NATIONAL VOCATIONAL EDUCATION
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RESEARCH REPORT

Does scored VET in Schools help or hinder access to higher education in Victoria?

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MELBOURNE INSTITUTE OF
APPLIED ECONOMIC AND
SOCIAL RESEARCH

NCVER

Australian Government
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About the research

Does scored VET in Schools help or hinder access to higher education in Victoria?

Cain Polidano, Domenico Tabasso and Rong Zhang, Melbourne Institute of Applied Economic and Social Research

The systematic introduction of vocational subjects to the secondary school curriculum in the 1990s — VET in Schools — was aimed at helping to retain less academically inclined students at school and to provide students with a broad range of post-secondary options and pathways. The early 2000s saw a broadening of the VET in Schools programs with the scoring of vocational subjects. This meant that particular vocational subjects could count towards both nationally recognised training and a university entrance score. The anticipated benefit of scored VET subjects was an improved status for vocational education and training (VET) in the secondary school curriculum and a further benefit was that it offered viable options to those students who were not entirely certain of which pathway to take — university or vocational training.

This study, which focuses on the experiences of Victorian secondary school students who completed 'scored' VET subjects — counting towards the Victorian Certificate of Education (VCE) — looks at whether taking these subjects affects their entry to university in terms of university entry score, receiving a university offer or receiving an offer in a preferred course. Victoria is the focus for two reasons: since the early 1990s, VET subjects have been highly integrated into the Victorian secondary school curriculum; and, secondly, Victoria was the first state to allow scores from some VET subjects to count fully towards a national vocational qualification, the Victorian Certificate of Education and a university entry score. In this study, those who take scored VET subjects represent fewer than 10% of all Year 12 completers in 2011.

Key messages

- For Victorian students who intend to go to university and who complete a scored VET subject this research indicates that there is a sizeable penalty. The average university entry scores for these students are estimated to be six points lower than they would have been had a general subject been chosen, representing around a 5% reduction in university entry scores, on average.
- This reduction in university entry scores negatively impacts upon the chances of receiving a university offer, from 79% to 67%, on average.
- The largest negative impacts on average university entry scores are found with engineering and technology; community, outdoor and recreation; and hospitality subjects.
- The authors suggest that the down-scaling of scored VET subjects may partly explain this impact and they offer an alternative scaling methodology for consideration.

This is an important study as it is the first to attempt to examine any impacts on university access of taking a scored VET subject (in Victoria). In doing so however it highlights an apparent adverse outcome of a pathway originally intended to offer students the best opportunities to pursue the post-school studies most suited to their ability and motivation.

Dr Craig Fowler
Managing Director, NCVER

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Contents

Tables

Executive summary

Despite comprising only a small fraction of all VET in Schools enrolments, programs that count towards both national vocational education and training (VET) qualifications and university entry potentially fill an important role in the upper-secondary school curriculum.

The aim of this study is to take a first step in gaining an understanding of the efficacy of VET in Schools courses by estimating the relationship between enrolling in Victorian Certificate of Education (VCE) VET subjects and university access. We choose to examine the outcomes from VCE VET courses because they represent a model of assessment, known as 'scored VET', that closely resembles that applied in general courses. In particular, the assessment involves both written exams and numerical assessment of performance in job-specific tasks associated with units of competency. In this study, the analysis is carried out on a sample of school completers in Victoria in 2011 who lodged a first preference for enrolment in a university course prior to sitting their final year exams.

To meet the aim of this study, we address the following key research questions:

- What is the relationship between taking a Victorian Certificate of Education VET subject and university entry scores?
- To what extent is any relationship explained by scores in VCE VET subjects (direct effect) as opposed to scores in all other subjects taken by VCE VET students (indirect effect)?
- Does any relationship depend upon the type of VCE VET subject chosen?
- What is the relationship between participating in VCE VET subjects and the chances of being offered a place at university?
- What is the relationship between participating in VCE VET subjects and the chances of attaining a first, third or sixth university entry preference?

As far as we are aware, this is the first study to estimate the relationship between taking a VCE VET subject and university access. In estimating the relationship, we compare the outcomes of students who do and who do not take VCE VET subjects, using a rich dataset and econometric techniques to control for differences in a large number of characteristics. Most importantly, we control for differences that may have an important bearing on university entry scores, such as prior academic performance, using Year 9 NAPLAN scores; academic aspirations, using field of education and course cut-off scores for each student's first preference submitted for university entry; student and peer socioeconomic background; and regional and school-level factors.[1] Although we control for a large range of differences between the two groups, to the extent that there are differences that are not controlled for or are imperfectly controlled for the relationship between taking a VCE VET subject and university access may not reflect a causal impact.

The econometric technique used in this study is propensity score matching, a quasi-experimental method that simulates random assignment into VCE VET by selecting, for each student who chooses a VCE VET subject, a control group with the same observable characteristics but who did not enrol in a

[1] The course cut-off score to control for the level of academic aspiration is from 2010, which was the latest available at the time students lodged their university course preferences. This control is not included in the standard results because there are a number of missing student preferences. This control is added as part of the sensitivity analysis (see appendix E).

VCE VET subject. The outcomes from the matched control group represent counterfactual outcomes, against which the VCE VET outcomes are compared to isolate the relationship between taking a VCE VET subject and university access. A key feature of this study is the use of a unique Victorian dataset that links, at the individual level, administrative population data on university preferences used in the university admission process; university entry scores; characteristics of students, schools, parents and place of residence; and university offer information (the last from a large survey of graduates).

Another key feature of this study is the development of a decomposition approach to help explain any estimated relationship. The decomposition approach splits any relationship into direct and indirect effects. For those who take a VCE VET subject, the direct effect is defined as the difference in the score in a VCE VET subject relative to the score if a general subject had been chosen instead. The indirect effect, or spillover, is defined as the average score in all general subjects when a VCE VET subject is chosen, relative to the average score in these subjects had an alternative general subject been chosen. The results are also estimated for scored VCE VET subjects across seven subject groupings: business and finance; community, outdoor and recreation; dance and music; engineering and technology; information technology; hospitality; and equine industry. The impacts are estimated across subject groups because there are insufficient observations to allow robust estimation by individual subjects.

Results

We find among students who intend to go to university, controlling for a range of differences between those who do and who do not take a VCE VET subject, that those who take a VCE VET subject have a six-point lower score on average than those who do not take a VCE VET subject (111 compared with 117 out of a possible 205). This represents around a 5% lower university entry score on average and is robust to the range of alternative key assumptions that underpin the analysis. Across VCE VET subject groupings, we find some variation in magnitude of the estimated negative association, with significant negative associations found in four of the seven subject groupings (engineering and technology; community, outdoor and recreation; hospitality; information technology) and no statistically significant negative results found for the rest (business and finance; dance and music; equine industry).

Consistent with a lower entry score, we also find that those who take VCE VET subjects have a lower chance of receiving a university offer. In particular, on average, taking a VCE VET subject is associated with a 12-percentage-point lower chance of receiving a university offer. In other words, 67% of students who take VCE VET subjects who apply to go to university receive an offer, but it is estimated that the chance of receiving an offer would be 79% (12 percentage points higher) if these students had taken a general course instead. The large difference in the chances of attaining a university offer, despite only relatively small differences in entry scores, is because VCE VET students are on average around the middle of the entry score distribution. Therefore, their chances of receiving an offer are sensitive to small changes in entry scores, including changes associated with course choice. Similarly, taking a VCE VET subject is associated with a seven-percentage-point lower chance of attaining a top six preference, from a total of 12 preferences.

We estimate that most of the six-point lower entry score associated with taking a VCE VET subject (around four points or 70%) can be attributed to a negative direct effect, while the remainder is due to a negative indirect effect. The dominance of the direct effect over the indirect effect reflects the relatively low scores attained in VCE VET subjects among students who intend to go to university. On average among VCE VET students who intend to go to university, their scores in VCE VET subjects are lower than those attained in their other subjects. In this study, we cannot be precise about the

underlying causes of the negative direct and indirect effects, but they may include the disruption associated with accessing training off campus, poor suitability of VET training for students who intend to go to university and down-scaling of VCE VET scores.

Although we cannot precisely pinpoint the source of the direct effect, an exploratory analysis suggests that the down-scaling of VCE VET subjects may be a key source. Scaling ensures that scores across different subjects can be compared on an equal footing so that students do not gain an unfair advantage by choosing any particular combination of courses. Existing scaling arrangements in Victoria correct for differences in the strength of competition or difficulty in attaining the mean score in a given subject. Competition in a given subject is measured as the mean score in all other subjects taken by students in that course. In subjects where competition is less than average (mean score in other subjects is less than 30), the scores are scaled down; the opposite holds when competition is above average. In VCE VET subjects, scores are scaled down, but we find evidence to suggest that the extent of the down-scaling may be greater, on average, than in many general courses because a large proportion of the students in these courses do not intend to go to university but appear to focus their effort on these courses, to the detriment of performance in other courses. Therefore, the measure of competition used in the scaling may underestimate the true difficulty of attaining the mean in VCE VET courses. Unlike general courses, VCE VET students who do not intend to go to university have an incentive to focus their effort to attain credit for, or attainment of, a national qualification.

In this study, we cannot rule out the possibility that the lower average entry score for VCE VET students is due to the differences in factors that are not controlled for and which affect entry scores. That said, the dominance of the direct effect suggests that this is unlikely. If there are uncontrolled differences in factors that lead to lower entry scores for VCE VET students, then to explain the entire gap they must have a disproportionately *negative* effect on scores in VCE VET subjects compared with scores in other subjects. Such factors may be differences in preferences, such as a preference for hands-on learning, but they are likely to disproportionately *increase* performance in VCE VET subjects. If we assume that uncontrolled-for factors have the same effect on all subjects, then at the most they are no larger than the per-subject indirect effect, which means they would explain no more than a third of the estimated gap in university entry scores.[2]

Implications

The stated aim for the introduction of VCE VET subjects to the academic curriculum was to enhance the status of VET programs by recognising performance in these subjects in the same way as performance in other VCE subjects (Victorian Curriculum and Assessment Authority 2010). As well as enhancing the status of vocational education and training, these subjects potentially also serve dual purposes: to provide vocational options for those who do not intend to go to university and to allow students in the middle of the academic distribution to pursue vocational options without closing off their pathways to university. In theory, these two purposes are compatible, but in practice the results presented in this paper suggest that there may be trade-offs.

To better meet the dual purposes of VCE VET subjects, we suggest two courses of action. First, more research is needed into the extent to which different student motivations in scored VET subjects leads

[2] If we assume that all of the indirect effect is due to differences in uncontrolled-for factors and that these factors have the same negative effect on all subject scores, then we can say that 0.408 (1.632/4) percentage points of the 3.985-percentage-point gap due the direct effect is also explained by uncontrolled-for factors. Therefore, at the most, uncontrolled-for factors would explain 2.04 out of 5.618-percentage-point gap.

to greater down-scaling than would otherwise be the case. If further investigation were to confirm our over-scaling explanation, then one possible response would be to adjust the scaling of VET subjects to account for differences in motivation. One way to do this would be to restrict the scaling to only those students who intend to go to university, measured by whether or not they lodge an application for admission to a university course prior to sitting their final exam. Scaling subjects in this way should have relatively minor impacts on scores in general subjects where a high proportion of students intend to go to university. However, there are some general VCE subjects outside the VET system, such as industry and enterprise studies, that also attract relatively high proportions of students who do not intend to go to university but who may also focus their effort in a particular course because the course is especially useful for employment preparation. Given that the main purpose of scaling is to allow students to be equitably ranked for university entry, then the scaling should be based on the scores of students who are competing for university entry.

