons to choose or reject a subject for students' final years of school.

Reasons to choose a subject	Reasons to reject a subject
Interest expectation	Enjoyment experience
Need for career	Interest expectation
Mark expectation	Mark expectation
Need for future study	Ability
Enjoyment experience	Classwork style
Ability	Need for career
Classwork style	Need for future study

from teachers was considered significantly more important by students who had chosen science (science students $M = 0.12$ versus no science students $M = -0.47$; $t(137) = 2.32$, $p = .0221$). The need for a subject in a student's personal life was also considered relatively less important than other factors, but this was significantly more so for students who chose science than those who did not choose science (science students $M = -0.69$ versus no science students $M = 0.05$; $t(119) = -2.31$, $p = .0226$). With so few differences in scores of the 21 factors and high overall correlation, the results largely indicate that the factors used by students to choose or reject subjects is the same among those who choose to study science and those who do not.

Discussion

This research seeks to inform strategies to improve the uptake of science by understanding how students evaluate and select subjects for study in their final years of schooling. It addresses the research question: 'What is the relative importance of the factors that students consider in choosing their subjects for their final years of school?' The BWS results presented here provide quantitative data on the relative importance of the factors that students considered in choosing and rejecting subjects for post-compulsory study at school. This study represents the first time that BWS has been used to study the factors for school subject choice.

Before discussing each theme emerging from the results in greater detail, it is worth noting that the choosing and rejecting versions of the survey showed that the same seven factors were ranked as most important in students' subject-selection decisions, and overall the two sets of results were highly correlated. This suggests that from the perspectives of choosing and rejecting subjects, it would not be fruitful to develop different strategies based on students approaching the subject-selection decision process from these differing viewpoints.

Overall, the results suggest the dominance of intrinsic factors relating to the student themselves over extrinsic factors relating to the environment within which subject choice is made. Of particular note is the greater importance placed on student interest in a subject, their past and anticipated performance in a subject, and need for choosing subjects that will be useful in their chosen careers. Extrinsic factors relating to the logistics of timetabling constraints or unit requirements appear to be much less important in considering subject choices. The importance of teachers both as advisors and in their role in delivering quality learning experiences is less clearly defined. What is apparent is that subject-selection advice from others, particularly older students, siblings and peers, is less important relative to students themselves believing they will excel in and enjoy subjects. As such, the results indicate some implications for encouraging students to choose science in the future.

Science needs to be interesting and engaging

Students ranked their expectations of finding a subject interesting and enjoyable as the most important influences on their decision to choose or reject a subject. These findings align with research that found enjoyment, interest, success, value, and prior school experience of science are key factors on choice of science at school (Osborne et al., 2003; Shirazi, 2013). Interest, anticipation and enjoyment therefore appear to be critical for the subject-selection and decision-making processes.

Science will be chosen by those with perceived ability and self-efficacy

A student's past performance and their expectation of 'getting a good mark' were all relatively important factors in choosing and rejecting subjects. These findings align with the concept that a student's self-efficacy beliefs influence their choices (Bandura, 2006). Students also ranked the difficulty of a subject relative to other subjects as one of the most important factors in their deliberations. Science is generally seen as a difficult subject compared to other subjects (Palmer, 2015; Osborne & Collins, 2001) and changing this perception may represent an important strategy to improve science subject choice.

Advice from others is relatively less important

The advice from others was seen as relatively less important in subject selection, with peer advice being considered the least important advice in both choosing and rejecting a subject. The low ranking given to the advice of peers and older siblings is interesting given adolescents are believed to be sensitive to their social environment (Silvers et al., 2012), and these findings indicate that students' social environments may complicate subject choice. Prior research on subject selection found that adolescents resented the notion that they chose subjects based on peer relationships (Palmer, 2015).

Science teaching needs to create relevance now and in the future

The results of the study indicate that teachers are relatively less influential in subject choice, not only through their advice, but also with respect to their likeability. This finding is interesting given the widely held view that teaching is a critical factor in student enjoyment and interest in subjects at school (Hattie, 2003; Osborne et al., 2003). As the BWS survey shows that enjoyment of a subject is the most important ranked factor in subject choice, this result may relate to students' not knowing who will be teaching senior subjects and hence discounting the importance of this factor in subject selection.

One role that teachers may provide in relation to uptake of science is creating more positive perceptions around the usefulness of the subject for future study plans, personal life and career. Interestingly, the results were mixed and depended on the type of need defined for a subject and whether students were considering subjects to choose or reject. Needing a subject for a student's career and future study is ranked as a relatively important factor in the decision to choose or to reject a subject. This indicates that students will study a subject if they need it for a career or future study, but not necessarily reject it if they do not. Students ranked the factor relating to university admission (ATAR scaling) as a middle ranking factor. This may be due to them being told by adults within schools not to choose subjects on the basis of calculation of the ATAR (Palmer, 2015).

It is clear that among the top factors in both choosing and rejecting subjects, the anticipated style of classwork was an important antecedent to subject choice. In this regard, a contemporary style of classwork with, for example, authentic investigations, is likely to address perceived shortcomings about how science is taught (Goodrum et al., 2001; Tytler, 2007).

The usefulness of a subject for a student's personal life was considered to be a medium-ranking factor in choosing subjects and a low-ranking factor in rejecting subjects. The lack of relevance of school science to everyday life has been noted as a reason that students may not choose science subjects (Aschbacher, Li, & Roth, 2010). This finding indicates that the importance of relating science to everyday life may not be as important as other factors students consider, particularly for students who are looking for subjects to reject. However, it is plausible that relating science to students' lives may increase their enjoyment of the subject and lead to selection of science indirectly. The relationship between teaching, subject enjoyment, classwork style and choice of science represents a further area of investigation.

Subject constraints and timetabling are relatively less important but not unimportant

The logistics of choice was relatively less important than other factors presented, suggesting that students did not feel limited in their subject choices by the availability of subjects or a lack of information about the subjects.

It is important to note that interpretations of the findings are made in relative terms. That is, the factors at the lower end of the scale of importance are not necessarily unimportant in science choice. The objective of the present study was to assess factors in relative terms rather than absolute terms.

Future research and conclusion

If we wish to encourage more students to study science for their final years of school, and perhaps into university, then knowledge of how science is chosen or rejected at the time subjects are chosen is important. The replication of this study in a range of geographical regions and socio-economic groups would be instructive. For example, the students participating in this study were from a socially advantaged group where university study upon completion of school was commonplace, so it would be interesting to see how influential the same factors might be in subject selection across other socio-economic groups.

These results suggest that enjoyment and interest in a science subject and the ability of students to obtain 'good marks' in it are key factors in subject choice. Broadening students' views of the value of science in their future careers may also affect their decisions, specifically in Year 10 when subject choices are made. While changes to curriculum, teaching, or programmes to address students' attitudes toward science may take considerable time to translate into increased enrolments, we suggest it is critical that schools begin implementing strategies that promote positive student perceptions of how interesting, enjoyable and useful science can be.

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