Second, while the negative indirect effect is small and may be potentially explained by uncontrolled-for factors, there are a number of possible low-cost precautionary measures that could be taken by government and schools. For government, collecting data on the time spent in off-campus training may help in assessing and monitoring any academic impacts. If necessary, these data would also allow better coordination of training across local school clusters where close-by options in TAFE (technical and further education) institutes may be inadequate. For schools, an appropriate response may be to encourage their students to complete VCE VET subjects in Year 11 rather than in Year 12.

Importantly, we stress that this study only examines the impacts of taking VCE VET subjects on direct access to university. Other important outcomes from VCE VET programs, such as indirect access to university (for example, by completing a diploma course), participation in post-school VET study, retention in post-school study, and employment outcomes are not investigated here, but should be considered in any overall evaluation of these programs. Previous studies by Anlezark, Karmel and Ong (2006), Lamb and Vickers (2006) and Polidano and Tabasso (2013) have demonstrated positive benefits to school retention and initial labour market outcomes from unscored VET in Schools courses.

Introduction

As occurred in other English-speaking countries such as Canada and the United States, vocational education was first introduced into the general upper-secondary school curriculum in Australia to keep less academically oriented youth at school and to improve their post-school pathways into further study or work (Ministerial Council on Education, Employment, Training and Youth Affairs 1999). However, because they are designed for less academically capable students and because of the strong emphasis on preparation for university in these countries, school vocational programs are often stigmatised (OECD 2000).

In Australia, under the New Framework for Vocational Education in Schools (Ministerial Council on Education, Employment, Training and Youth Affairs 2001) governments attempted to remove the stigma and broaden the participation in VET in Schools subjects by encouraging performance in upper-secondary VET subjects to count towards university entry.[3] To date, all states and territories in Australia, except Western Australia, have upper-secondary VET programs that can count towards both a national qualification and a university entry score (Australasian Curriculum, Assessment and Certificatation Authorities 2012). The way by which performance in upper-secondary VET contributes towards university entry scores varies by state. For example, subject to certain conditions, VET in Schools students in New South Wales can opt to take a written exam, their performance in which counts towards their university entry score, while in South Australia, graded performance in VET subjects is converted to numerical scores for use in the calculation of entry scores. In Victoria, some VET subjects, known as VCE VET subjects, are scored in much the same way as academic subjects.[4] For these subjects, an assessment framework has been developed to measure, on a numerical scale, competency-based performance. Recognising VET subject performance in measures of university entry not only helps to improve the status of VET, but for students who are in the middle of the academic distribution and who intend to go to university, they provide an alternative pathway for consideration without potentially compromising their chances of attaining access to university.

In this study, we make a first attempt to better understand the efficacy of VET programs that count towards university entry by examining the relationship between taking a VCE VET course and attaining university entry. A priori, the sign of any effect from taking VCE VET subjects is unclear. On the positive side, the 'real world' context used to teach concepts, known as experiential learning (Kolb 1984), may improve learning. In particular, it is argued that experiential learning gives students the context in which theory is applied, which in turn helps them to understand the importance of theory and engages them in the learning process (Kolb 1984). All else being equal, the more complementary the VET subject is to other general subjects, the greater the effect on student learning. Experiential learning has also been argued to better suit the learning styles of less academic students (Smith 2002). However, while there is strong evidence suggesting that students have different preferences for teaching practices, there is very little empirical evidence that matching student preferences and teaching methods is important in learning (Pashler, McDaniel & Bjork 2008).

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[3] To achieve this end, the New Framework underlines the importance of course competency counting towards both the attainment of a VET qualification and university entry scores. In practice, the group of vocational courses that count towards a qualification and a university entry score vary across states.

[4] It is also possible in Victoria to undertake a VET subject in Year 12 that counts towards a national VET qualification, but does not attract a study score. In these cases, students who receive a university study score get a 10% bonus on their 'primary four' subjects (English score plus their top three courses). However, to simplify things, we restrict the analysis to examining the effects of undertaking VCE VET subjects.

But taking a VCE VET subject may hinder access to university for three reasons. First, on average, the scores used in the calculation of university entry scores for VCE VET subjects may be scaled down to a degree because the measure of student competition that scaling corrects underestimates the intensity of competition in these subjects. Second, because they are often, in part or in full, taken off-campus, VCE VET subjects may have a disruptive effect on performance in other subjects. Finally, students who intend to go to university who choose VCE VET subjects may be attracted by the opportunity to attain a qualification, but they may not be well suited to the hands-on nature of VET training.

To estimate the relationship between taking VCE VET subjects and university access, we use a number of measures of university access, including university entrance scores, the chances of receiving a university offer and the chances of receiving an offer in a preferred course (top three and top six). Because some students may take VCE VET subjects for reasons besides university entry, we restrict the analysis to those who lodge a first preference (with the Victorian Tertiary Admissions Centre [VTAC]) in a higher education course prior to sitting their final VCE exams. This sample represents 64% of all Year 12 VCE VET students in 2011. We test the sensitivity of the results to this restriction.

The specific questions addressed in this study are:

- What is the relationship between taking a VCE VET subject and university entry scores?
- To what extent is any relationship explained by scores in VCE VET subjects (direct effect) as opposed to scores in all other subjects taken by VCE VET students (indirect effect)?
- Does any relationship depend upon the type of VCE VET subject chosen?
- What is the relationship between participating in VCE VET subjects and the chances of being offered a place at university?
- What is the relationship between participating in VCE VET subjects and the chances of attaining a first, third or sixth university entry preference?

We decompose the relationship between taking a VCE VET subject and university entry scores into direct and indirect effects. A direct effect is defined as the score in a chosen VCE VET subject, relative to the score if a general subject had been chosen instead. An indirect effect is defined as the average scores in all general subjects when a VCE VET subject is chosen, relative to the scores had an alternative general subject had been chosen. Indirect effects measure spillover effects. We only decompose the relationship between taking a VCE VET course and university entry scores because it is the main driver of university entry and should broadly reflect the decomposition of any relationship explaining the chances of receiving university offer.

A key feature of the approach in this study is the use of propensity score matching to deal with non-random selection into VCE VET subjects. Non-random selection is present when there are differences in the characteristics that affect university entry scores, such as academic ability, between those who do and those who do not participate in VET. The failure to fully control for non-random selection means that estimates may not represent the causal impacts of taking a VCE VET subject. Another feature of this study is the unique and rich dataset that is being assembled. The outcomes of interest are subject scores from the Victorian Curriculum and Assessment Authority (VCAA) and university offer information from the Victorian On Track[5] survey of 2011 school completers. This information is linked

[5] On Track surveys school leavers who have left school in the previous six months to ascertain whether they are on a path to further education, training or employment. It also enables young people to seek further advice and assistance via a referral service if required.

at the student level with Year 9 NAPLAN scores (from 2008) and the university course preference data submitted by students to the Victorian Tertiary Admissions Centre (VTAC) prior to sitting their final exams. Linking data from these sources enables us to control for differences in academic ability and past education investments, study aspirations, post-school subject preferences, socio-demographic variables and school and peer-level factors.

Integrating VET into the academic curriculum

The integration of vocational education and training into the school curriculum began in Australia in the mid-1990s and coincided with a move to a competency-based VET qualification system nationally. Under a competency-based system, qualifications are awarded for the demonstration of competency in carrying out the job-specific tasks defined in nationally agreed training packages. The incompatibility between competency-based and grade-based assessment was a key challenge in integrating VET subjects in the upper-secondary curriculum (Barnett & Ryan 2005).

The degree to which VET subjects have been integrated into the upper-secondary school curriculum varied across states. For example, in New South Wales and Queensland, many of the endorsed VET in Schools subjects sat outside the academic curriculum and did not count towards a school completion certificate. At the other extreme, Victoria, keen to promote VET in Schools programs, integrated parts of the nationally accredited subjects into existing academic subjects, which meant that the subjects contributed to both a secondary school certificate and a nationally accredited VET qualification (known as the dual model). While academic scores from VET subjects initially did not count towards university entry, to entice more academically inclined students to take them, a 10% increment was offered on a student's primary four academic scores.

Since the publication of the New Framework for Vocational Education in Schools (Ministerial Council on Education, Employment, Training and Youth Affairs 2001), most VET subjects now count towards both a national VET qualification and a secondary school certificate in all states. And in response to the New Framework recommendation to extend participation in vocational education and training by ensuring that it provides a pathway to university entry, to the best of our knowledge, all states except Western Australia have upper-secondary VET subjects that count to both a national qualification and university entry scores (Australasian Curriculum, Assessment and Certification Authorities 2012).

We concentrate on estimating the impacts of undertaking VCE VET subjects in Victoria for two reasons. First, as noted above, since the inception of VET in Schools in 1994, Victoria has adopted a model whereby VET subjects are highly integrated into the secondary school curriculum. Second, Victoria was also the first state, in 1997, to allow scores for some VET subjects to count fully towards a national qualification, a state secondary school certificate (the Victorian Certificate of Education) and university entry.[6] The analysis in this paper is based on outcomes for students in their final year of study in 2011.

VET in Schools in Victoria

In Victoria in 2011 there were 27 subjects that counted towards both a nationally accredited VET qualification and the Victorian Certificate of Education. Of these subjects, 17 (see table 1), which are at the VCE unit 3 and 4 level, can be scored and included in the calculation of the university entry score. It is important to note that scored VCE VET subjects are not designed as stand-alone subjects;

[6] Following the Victorian Certificate of Education review.

instead, it is highly recommended that students undertake lower-level subjects in these fields first (VCE unit levels 1 and 2) in Year 10 and/or Year 11.[7]

Table 1 VCE VET subjects in 2011

Subjects that can be scored	Subjects not scored
Business	Agriculture
Community recreation	Applied fashion design and technology
Community services	Automotive
Dance	Building and construction
Electrotechnology	Cisco
Engineering studies	Conservation and land management
Equine industry	Desktop publishing and printing
Financial services	Food processing (wine)
Furnishing	Horticulture
Hospitality	Small business
Hospitality (kitchen operations)	
Information technology	
Interactive digital media	
Laboratory skills	
Music	
Music industry (technical production)	
Sports and outdoor recreation	

Notes: All scored subjects are units 3 and 4. The VCE VET subject small business is not included because it does not include units 3 and 4 sequence and is not scored.

Sources: For scored subjects, Victorian Curriculum and Assessment Authority data; for not scored subjects, Victorian Curriculum and Assessment Authority (2010).

Students who enrol in a scorable VCE VET subject may opt not to have their VET subject scored.[8] This is not the norm and we exclude from our analysis any student who does not attain a study score for their VCE VET subject.

For VCE VET subjects to count towards a national qualification, students must demonstrate a minimum performance in carrying out the job-specific and general work-related tasks (called units of competency) set out in national training package standards. Ideally, such competencies are attained through structured workplace learning (Victorian Curriculum and Assessment Authority 2011). Structured workplace learning is different from work experience in that it involves a set of learning objectives (attainment of workplace competencies) against which achievement is tested. Work experience on the other hand contains no such learning objectives and its purpose is mainly to give students an opportunity to familiarise themselves with different working environments. Although it is encouraged, it must be noted that, except for two VCE VET courses, undertaking structured workplace learning is not essential for gaining competency in the specified units of competency. In practice, difficulty matching students to employers means that students often do not receive any structured workplace learning. In these cases, students attain their units of competency in a 'simulated' work environment in the school or a VET institute. Estimates from a previous study by the authors (Polidano & Tabasso 2013) suggest, nationwide, that only around 45% of students who take upper-secondary VET in Schools subjects (excluding those in apprenticeships) experience part of their

[7] VCE subjects at units 1 and 2 contribute towards a secondary school certificate, but do not attract a university score.

[8] In such cases, students will not receive an increment of 10% of their primary four subjects, which is available to students who complete VCE VET subjects that are not scored.

training in the workforce. Structured workplace learning can take place over weekends, during school holidays and/or during the school week.

Scoring VCE VET subjects

A key challenge when integrating competency-based VET subjects into an academic curriculum is designing an assessment system that allows subject performance to be compared with performance in academic subjects without compromising the vocational, task-based nature of the training.[9] Because competency-based training is task-based, assessment is geared towards ascertaining whether or not vocational tasks can be performed to a minimum required standard.

In Victoria, to extend the minimum competency framework to an academic one, where assessment is measured on a continuous scale, internal assessment (which comprises 66% of all assessment in scored VCE VET subjects) is based on graded performance in three tasks.[10] The available task types (work performance, product, work project and portfolio) are designed by the Victorian Curriculum and Assessment Authority; however, registered training organisations (RTOs) and schools have the flexibility to design tasks to suit their specific needs. The task type selection must include all the (3 and 4) units of competency for the course and there must be only two of any one task type included.

Task assessment is carried out by a trained assessor who is approved by the relevant registered training organisation. The assessor rates performance in each of the three tasks using five specific criteria. For each criterion, performance is measured on a scale of 1 to 5, where 1 is base performance and 5 is high performance. The five criteria vary with the task, but are generally all related to demonstrating the application of knowledge to carry out a task, including the application of technical job-specific knowledge as well as general knowledge, such as communication, personal management and problem-solving techniques. To help the assessor rate the student on each of the criteria, a description of the expected performance at three of the five levels is provided — 1 (base), 3 (medium) and 5 (high). (See appendix A for the expected performance for the five criteria related to work performance tasks.) The contribution of each of the tasks to the overall subject score is weighted by the nominal hours for each task as a proportion of the total nominal hours required for (units 3 and 4) enrolment.

With the exception of dance and music, an external assessment for VCE VET subjects involves written examinations carried out during the end-of-year examination period. The focus of the exam is on testing students' underpinning knowledge and understanding of the skills identified in the competency standards relevant to the associated VET qualification. For more information on the assessment of VET subjects, see Victorian Curriculum and Assessment Authority (2010).

Contribution to university entry scores

To generate a university entry score, raw subject scores are standardised to make performance comparable across subjects. For each subject, the standardisation process sets the mean subject score at 30 (out of a possible 50). However, it is important to note that the standardised scores represent student rankings or relative positions within a subject. Those with a standardised score above 30 are ranked above average in that subject and those with a standardised score below 30 are

[9] Except for dance, where assessment is 50% examination and 50% coursework. The higher weighting given to internal assessment is in contrast to assessment in general courses, where external assessment is given greater weight.

[10] Only students who attain at least minimum competency in all units attain a study score. Students who attain a minimum competency can also opt not to receive a study score.

ranked below average. However, as relative ranks, these scores cannot be simply combined to produce an overall rank because such a method would disadvantage students who chose subjects where the strength of student competition is high. Therefore, to combine subject scores to produce an overall rank, the Victorian Tertiary Admissions Centre scales standardised subject scores to correct for differences in the strength of student competition, or how difficult it is in a subject to attain the middle rank of 30. For a given subject, the strength of competition is measured by the mean score in the student's other subjects. The scaling works so that the mean score for a given subject is equal to the mean (standardised and unscaled) score in the student's other subjects (Victorian Tertiary Admissions Centre 2011). Therefore, in subjects where the student's mean score in other subjects is greater than 30, the subject is scaled up, and in subjects where the opposite is the case, the scores are scaled down.

The average scaled VCE scores for VET subjects and the general subjects (non-VET) with which they are most frequently combined are presented in table 2. From table 2, it is clear that raw VCE VET subject scores are scaled down, and are scaled down by more than in the general subjects with which VCE VET subjects are commonly combined (with the exception of food technology). However, VCE VET scores are likely to be scaled down by more than general subjects because a relatively high proportion of VCE VET students do not intend to go to university and focus their effort in VET to attain credit towards a qualification to the detriment of their performance in other subjects. Therefore, using measures of the performance of VCE VET students in other subjects may under-represent the true difficulty of attaining the middle rank and lead to excessive down-scaling. Students who intend to go to university cannot afford to concentrate their efforts to the same extent because their aim is to maximise their aggregate score to gain entry to university.

The data presented in table 2 support the notion that VCE VET students who do not intend to go to university concentrate their effort in VET. Columns (a) and (b) of table 2 are the average raw scores (before scaling) for students who do and who do not intend to go to university, relative to the average raw scores in all other subjects taken by the same students.[11] Indices greater than 1 for all VCE VET subjects for both groups suggest that on average both groups do better in VCE VET subjects than in their other subjects, which is why VCE VET subjects are scaled below 30. However, there is a clear difference between the two groups in the extent to which they do better in VCE VET subjects (column [c]). The higher relative performance in VCE VET scores compared with scores in other subjects is around three percentage points greater for students who do not want to go to university than for those who do. For engineering studies, hospitality (kitchen operations), music, community services, and music industry (technical production), the relative performance among those who do not intend to go to university is over five percentage points greater compared with those who do intend to go to university. The same pattern is not observed for the general VCE subjects commonly combined with VCE VET subjects.

[11] Whether or not students intend to go to university is determined by whether students apply to the Victorian Tertiary Admissions Centre for entry to tertiary study with a university course as their first preference.

Table 2 Average VCE scaled scores for VET and selected general subjects (out of 50) for students who completed school in 2011

	Average scaled subject score	Proportion who intend to go to university[a]	Raw scores in a given subject, relative to raw scores in other subjects taken by the same students[b]		
			(a) Intends to go to university	(b) Doesn't intend to go to university	(c) Diff (b)-(a)
		%	*Ratio*	*Ratio*	*Ratio*
VCE VET subject					
Business	24.02	72.22	1.12	1.13	0.01
Community recreation	23.56	60.89	1.13	1.13	0.00
Community services	23.13	70.17	1.17	1.23	0.06
Dance	28.79	63.10	1.11	1.12	0.01
Electrotechnology	24.17	35.14	1.18	1.09	-0.09
Engineering studies	23.94	45.67	1.19	1.27	0.08
Equine industry	25.57	61.90	1.04	1.06	0.02
Furnishing	24.01	35.48	1.11	1.06	-0.05
Hospitality	25.02	60.63	1.07	1.12	0.05
Hospitality (kitchen operations)	24.65	52.94	1.09	1.16	0.07
Information technology	24.84	71.43	1.21	1.18	-0.03
Interactive digital media	25.52	68.62	1.07	1.10	0.03
Music	27.12	65.83	1.11	1.18	0.07
Music industry (technical production)	26.12	58.30	1.09	1.15	0.06
Sport and outdoor recreation	23.84	67.74	1.16	1.13	-0.03
All VET subjects[b]	24.81	62.96	1.11	1.14	0.03
General VCE subject					
Business management	25.93	74.85	1.08	1.03	-0.05
Health and human development	25.63	77.48	1.09	1.04	-0.05
Dance	26.67	73.52	0.99	1.01	0.02
Physics	32.30	92.92	0.97	0.89	-0.08
Food and technology	23.48	58.51	1.18	1.19	0.01
Information technology applications	24.79	72.37	1.13	1.13	0.00
Visual communications and design	26.43	71.80	1.07	1.05	-0.02
Music performance	28.53	80.19	0.99	1.02	0.03
Physical education	26.76	78.31	1.06	1.01	0.05

Note: The results for 'financial services' and 'laboratory skills' are not reported because they are based on fewer than ten observations.

a Determined by whether they lodge a first preference to VTAC to attend a university. The differences in the ratio of scores for all VCE VET students who do and do not intend to go to university are statistically significant at 1%.

b It is estimated as the average raw study score (unscaled) for the given subject (column 1) divided by the average raw score for all other subjects taken by the students who took the given subject.

Source: VCAA student performance data and VTAC preference data.

Data

A feature of this study is the use of population unit record data of Year 12 completers in Victoria in 2011 from all school sectors (government, Catholic and independent). The data comprise information from four sources: student and subject choice information from the Victorian Curriculum and Assessment Authority; preferences for post-school study and scaled subject scores from the Victorian Tertiary Admissions Centre; Year 9 NAPLAN test scores from the Department of Education and Early Childhood Development (DEECD); and self-reported information on university enrolments and offers from the On Track survey of 2011 school completers. These datasets were linked by the Department of Education and Early Childhood Development using a de-identified student number common to each of the datasets, which ensured that the datasets could be linked with close to 100% accuracy. Linking this information produces an extremely rich dataset, one that allows us to control for the differences in academic ability, post-school preferences and personal, regional and school characteristics between those who do and those who do not choose VCE VET subjects.

Overall, we observe 49 003 school completers, of which 3628 (or 7.4%) took at least one VCE VET subject in their five (or six) VCE subjects (table 3). It is important to note that the students who undertake unscored VET subjects as part of their upper secondary school are not part of this analysis. The most popular VCE VET subjects are interactive digital media (around 18% of all VCE VET); community recreation and sport and outdoor recreation (19% of all VCE VET); hospitality and hospitality (kitchen operations) (18% of all VCE VET); music and music industry (11% of all VCE VET); information technology and electrotechnology (9% of all VCE VET); and business (7% of all VCE VET).

We retain in the sample of analysis only those with a university entry score who had Year 9 NAPLAN test score results and who lodged a first preference for a university course with the Victorian Tertiary Admissions Centre prior to sitting their final exams (before the end of October 2011). Restricting the sample to those who lodge a first-round university preference is to ensure that the analysis is only conducted on those who have an intention to go to university. There may be other ways of measuring intention to go to university, such as whether or not a student has lodged any preference for a university course. To test the sensitivity of our results to this restriction, we also estimate results with this restriction relaxed (see appendix E).

For VCE VET students, we also restrict the sample to those who only take one VCE VET subject and who attain a study score for their VCE VET subject, which as discussed above is optional. These restrictions reduce the sample by around 27%, to 35 511 observations. Most of this reduction in observations is due to omitting those who did not lodge a first preference for a university course and those with missing NAPLAN scores. All else being equal, those with missing NAPLAN scores are likely to be below-average students, which means that if the chance of having a missing NAPLAN score is strongly correlated with the chance of taking a VCE VET subject, the sample and results from the analysis may be biased. However, from table 3, no evidence of a strong correlation exists, with a slightly higher rate of omissions among those who did not take a VCE VET subject than among those who did.

Table 3 Number of students in the sample

Subjects	Total number of students	Less number without a study score	Less number without Year 9 NAPLAN	Less number who don't attain a study score for VET subject or take multiple VCE VET subjects	Less those who do not intend to go to university
Business	257	244	214	210	194
Community recreation	572	547	497	487	361
Community services	274	251	216	209	182
Dance	90	88	72	70	54
Electrotechnology	96	84	70	66	34
Engineering studies	146	135	121	116	71
Equine industry	49	48	44	39	26
Financial services	8	8	6	6	5
Furnishing	102	96	85	83	43
Hospitality	338	327	273	269	226
Hospitality (kitchen operations)	297	288	246	240	183
Information technology	241	234	203	190	156
Interactive digital media	660	637	566	552	480
Laboratory skills	9	8	8	8	8
Music	128	127	115	112	95
Music industry (technical production)	253	238	218	217	178
Sports and outdoor recreation	108	104	92	86	68
Takes a VCE VET subject	3 628	3 464	3 046	2 960	2 364
% Reduction	*0.00*	*-4.52*	*-12.07*	*-2.82*	*-20.01*
Doesn't take a VCE VET subject	45 375	43 700	36 907	36 457	33 147
% Reduction	*0.00*	*-3.69*	*-15.54*	*-1.22*	*-26.95*

Source: VCAA student performance data.

We remove from the sample those who do not lodge a first preference for a university course because we assume that these students have no intention of attending university and hence their chances of gaining entry to university are unaffected by whether or not they choose a VCE VET subject. Students lodge up to 12 post-school course preferences, with their first preference being the most preferred and the 12th being their least preferred, at any time between 1 April until just prior to Christmas.[12] The robustness of the result to this restriction is tested in the sensitivity analysis section (appendix E).

Outcomes of interest

The main outcome of interest is students' university entry score. University entry scores are derived by adding the highest English study score (from English, English as a second language or English literature) to the remaining best three scaled subject scores in the final year of study (known as the primary four subjects) and adding 10% of the fifth-best scaled subject score. If a sixth subject is taken, which is not the norm, an additional 10% of a sixth subject is also included. The maximum university study score is 205 (or 210 if students undertake six subjects) and is used to derive the

[12] Preferences entered prior to sitting their final exams can be altered in December once final results are released. Students who have not entered preferences before the final exams can also do so in December.

student's rank within their year — their Australian Tertiary Admission Rank (ATAR). ATAR distributes the university entry score as evenly as possible on a scale of 0 to 100, according to the level of their university entry score and using an interval of 0.05. Therefore, the highest rank is 99.95, which means that the student's entry score is in the top 0.05% of students who commenced secondary school in the same year.

A limitation of using university entry scores as the outcome of interest is that it is unclear whether any effect of taking a VCE VET subject translates into an impact on the chance of attaining access to university. For some university courses, entry is not solely based on entry scores, but on other criteria such as performance in an interview and work produced as part of a Year 12 portfolio. To address this issue, we use information on university offers from the On Track survey of 2011 school completers, which are linked via a unique student identifier (conducted in 2012). The 2012 On Track survey of school completers contains information from around 34 000 graduates at around six months after completing school (April—May 2012).[13] Receiving an offer is identified by whether graduates report either being enrolled in a university course, receiving an offer and deferring, or receiving an offer and declining the offer.

Not only may taking a VCE VET subject impact on the chances of attaining a university offer, but it may also affect the receipt of a more preferred course offer. To examine how taking a VCE VET subject may affect the attainment of a preferred offer, we compare the university entry cut-off scores (measured as ATARs) for each student's university preferences with their realised scores. All else being equal, the higher their realised score relative to the cut-off scores of their preferred courses, the more likely they received an offer from a preferred course. We measure entry to a preferred course using three measures: a realised score that is higher than the cut-off for their first preference; a realised score that is higher than the cut-off for their third preference; and a realised score that is higher than the cut-off for their sixth preference. Cut-off scores are taken from the year prior (2011) because they are the only ones available to students at the time they lodge their preferences and may be considered as student target scores. However, these measures should be considered as only indicative of the receipt of a course offer: universities still offer places to students who did not attain the course cut-off score; for example, because of equity reasons. Also, in line with year-on-year changes in student demand, the cut-off scores in 2011 may vary from the cut-off scores in 2012.[14]

Descriptive statistics

Key to estimating causal impacts is controlling for self-selection bias, which occurs because allocation to a VCE VET subject is not random. This means controlling for differences in the factors that may affect both the choice of a VCE VET subject and university entry scores, such as academic aspirations and academic ability. Failure to take into account self-selection bias may lead to the wrong conclusion about the impacts of taking a VCE VET subject. As discussed above, restricting the sample of analysis to those who intend to go to university controls for differences in aspirations to attend university, but there are other factors, such as academic ability, that need to be controlled for as well. We examine the differences in some of the other factors below.

[13] For more information on On Track, including the survey questionnaires, visit the On Track website: <http://www.education.vic.gov.au/about/research/Pages/ontrackdata.aspx>.

[14] Ideally, we would compare course preferences from VTAC with course offers from On Track. However, On Track only includes information on the field of education of course offer and cannot be accurately reconciled with course preference.

On average, there are differences in the first-preference field of education (table 4) and associated cut-off scores (table 5) between students who take VCE VET subjects and those who do not. For VCE VET students, the lower required cut-off scores to attain their first preference suggest that they have lower aspirations and that, all else being equal, they may not require as high a university entry score to attain a university offer. In terms of differences in intended fields of study, VCE VET students are around seven percentage points less likely to want to study natural and physical sciences at university, five percentage points less likely to want to study health, but four percentage points more likely to want to study education, four percentage points more likely to want to study creative arts and three percentage points more likely to want to study management and commerce.

An additional observation from table 4 is that the field of education for the first preference is closely related to the VCE VET subject field of education. For example, 42% and 48% of VCE VET students who take electrotechnology and engineering, respectively, intend to study engineering and related fields at university. Similarly, 67% and 48% of VCE VET students enrolled in music industry and music students, respectively, intend to study creative arts at university. This suggests that the choice of VCE VET subject is closely related to students' vocational interests, perhaps more closely related than for the general subjects taken by VCE VET students. Evidence presented in appendix B shows that students who choose VCE VET subjects often also choose courses from related fields. For example, 83% of students who choose community services also choose related courses in health and human development and psychology. However, there are marked differences across VCE VET courses, with only around 36% and 15% of students studying music and interactive digital media, respectively, choosing related general courses.

Other differences in the characteristics between students who do and who do not enrol in a VCE VET subject are differences in academic ability, in the types of schools attended and in parents' education (table 5). On average, students who take a VCE VET subject have a 5% lower Year 9 NAPLAN reading score, are ten percentage points less likely to come from a government school and are around 12 percentage points less likely to have a parent with bachelor degree. To the extent that these factors affect study scores, the failure to control for differences between students who do and do not take VCE VET scores will lead to self-selection bias.

Table 4 Field of education (1-digit ASCED) of first preference among students who intend to go to university prior to sitting their final exams (row %)

VCE VET subject	Natural and physical sciences	Information technology	Engineering and related technologies	Architecture and building	Agriculture, environmental and related studies	Health	Education	Management and commerce	Society and culture	Creative arts	Food, hospitality and personal services
Business	1.49	2.49	0.00	3.98	1.00	9.45	7.46	37.31	21.89	13.93	1.00
Community recreation	1.93	2.21	1.10	6.08	1.66	28.45	14.64	14.64	24.31	4.70	0.28
Community services	0.52	0.00	0.00	0.52	0.52	26.70	30.89	6.28	32.98	0.52	1.05
Dance	1.75	0.00	3.51	0.00	1.75	19.30	12.28	8.77	12.28	40.35	0.00
Electrotechnology	5.26	10.53	42.11	10.53	2.63	2.63	5.26	10.53	5.26	5.26	0.00
Engineering studies	4.23	2.82	47.89	11.27	5.63	5.63	4.23	9.86	4.23	4.23	0.00
Equine industry	13.33	0.00	0.00	0.00	16.67	16.67	6.67	3.33	36.67	6.67	0.00
Financial services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	80.00	20.00	0.00	0.00
Furnishing	0.00	3.92	13.73	37.25	3.92	3.92	7.84	9.80	11.76	7.84	0.00
Hospitality	2.50	0.00	1.67	2.50	2.08	10.00	7.92	41.67	15.00	11.67	5.00
Hospitality (kitchen operations)	7.77	0.52	3.63	2.59	1.04	10.36	8.29	30.05	14.51	9.33	11.92
Information technology	4.12	49.41	5.88	1.76	1.18	2.94	1.18	8.82	12.35	12.35	0.00
Interactive digital media	2.85	20.28	3.74	4.45	1.60	3.02	3.56	8.90	10.32	40.93	0.36
Laboratory skills	62.5	0.00	0.00	0.00	0.00	25.00	0.00	0.00	12.50	0.00	0.00
Music	5.00	1.00	8.00	4.00	1.00	5.00	5.00	7.00	14.00	48.00	2.00
Music industry (technical production)	1.62	2.70	3.78	3.24	1.62	2.16	2.70	3.24	12.43	66.49	0.00
Sport and outdoor recreation	2.70	2.70	1.35	4.05	4.05	25.68	21.62	13.51	17.57	6.76	0.00
All VCE VET subjects	3.32	5.82	4.83	3.64	1.87	14.18	10.60	18.55	18.44	16.57	2.18
No VCE VET subjects	9.90	2.97	5.23	3.61	2.39	19.26	6.48	15.66	21.83	12.22	0.44
Total	**9.56**	**3.12**	**5.21**	**3.61**	**2.36**	**19.00**	**6.70**	**15.80**	**21.65**	**12.46**	**0.52**

Sources: VCAA database; VCE-VTAC data, ABS data.

Table 5 Mean values of selected student characteristics

Subjects	Males (%)	At least one parent with a bachelor degree (%)	NAPLAN reading score in Year 9 (out of 874)	Peer NAPLAN reading score (out of 735)	Government school (%)	First preference 2010 cut-off (ATAR)	Number of Year 12 students in school	Non-English speaking background (%)
Business	11.90	14.29	556.28	588.39	52.38	70.12	193	39.52
Community recreation	67.56	18.69	569.22	589.09	43.94	70.85	223	25.46
Community services	4.31	11.96	558.81	587.97	26.79	70.44	210	12.92
Dance	20.00	22.86	593.96	597.39	22.86	75.86	190	15.71
Electrotechnology	96.97	15.15	574.18	583.52	24.24	70.23	255	33.33
Engineering studies	97.41	16.38	578.33	594.09	31.90	77.77	197	19.83
Equine industry	5.13	25.64	599.39	600.79	30.77	73.87	188	2.56
Financial services	16.67	16.67	533.43	577.44	16.67	76.40	145	50.00
Furnishing	87.50	6.67	562.34	585.60	93.75	69.70	195	16.67
Hospitality	27.88	24.54	570.01	601.93	62.08	73.74	193	30.11
Hospitaly (kitchen operations)	38.33	20.42	576.21	594.87	40.83	72.21	201	26.67
Information technology	92.11	15.79	582.79	578.12	17.37	68.24	217	44.21
Interactive digital media	65.99	19.58	595.30	593.10	47.65	72.81	198	24.92
Laboratory skills	25.00	0.00	604.46	583.83	25.00	80.16	188	25.00
Music	59.82	25.00	600.32	593.45	48.21	77.33	188	26.79
Music industry	79.26	35.02	615.81	600.12	39.17	77.93	222	18.43
Outdoor recreation	61.63	13.95	576.68	584.76	27.91	70.81	198	15.12
Takes a VCE VET subject	51.31	19.91	577.04	591.68	39.78	72.08	208	26.15
Doesn't take a VCE VET subject	45.65	31.64	607.74	602.65	49.93	79.80	190	28.67

Note: The sample is restricted to those who take at least one VET subject. In 97% of the cases, this is one subject only. Cut-off scores from 2010 are not available for all first-preference courses in 2011.

Methodology

As mentioned earlier, the key methodological issue in this study is dealing with self-selection bias, which arises because of the differences, such as academic ability, between students who take VCE VET subjects and those who do not, that potentially also affect university entry scores. To deal with self-selection bias, we rely on the richness of the controls in our data and propensity score matching (PSM). PSM deals with self-selection by constructing a 'like' or 'matched' control group (from students who do not take a scored VCE VET subject) against which the outcomes from the treatment group (those who take a scored VCE VET subject) can be compared to isolate the effects of the treatment (those who take a scored VCE VET subject). Propensity score matching is generally preferred to standard regression techniques in dealing with self-selection bias because it ensures common support; that is, overlap in the distribution of characteristics between those who do and those who do not receive a treatment (Blundell & Costa Dias 2008). Standard regression techniques do not ensure common support, which means that the estimated effects of treatment may be based on extrapolation, which makes them difficult to interpret. A feature of propensity score matching in relation to other approaches used to deal with self-selection, such as instrumental variables, is that it does not rely on a valid exclusion restriction, which in practice, is often difficult to find (Blundell & Costa Dias 2008).[15] However, a limitation of PSM is its heavy reliance on rich data to create large control groups to control for differences in all the factors that affect both selection and outcomes (conditional independence assumption).

Ideally, to ensure that the conditional independence assumption holds, we would restrict the matched control group to individuals who took the same subjects as those of the treatment group, except for one, the VCE VET subject. However, given that students have great flexibility in choosing from around 60 VCE subjects, such an approach would impose a tight constraint on the matching, and any estimates would be arbitrarily based on choosing a specific general subject as an alternative to taking a VCE VET subject. In this study, we do not impose such a tight restriction on the matching, but instead assume that the outcome from taking an alternative general subject instead of a VCE VET subject is equal to the outcome from the matched control group, even though the general courses taken by the two groups may be different. This is not likely to be a limiting assumption because after selecting a matched control group, we find that there are only minor differences between the two groups in the general subjects chosen (table D2 in appendix D).

Propensity score matching methods used

Constructing a matched counterfactual group using propensity score matching involves using a function (usually predicted probabilities of treatment from a probit model) to choose individuals who are estimated to have the same, within some range, propensity for treatment, but who did not receive a treatment. In this study, two standard and common PSM approaches are used to construct a matched control group — Nearest Neighbour and Kernell.

Nearest Neighbour involves using a propensity score to select, for each treated individual, the individual from the control group with the closest propensity of treatment. A limitation of Nearest Neighbour is that it only uses information from one control group observation per treated individual and ignores information from control group members who may have similar predicted probabilities of

[15] Exclusion restrictions are variables that affect selection into treatment, but do not affect the variable of interest.

treatment. To better utilise the available information, we also use 'closest-5' Nearest Neighbour estimation and Kernell matching. The closest-5 Nearest Neighbour chooses five control group members with the closest predicted probabilities; the outcomes from each of the five are given equal weight in constructing the counterfactual. In contrast, Kernell matching selects all control group members within a certain range of the treated individual's propensity score and takes a weighted average of the selected control group outcomes. The weights depend on the distance between the control and the treated propensity score.[16] In small samples there is generally a trade-off between bias and efficiency (Smith & Todd 2005). Notably, Nearest Neighbour estimators are less biased, while Kernell are more efficient. Because we have a large control group, our default choice is estimation using one-to-one Nearest Neighbour. Estimates using closest-5 Nearest Neighbour and Kernell matching are also generated for the sake of robustness. When examining impacts by subject area when the use of small samples is involved, Kernell matching is used because it produces more precise estimates.

Because of the small sample sizes, we cannot precisely estimate impacts for individual subjects. Instead, we estimate impacts across similar groups of subjects. The subject groups used are:

- business and finance: business and financial services
- community, outdoor and recreation: community services; community recreation; and sport and outdoor recreation
- dance and music: dance; music; and music industry (technical production)
- engineering and technology: engineering studies; and electrotechnology
- information technology: information technology; and interactive digital media
- hospitality: hospitality; and hospitality (kitchen operations)
- equine industry.

We do not estimate the impacts for students who take laboratory skills and furnishing because there are too few observations with respect to scaled scores for robust estimation.

A feature of this study is the derivation of a decomposition method that attempts to explain any gap in university entry scores between those who do and those do not take VCE VET subjects. The details of this method are presented in appendix C.

Specification of the propensity score function

As mentioned above, for propensity score matching to deal with self-selection bias, the conditional independence assumption must hold; that is, we must control for differences in all factors that affect both the choice of VCE VET and the outcomes of interest. The key differences are likely to be in past academic performance and ability; in school-level factors, such as school resourcing; in peer characteristics; and in post-school study aspirations. The richness of our data allows us to control for all of these differences by including them in our binary probit model of selection into a VCE VET subject. See table D1 for a list of all the variables used in the selection equation and the selection equation results.

[16] Kernel matching is conducted using a conservative bandwidth of 0.02.

To control for differences in school factors, we include peer information (information on other Year 12 students in 2011 at the same school) and other school information in the selection equation. For each student in the sample, peer information is the average of their Year 12 peer NAPLAN scores from Year 9 (in 2008), their Year 12 peer participation rate in VCE VET subjects and the number of Year 12 peers. Peer participation in vocational education and training and peer enrolments provide information on the possible quality and range of VCE VET options. Other school information includes an indicator of whether the school is a government school, which may also be related to the availability of school resources.

There is a strong body of literature that shows parents' education and occupational preferences are important in influencing students' academic performance and occupational preferences (see for example Polidano, Hanel & Buddelmeyer 2013). To control for this source of self-selection, we include information on the highest education level (Australian Standard Classification of Education [ASCED] 1-digit) and the occupation skill level (Australian Standard Classification of Occupations [ASCO] 1-digit) of either parent in the binary probit model of VCE VET.

We control for a range of individual-level factors, the most important being differences in past academic performance and ability, where we use NAPLAN numeracy and reading results in Year 9 (2008 data). Using past test scores in a multivariate model of academic performance to control for differences in academic ability and the effects of historical investments in education is known as a 'value-added' model. Value-added models are commonly used to estimate the influence of changes to academic inputs; for example, the effects of teachers (Hanushek 1979; Todd & Wolpin 2003). Other individual-level information used in the matching is gender, age, Indigenous status, whether the individual is from a non-English speaking background, remoteness of region, number of VCE subjects chosen and a measure of regional disadvantage. We control for differences in the availability of VCE VET subjects by local economic opportunities by using information on local (statistical local area) unemployment rates from the Australian Bureau of Statistics (ABS). These were found to explain more of the variation in selection into VCE VET courses than the SEIFA indices of socio-economic disadvantage (ABS 2006), but overall regional economic factors were not important in explaining selection (see table D1).

Besides restricting the sample of analysis to those who apply for university entry prior to sitting their final exams, in the propensity score matching we also control for differences in intended field of education at university. As discussed above, it is possible that students who do and those who do not choose VCE VET subjects aspire to different university courses, so that there are also differences in the general subjects taken between the two groups that may affect outcomes. We control for the differences in field of education by including dummy variables for 25 fields of university study (2-digit ASCED) in the standard propensity score matching. In the standard estimation, we do not control explicitly for the level of aspiration, measured by the cut-off score of the first preference, because this contains large numbers of missing observations, which may affect the analysis. We test whether the inclusion of first-preference cut-off scores affects the standard estimates in the sensitivity analysis (appendix E).

Results

The effects of taking a scored VCE VET subject are presented in tables below as average treatment effects on the treated (ATET). It is important to note that ATET applies only to those who are observed to take a VCE VET subject and cannot be interpreted as the effect of extending the coverage of the program; that is, the results can't be interpreted as potential effects from an increase in the number of people who take scored VET in Schools subjects. They are only the estimated effects for those who are observed to take scored VET courses. The tables also include the average outcome values for both the treatment (enrolled in a VCE VET subject) and matched control groups (did not enrol in a VCE VET subject). The standard errors reflect the average error associated with the estimates. Generally speaking, the larger the relative size of the estimate's standard error, the greater the imprecision of the estimate. Whether the average treatment effects on the treated are significantly different from zero is indicated by asterisks. More asterisks mean more confidence that the estimates are significantly different from zero.

Except for the results by subject grouping (table 8), all the results are generated using one-to-one Nearest Neighbour matching. Because the results for subject groups are derived using smaller samples, we use Kernell matching to help improve the precision of the estimates. We find no evidence to suggest that any of the results given below are sensitive to the choice of matching method (see tables D3 and D4 in appendix D). All the results generated pass balancing tests, which means that after matching, except for their treatment status, there are no statistical differences in the characteristics of those who do and those who do not choose a VCE VET subject. (The results are presented in tables D1 and D2 in appendix D.)

Overall impacts on university entry scores

Table 6 Estimated impacts from taking a VCE VET subject on university entry scores (out of a maximum of 205) among those who intend to go to university

	Enrolled in a VCE VET subject		Did not enrol in a VCE VET subject		Difference (ATET)		Number of obs
	Avg. entry score	s.e.	Avg. entry score	s.e.	Avg. entry score	s.e.	
Unmatched	111.32	23.186	128.578	27.123	-17.257***	0.714	27 437
Matched	111.32	23.186	116.939	24.058	-5.618***	1.149	27 437

Note: ***Significant at 1%.

The results presented in table 6 are average effects across our sample of VCE VET students who intend to go to university. It is clear from table 6 that controlling for non-random selection into VCE VET subjects is important. In particular, before the matching there is a 17-point gap in the average university entry scores between those who take a VCE VET subject and those who do not. After matching, the gap shrinks to around six points. This suggests that most of the unmatched gap (12-point gap) is due to non-random selection into VET and is not causally linked to the impacts of taking a VCE VET course. The remaining six-point gap after matching can be interpreted as the reduction in the average university entry score associated with taking a VCE VET subject. To put this into context, taking a VCE VET subject is associated with a reduction in the average university entry score for VCE VET students from 117 to 111, out of a possible 205. This represents around a 5% reduction in entry

scores, on average. This estimate is robust to the range of alternative key assumptions that underpin the analysis. (See the sensitivity analysis in appendix E for details.)

Decomposition of entry score results

A major innovation of this study is the derivation of a decomposition method that breaks the total effects presented in table 6 into direct effects and indirect effects. All else being equal, the direct effect is the change in the university entry score associated with taking a VCE VET subject instead of a general subject; the indirect effect is the change in the university entry score in all general subjects associated with a substitution of a VCE VET subject for a general subject.

Table 7 Estimated total, direct and indirect impacts of taking a VCE VET subject on university entry scores (out of a maximum of 205) among those who intend to go to university

VCE VET status	Total	Direct effect	Indirect effect
Enrolled in a VCE VET subject	111.320	19.311	92.008
Did not enrol in a VCE VET subject	116.939	23.297	93.641
Difference (ATET)	*-5.618****	*-3.985****	*-1.632****

Note: ***Significant at 1%.

It is clear from the results in table 7 that most of the gap in test scores arises because of low scores in VCE VET. For students who take a VCE VET subject, on average, their VET subject contributes 19 points out of a maximum 50 to their university entry score, compared with an average of around 23 points in all of their other subjects (92.008 divided by four). The average subject contribution of 23 points in subjects apart from VET is only marginally smaller than the per-subject contribution for students who do not take VCE VET subjects (23.41). It is important to note that these scores are average contributions to the university entry score and not average scores: they take into account the different weighting given to subjects in making up individual entry scores.[17]

Overall, we can conclude that of the six-point reduction in university entry scores associated with taking a VCE VET subject (table 6), around four points (or 70%) can be attributed to the direct effect and the remainder due to indirect effects. We cannot be sure of the origin of the direct and indirect effects and there may be a number of different explanations. The negative direct effect includes: excessive down-scaling of VCE VET subjects; the onerous training commitments associated with VET qualifications; and/or because students who intend to go to university are not well suited to these subjects. A possible explanation for the negative indirect effect is that performance in other subjects is affected by onerous off-campus training commitments. While schools try to minimise any disruptive impact that off-campus training has on academic achievement, we cannot rule out this possibility because no data are available on the time spent in off-campus training.

The decomposition results tell us something about the contribution of uncontrolled-for factors in explaining our results. In this study, we cannot rule out the possibility that the lower average entry score for VCE VET students is due to differences in factors that are not controlled for and which affect entry scores. That said, the dominance of the direct effect suggests that this is unlikely. If there are uncontrolled differences in factors that lead to lower entry scores for VCE VET students, then to

[17] In Victoria, only English and the highest three contribute equal weight (100%) and the fifth subject (and potentially sixth) only contributes 10%. See appendix C for technical details. Note that in working out the average contributions of the indirect effect to the overall entry score, we divide by four because the vast majority students take five VCE subjects.

explain the entire gap, they must have a disproportionately *negative* effect on scores in VCE VET subjects compared with scores in other subjects. The difference in preferences is an example of an uncontrolled-for factor that may disproportionately affect performance in VCE VET. However, differences in preferences are likely to disproportionately *increase* performance in VCE VET subjects. At the most, if we assume that all of the indirect effect can be explained by uncontrolled-for differences between the two groups and that uncontrolled-for factors impact on scores in all subjects equally, then uncontrolled-for factors would only account for around a third of the estimated gap in university entry scores.[18]

Results by VCE VET subject group

The results in table 8 show the estimated relationships between enrolling in different subject groupings (presented in the methodology section) and university entry scores for students who intend to go to university. A point of note when interpreting the results in table 8 is that the small number of observations by subject group means that the results are estimated with less precision than in tables 6 and 7. Overall, the results by subject group are either insignificant or significant and negative. Consistent with the aggregate results presented in table 6, the negative results are driven more by negative direct than indirect effects. The largest negative relationships are from taking VCE VET subjects in engineering and technology; community; outdoor and recreation; and hospitality, which are associated with seven-point, six-point and six-point lower university entry scores respectively. While these impacts are driven mostly by direct effects, there is variation in the indirect effects that explain some of the differences in impacts across subjects. Of note, we find some evidence of positive, albeit insignificant, indirect effects in dance and music and information technology that suggest that the skills developed in these subjects may benefit learning in other general subjects. For example, taking the VCE VET subject music may help in the learning of music performance, a general course that it is commonly combined with studio arts (table B5 in appendix B).

[18] If we assume that all of the indirect effect is due to differences in uncontrolled-for factors and that these factors have the same negative effect on all subject scores, then we can say that 0.408 (1.632/4) percentage points of the 3.985-percentage-point gap due to the direct effect is also explained by uncontrolled-for factors. Therefore, at the most, uncontrolled-for factors would explain 2.04 of the 5.618-percentage-point gap.

Table 8 Estimated impacts from taking individual VCE VET subjects on university entry scores (out of a maximum of 205) of those who intend to go to university, Kernell matching

VCE VET status	Total	Direct effect	Indirect effect
Business and finance			
Enrolled in a VCE VET subject[a]	108.16	20.762	87.398
Did not enrol in a VCE VET subject	111.664	22.195	89.469
Difference (ATET)	*-3.503*	*-1.432*	*-2.071*
Community, outdoor and recreation			
Enrolled in a VCE VET subject[a]	105.033	18.626	86.407
Did not enrol in a VCE VET subject	111.529	22.279	89.249
Difference (ATET)	*-6.495****	*-3.653****	*-2.841***
Dance and music			
Enrolled in a VCE VET subject[a]	118.496	20.671	97.825
Did not enrol in a VCE VET subject	119.713	23.831	95.881
Difference (ATET)	*-1.216*	*-3.160****	*1.943*
Engineering and technology			
Enrolled in a VCE VET subject[a]	111.982	18.47	93.512
Did not enrol in a VCE VET subject	119.024	23.615	95.409
Difference (ATET)	*-7.042**	*-5.144****	*-1.897*
Information technology			
Enrolled in a VCE VET subject[a]	113.974	18.991	94.983
Did not enrol in a VCE VET subject	117.5	23.417	94.083
Difference (ATET)	*-3.525***	*-4.425****	*0.899*
Hospitality			
Enrolled in a VCE VET subject[a]	113.105	18.983	94.122
Did not enrol in a VCE VET subject	118.607	23.599	95.008
Difference (ATET)	*-5.502****	*-4.616***	*-0.885*
Equine industry			
Enrolled in a VCE VET subject[a]	116.308	20.402	95.905
Did not enrol in a VCE VET subject	122.719	24.47	98.249
Difference (ATET)	*-6.411*	*-4.068*	*-2.343*

Notes: ***Significant at 1%, ** significant at 5%, *significant at 10%. [a] Using a bandwidth of 0.02.

Impacts on university access

A key question is the extent to which the six-point lower average university entry score associated with taking a VCE VET course affects access to university and the gaining of a preferred university offer. On face value, a six-point gap in entry scores does not seem to be a large effect and, given that VCE VET students apply to courses with lower required cut-off scores than students who do not take VCE VET subjects (table 5), we might expect only small or insignificant impacts. However, the results in table 9 present a different picture. We estimate that taking a VCE VET subject is associated with a 12-percentage-point reduction in the reported chance of receiving a university offer. More specifically, on average, taking a VCE VET subject is associated with a reduction in the reported chances of receiving a university offer from 79% to 67%. This result suggests that a six-point reduction in university entry scores translates into a large effect on the receipt of a university offer.

Table 9 Estimated impacts from taking a VCE VET subject on the chances of attaining entry to a university course

	Enrolled in a VCE VET subject[a]		Did not enrol in a VCE VET subject		Difference (ATET)		Number of obs[a]
	Predicted probability	s.e.	Predicted probability	s.e.	Predicted probability	s.e.	
Offered a university place							
Unmatched	0.674	0.468	0.864	0.342	-0.189***	0.012	16 923
Matched	0.674	0.468	0.792	0.405	-0.118***	0.027	16 923
University course preference attained (out of 12 preferences)							
First preference							
Unmatched	0.216	0.411	0.291	0.454	-0.074***	0.012	26 875
Matched	0.216	0.411	0.238	0.426	-0.021	0.021	26 875
One of first three preferences							
Unmatched	0.404	0.490	0.543	0.498	-0.139***	0.013	28 271
Matched	0.404	0.490	0.440	0.496	-0.035	0.024	28 271
One of first six preferences							
Unmatched	0.509	0.500	0.686	0.463	-0.176***	0.012	29 266
Matched	0.509	0.500	0.580	0.493	-0.070***	0.024	29 266

Notes: ***Significant at 1%.

The number of observations for being offered a university place is fewer than in table 6 because the sample is based on On Track data, which is a sample of the population of school completers. The number of observations for attaining the preferred university preference and for attaining one of the first three and first six preferences is higher than in table 6 because of the higher number of non-missing observations in the outcome variable.

Given that we know that VCE VET students apply to courses with lower cut-off scores than students who do not undertake VCE VET subjects, this result appears to contradict expectations. However, there are good reasons for this result. First, the descriptive statistics that show VCE VET students apply for courses with lower cut-off scores are based on unmatched data (table 5). In estimating the relationships between VCE VET and receiving an offer, propensity score matching compares the offer rate of VCE VET students with the offer rate of a select group of students who did not take a VCE VET course but who have the same observable characteristics. In appendix E, we show that adding the controls for the differences in the level of aspiration using the first-preference cut-off scores makes very little difference to the estimated results. The clear interpretation of this result is that once we control for the differences in the observable characteristics between those who do and those who do not take VCE VET subjects (especially academic performance and intended field of study), their level of aspiration is much the same as for the students who do not take VCE VET. Therefore, after controlling for the differences in observable characteristics, any change in university entry score is likely to have similar impacts on both groups' chances of receiving a university offer.

Second, for VCE VET students who intend to go to university, the chances of receiving a university offer are particularly sensitive to changes in entry scores because, on average, they are around the middle of the entry-score distribution. For VCE VET students who are towards the bottom of the academic distribution, small impacts in university entry scores are likely to have little effect on their chances of receiving a university offer because their scores are too low to receive an offer, even without the small impact. Similarly, for VCE VET students who are high up the academic distribution, a small impact on their entry scores is likely to have only minor effects on their chances of receiving an offer but may be more likely to affect their chances of receiving a more preferred offer.

The estimated results for the attainment of a preferred course, using Victorian Tertiary Admissions Centre preference and course cut-off information, are also presented in table 9. As discussed above,

the use of cut-off scores to identify the receipt of an offer should be considered at best as the association between taking VCE VET courses and being 'guaranteed' a preferred offer. However, we can take some comfort in the fact that the results generated using this measure are broadly consistent with those using reported university offers from On Track. What we can assume from these results is that taking a VCE VET course is only associated with a lower chance of receiving offers from *outside* the three most preferred courses. Taking a VCE VET subject is associated with a seven-percentage-point lower chance of attaining a top six preference, from a total of 12 preferences. The effect on attaining a top and top three preferences is likely to be low because, on average, the likelihood of VCE students attaining a high preference is low, regardless of whether or not they take a VCE VET subject (around a 20% chance).

Conclusions

VET in Schools in Australia was introduced in upper secondary school in the mid-1990s with the aim of retaining less academic youth at school and preparing students for work and further training (Ministerial Council on Education, Employment, Training and Youth Affairs 1999). However, to help improve the status of students undertaking these courses and to provide them with opportunities to pursue vocational options without closing off university pathways, the VET in Schools program has been expanded to include upper-secondary subjects that count towards a national qualification and university entry.[19]

In this study, we have taken a first step in evaluating the outcomes of VET courses that also contribute to university entry by estimating the relationship between taking a VCE VET subject and university access for those students who lodge a first preference to study a university course. Using a rich dataset and propensity score matching to control for a range of contextual factors that may explain academic performance, we find that, on average, taking a VCE VET subject is associated with a 5% lower university entry score and a 12-percentage-point lower chance of receiving a university offer. We find overall that the relationship between taking a VCE VET course and university entry scores is robust to a range of modelling assumptions, but that the magnitude of the negative impacts across courses varies somewhat. Using a decomposition method developed in this study, we estimate that around 70% of the deficit in university entry scores of students who do VCE VET subjects is, on average, because of the lower scores attained in their VCE VET subject (direct effect), with 30% due to lower performance in their other subjects (indirect effect).

While we cannot rule out the possibility that the estimated relationship between taking a VCE VET subject and university entry scores stems from a factor that is not fully controlled for, there are good reasons for investigating the estimated relationship further. First, as demonstrated in this study, VCE VET students are on average in the middle of the academic distribution, which means that small impacts on university entry scores can potentially have large impacts on their attainment of a university offer. Second, the fact that we can attribute most of the gap in university entry scores to the lower performance of VCE VET students in their VCE VET subjects, rather than in their general subjects, suggests that it is unlikely that the entire gap in entry scores is explained by uncontrolled for factors. Third, evidence presented in this study points to a potential bias in the scaling applied to scored VCE VET subjects; this is because a relatively high proportion of students in this study do not apply for university study but, to attain credit towards a VET qualification, focus their efforts on VCE VET subjects to the detriment of their performance in their other subjects. Under current scaling arrangements in Victoria, for a given subject the scaling is conducted so that the average score is equal to the student's average score in their other subjects.

Given these findings, we suggest the following responses. First of all, the extent of any excessive down-scaling of VCE VET subjects should be investigated further. If further investigation confirms our findings, then a clear response should be to adjust the scaling of subjects to account for the differences in motivation for specialisation that stems from courses being linked to the attainment of

[19] Making VET in Schools more accessible for students of all academic backgrounds, including those who intend to go on to university, is an objective of the Australian Government, as outlined in the New Framework for Vocational Education in Schools (Ministerial Council on Education, Employment, Training and Youth Affairs 2001). To achieve this end, the New Framework underlines the importance of course competency counting towards both the attainment of a VET qualification and university entry scores.

VET qualifications. One way to do this would be to scale subjects using only the scores of students who intend to go to university, measured by whether or not they lodge an application for admission to a university course prior to sitting their final exam. A second implication is that governments should monitor and collect data on the time students spend in their VET training, including their off-campus training. Not only will this assist in understanding the effect of training, but it will also help in coordinating training across local school clusters where close-by options in TAFE institutes may be inadequate. As a precaution, schools may help to reduce any burden on students in their final year of study by encouraging them to take these subjects in Year 11.

Importantly, we stress that this study only examines the impacts of taking VCE VET subjects on direct access to university. Other important outcomes from VCE VET programs, such as indirect access to university (for example, by completing a diploma course); participation in post-school VET study; retention in post-school study; and employment outcomes, are not investigated here, but should be considered in any overall evaluation of these programs. Previous studies by Anlezark, Karmel and Ong (2006), Lamb and Vickers (2006) and Polidano and Tabasso (2013) have demonstrated positive benefits to school retention and initial labour market outcomes from unscored VET in Schools courses.

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Appendix A: Assessment

Table A1 Prescribed performance criteria for work performance task

Criteria	Performance level				
	1 (base)	2	3 (medium)	4	5 (high)
Application of knowledge underpinning work task	Displays an understanding of key knowledge and applies these in work functions		Displays a sound understanding of key knowledge and proficiently applies these in work functions		Demonstrates a thorough understanding of all knowledge and effectively applies these in work functions
Knowledge and use of communication, language and interpersonal skills	Displays an understanding and appropriate use of key industry and enterprise language		Displays a sound understanding and correct use of key industry and enterprise language		Demonstrates a thorough understanding and correct use of key industry and enterprise language
	Uses communication and interpersonal skills appropriate for the audience and situation		Uses a range of communication and interpersonal skills appropriate for the audience and situation		Effectively selects and uses a range of communication and interpersonal skills appropriate for the audience and situation
Performance of techniques and processes	Performs key technical skills/procedures to the standard required in the workplace, including correct use of any equipment		Performs all technical skills/procedures to the standard required in the workplace, including correct use of any equipment		Effectively performs key technical skills/procedures to the standard required in the workplace, including correct use of any equipment
Understanding and application of work organisation	Demonstrates an awareness of the benefits of effective organisation. Describes the key stages in planning and organising a work function. Applies planning and organisational skills in the performance of work functions		Demonstrates a sound understanding of the benefits of effective organisation. Describes accurately the stages in planning and organising a work function. Applies sound planning and organisational skills in the performance of work functions		Demonstrates a thorough understanding of the benefits of effective organisation. Clearly and accurately explains the stages in planning and organising a work function. Independently applies planning and organisational skills in the performance of work functions
Performance of work tasks and need for supervision	Under normal workplace supervision, requires additional supervisor-initiated support to complete tasks safely in accordance with workplace requirements. Demonstrates competence in all units of all learning outcomes. Work performance complies with most enterprise work standards		Under normal workplace supervision, seeks limited additional supervisor support to complete tasks safely in accordance with workplace requirements. Demonstrates competence in all units of all learning outcomes. Work performance complies with all key enterprise work standards		Works independently under normal workplace supervision conditions to complete tasks safely in accordance with workplace requirements. Demonstrates competence in all units of all learning outcomes. Work performance complies with all enterprise work standards

Source: VCAA 2010.

Appendix B: VCE VET subjects

Table B1 General subjects taken by students who enrol in business and financial services

	No.	%
Take one of		
Accounting	11	4.87
Business management	64	28.32
Economics	2	0.88
Legal studies	26	11.5
Take two of		
Accounting and business management	9	3.98
Accounting and economics	2	0.88
Accounting and legal studies	4	1.77
Business management and economics	0	0
Business management and legal studies	13	5.75
Economics and legal studies	1	0.44
Take more than two of the above	4	1.77
Take none of the above	90	39.82
Total	**226**	**100.00**

Note: The sample is restricted to those who only take one VET subject and who attain a university enter score.

Table B2 General subjects taken by students who enrol in engineering studies

	No.	%
Take one of		
Design and technology	23	18.55
Physics	29	23.39
Systems engineering	3	2.42
Visual communication and design	9	7.26
Take two of		
Design and technology and physics	2	1.61
Design and technology and systems engineering	5	4.03
Design and technology and visual communication and design	1	0.81
Physics and systems engineering	3	2.42
Physics and visual communication and design	6	4.84
Systems engineering and visual communication and design	0	0
Take more than two of the above	0	0
Take none of the above	43	34.68
Total	**124**	**100.00**

Note: The sample is restricted to those who only take one VET subject and who attain a university enter score.

Table B3 General subjects taken by students who enrol in electrotechnology studies

	No.	%
Take one of		
Design and technology	8	10.39
Physics	11	14.29
Systems engineering	15	19.48
IT applications	1	1.3
Take two of		
Design and technology and physics	1	1.3
Design and technology and systems engineering	4	5.19
Design and technology and IT applications	0	0
Physics and systems engineering	4	5.19
Physics and IT applications	0	0
Systems engineering and IT applications	0	0
Take more than two of the above	1	1.3
Take none of the above	32	41.56
Total	**77**	**100.00**

Note: The sample is restricted to those who only take one VET subject and who attain a university enter score.

Table B4 General subjects taken by students who enrol in information technology studies

	No.	%
Take one of		
IT applications	45	22.84
Visual communication and design	14	7.11
Interactive digital media	0	0
Software development	16	8.12
Take two of		
IT applications and visual communication and design	0	0
IT applications and interactive digital media	0	0
IT applications and software development	2	1.02
Visual communication and design and interactive digital media	0	0
Visual communication and design and software development	3	1.52
Interactive digital media and software development	0	0
Take more than two of the above	0	0
Take none of the above	117	59.39
Total	**197**	**100.00**

Note: The sample is restricted to those who only take one VET subject and who attain a university enter score.

Table B5 General subjects taken by students who enrol in music studies[a]

	No.	%
Take one of		
Music performance (solo or group)	126	13.74
Studio arts	179	19.52
Take two of		
Music performance and studio arts	27	2.94
Take none of the above	585	63.79
Total	**917**	**100.00**

Note: The sample is restricted to those who only take one VET subject and who attain a university enter score.
a Includes both music and music industry (technical production).

Table B6 General subjects taken by students who enrol in community services work

	No.	%
Take one of		
Health and human development	77	32.08
Psychology	63	26.25
Take two of		
Health and human development and psychology	59	24.58
Take none of the above	41	17.08
Total	**240**	**100.00**

Note: The sample is restricted to those who only take one VET subject and who attain a university enter score.

Table B7 General subjects taken by students who enrol in hospitality studies[a]

	No.	%
Take one of		
Food and technology	120	22.06
Health and human development	105	19.3
Take two of		
Food and technology and human development	34	6.25
Take none of the above	285	52.39
Total	**544**	**100.00**

Note: The sample is restricted to those who only take one VET subject and who attain a university enter score.
a Includes both hospitality and hospitality (kitchen operations).

Table B8 Subjects taken by students who enrol in interactive digital media

	No.	%
Take one of		
Visual communication and design	3	3.03
Studio arts	4	4.04
Media	5	5.05
Take two of		
Visual communication and design and studio arts	1	1.01
Visual communication and design and media	1	1.01
Studio arts and media	1	1.01
Take more than two of the above	0	0
Take none of the above	84	84.85
Total	**99**	**100.00**

Note: The sample is restricted to those who only take one VET subject and who attain a university enter score.

Table B9 Subjects taken by students who enrol in sport and recreation[a]

	No.	%
Take one of		
Physical education	177	34.3
Health and human development	70	13.57
Outdoor and environmental studies	15	2.91
Take two of		
Physical education and health and human development	100	19.38
Physical education and outdoor and environmental studies	14	2.71
Health and human development and outdoor and environmental studies	7	1.36
Take more than two of the above	7	1.36
Take none of the above	126	24.42
Total	**516**	**100.00**

Note: The sample is restricted to those who only take one VET subject and who attain a university enter score.
a Includes sport and outdoor recreation.

Appendix C: Technical appendix

As described in the text, an individual's university entry score is derived by adding the highest English study score (from English, English as a second language or English literature) to the remaining best three subject scores in the final year of study (known as the primary four subjects) and adding 10% of the fifth-best subject score. In algebraic notation:

$$s_i = x_{English_i} + \sum_{c=1}^{3} x_{ic} + 0.1x_{i5} \qquad \text{(C.1)}$$

where,

$x_{iEnglish}$ = highest scaled study score in English, English (ESL) or English literature
x_{ic} = top three c scaled study scores, excluding highest English score
x_{i5} = scaled study score for the fifth highest subject.

Note that if a sixth subject is taken, an extra 10% of that subject is added as well, which would mean adding $0.1x_{i6}$ to equation C.1.

To estimate the effect of taking a VCE VET subject on university entry scores, we estimate the difference in the entry score if a VCE VET subject is taken, minus the entry score if an alternative general subject is taken. To present this algebraically, we need to modify C.1 by introducing terms for weights (w), which are equal to 1 if the score is in the top three (excluding highest English subject) and 0.1 otherwise, and introduce subscripts *VET* to denote a VCE VET subject and k to denote a general subject (scored subjects that are neither the highest English score or a VCE VET subject):

$$s_i = x_{English_i} + \sum_{k=1}^{N} w_{ik}x_{ik} + w_{iVET}x_{iVET}. \qquad \text{(C.2)}$$

Algebraically, the effect of taking a VCE VET subject for individual i is equal to the university entry score when a VCE VET subject is taken (s_i), less the score for the same individual if the VCE VET subject was not taken (s_i'):

$$s_i - s_i' = \left[x_{English_i} + \sum_{k=1}^{N} w_{ik}x_{ik} + w_{iVET}x_{iVET} \right] - \left[x'_{English_i} + \sum_{k=1}^{N} w'_{ik}x'_{ik} + w'_{iVET}x'_{iVET} \right]. \qquad \text{(C.3)}$$

In this study, we assume that the effect of taking a VCE VET subject (equation C.3), for students observed to take such subjects, can be described as the sum of two effects — a direct and an indirect effect of taking a VCE VET subject. The direct effect is the weighted subject score for individual i's chosen VCE VET subject, relative to the weighted subject score if individual i took a general subject instead, all else being equal, while the indirect effect, or spillover effect, is the impact from taking a VCE VET subject on the subject scores of general subjects taken by individual i. The decomposition of C.3 can thus be expressed as:

$$DE_i = \left[w_{iVET}x_{iVET} \right] - \left[w'_{iVET}x'_{iVET} \right] \qquad \text{(C.4)}$$

$$IE_i = \left[x_{English_i} + \sum_{k=1}^{N} w_{ik}x_{ik} \right] - \left[x'_{English_i} + \sum_{k=1}^{N} w'_{ik}x'_{ik} \right] \qquad \text{(C.5)}$$

A problem with estimating equations C.3—C.5 is that we do not observe the counterfactual outcomes (the second terms in C.4 and C.5), which is known as the classic evaluation problem. Propensity score

matching addresses this problem by constructing a counterfactual outcome using information from 'matched' or 'like' individuals who did not take a VET subject (control group). Before matching is conducted, assumptions are needed on what the counterfactual outcomes for the control group are.

Ideally, we would limit the control group for each *i* treatment group member as individuals who take the same subjects, except take another general subject instead of a VCE VET subject. However, students have a great deal of flexibility in the choice of up to around 60 subjects (not including VCE VET subjects), which means that such a control group limited on these grounds would be too small to construct well-matched counterfactual outcomes. Instead, we have to make assumptions about the counterfactual outcomes $w'_{ik}x'_{ik}$ and $w'_{iVET}x'_{iVET}$. The standard assumption used in this study is that individual *i*'s counterfactual outcome is the same for each subject and is equal to the average weighted subject scores from *j* members of the control group:

$$w'_{iVET}x'_{iVET} = w'_{ik}x'_{ik} = \frac{\sum_{k=1}^{N_k^C} w_{jk}x_{jk}}{N_k^C} = \overline{w_{jk}x_{jk}} \qquad \text{(C.6)}$$

Because individuals from the control group generally take an extra general subject instead of a VET subject, we distinguish between the number of general subjects taken by the control group (N_k^C) from the number of subjects taken by the treatment group (N_k^T).[20] Substituting C.6 into the C.3, C.4 and C.5 equations, the total, direct and indirect effects estimated in this study can be expressed as:

$$s_i - s'_i = \left[x_{iEnglish} + \sum_{k=1}^{N_k^T} w_{ik}x_{ik} + w_{iVET}x_{iVET} \right] - \left[x_{jEnglish} + \sum_{k=1}^{N_k^T} \overline{w_{jk}x_{jk}} + \overline{w_{jk}x_{jk}} \right] \qquad \text{(C.7)}$$

$$DE_i = w_{iVET}^T x_{iVET}^T - \overline{w_{jk}x_{jk}} \qquad \text{(C.8)}$$

$$IE_i = \left[x_{iEnglish} + \sum_{k=1}^{N_k^T} w_{ik}x_{ik} \right] - \left[x_{jEnglish} + \sum_{k=1}^{N_k^T} \overline{w_{jk}x_{jk}} \right] \qquad \text{(C.9)}$$

Using average weighted scores across all general subjects from the control group to construct counterfactual outcomes implicitly assumes that the students who take a VCE VET subject would, on average, choose general subjects that are similar to those taken by the matched control group if VCE VET subjects weren't available.[21] After matching, there are only minor differences in the choice of general subjects between treatment and matched control group members (see table D2), which validates the assumption of common general subjects between the two groups.

To estimate the total, direct and indirect effects of taking a VCE VET subject involves generating three outcome variables using C.7, C.8 and C.9. The values of these outcome variables depend upon whether or not individuals are in the treatment or control group. For example, for the direct effect outcome, the values for the treatment group members are equal to the first term in equation C.8, while for the control group members, the direct effect outcomes are equal to the second term. After the three outcome variables are estimated, PSM is applied to select a matched control group for each VCE VET student in the sample to construct the counterfactual outcomes. Refer to the methodology section in the main text for information about the different PSM techniques used and how they derive the counterfactual outcomes.

[20] For simplicity of estimation, we assume that $N_k^T = N_k^C - 1$, which it is in the vast majority of cases.

[21] Or at least similar enough so that there are no differences in university entry scores between students who take VET courses and those who do not due to differences in general courses taken.

Appendix D: Probit results and balancing test results

Table D1 Results from the probit model of participation in a VCE VET subject used in the propensity score matching

	All students		Students that intend to start higher education	
	Marginal effect	t-stat	Marginal effect	t-stat
Individual characteristics				
Respondent is male	0.00211***	(2.59)	0.00116*	(1.87)
Age of respondent	-0.00107	(-1.42)	-0.000684	(-1.22)
Indigenous status	-0.00461	(-1.33)	-0.00312	(-1.48)
Non-English speaking background	0.000547	(0.60)	-0.000264	(-0.41)
Rural area	-0.000922***	(-3.29)	-0.000582***	(-2.69)
Unemployment rate in SLA	-0.000173	(-1.12)	-0.00000621	(-0.05)
NAPLAN numeracy score in Year 9	-0.00004***	(-4.60)	-0.000024***	(-3.75)
NAPLAN reading score in Year 9	-0.0000154*	(-1.92)	-0.0000131**	(-2.19)
Number of subjects taken in VCE	0.0165***	(7.68)	0.0104***	(6.45)
Taken VET subjects at unit 1 or 2 level	0.00275***	(15.72)	0.00174***	(11.36)
School-level factors				
Non-government school	0.00585***	(6.02)	0.00352***	(4.97)
School average NAPLAN numeracy score[a]	-0.0000214	(-0.75)	-0.000009	(-0.48)
School average NAPLAN numeracy score[a]	-0.0000648*	(-1.80)	-0.0000265	(-1.00)
School average % of students taking VCE VET[a]	-0.0000009	(-0.01)	0.000120*	(1.69)
Number of students in the school	0.0000353***	(7.59)	0.0000217***	(6.06)
Highest ANZSCO occupation among parents (ref. case: senior managers, qualified professionals)				
Not stated	0.00357	(1.42)	0.00112	(0.68)
Not in paid work	0.00377	(1.53)	0.00405*	(1.81)
Labourer	0.00374*	(1.95)	0.00250*	(1.66)
Tradesman/clerk	0.00140	(0.97)	0.00157	(1.36)
Other manager	0.00308**	(2.22)	0.00181*	(1.81)
Highest ASCED education level among parents (ref. case: Bachelor degree or above)				
Not known	0.00122	(0.63)	0.00242	(1.39)
Year 9 or below	-0.00256	(-1.43)	-0.00163	(-1.29)
Year 10/11	-0.000156	(-0.11)	-0.000468	(-0.46)
Year 12	-0.00104	(-0.79)	-0.00132	(-1.54)
Certificates I–IV	-0.000986	(-0.89)	-0.000472	(-0.58)
Diploma	-0.00165	(-1.53)	-0.00102	(-1.33)
Intended field of education at university (ASCED code for VTAC first preference. ref. category: maths and science)[b]				
Other natural and physical sciences	-0.00636***	(-6.18)	-0.00473***	(-8.54)
Computer science and it systems	-0.00599***	(-6.16)	-0.00635***	(-5.68)
Other IT	0.000694	(0.24)	-0.00438***	(-5.88)
Engineering, manufacturing and technology	0.0194***	(3.05)	-0.00323	(-1.38)
Maritime engineering and technology	-0.00298	(-1.51)	-0.00466***	(-7.32)
Other engineering and technology	-0.00347**	(-2.06)	-0.00471***	(-8.42)
Architecture and building	-0.00389**	(-2.21)	-0.00470***	(-8.09)
Agriculture; natural resources and environment	-0.00429***	(-3.66)	-0.00491***	(-7.38)
Other agriculture and related studies	-0.00462***	(-3.40)	-0.00479***	(-8.19)
Medical studies; pharmacy and nursing	-0.00497	(-1.52)	-0.00450***	(-8.69)

	All students		Students that intend to start higher education	
	Marginal effect	t-stat	Marginal effect	t-stat
Veterinary studies; public health and related	-0.00528***	(-5.70)	-0.00645***	(-5.03)
Other health	-0.00471***	(-4.21)	-0.00541***	(-6.69)
Teacher education; curriculum and education studies	-0.00335***	(-2.58)	-0.00511***	(-6.47)
Other education	-0.000384	(-0.25)	-0.00515***	(-4.90)
Accounting, business, marketing and related	0.000788	(0.22)	-0.00438***	(-6.57)
Banking and finance and related	-0.00139	(-1.16)	-0.00604***	(-4.33)
Other management and commerce	-0.00439	(-1.39)	-0.00449***	(-8.64)
Behavioural science; law and related	-0.00662***	(-7.55)	-0.00553***	(-7.33)
Language and literature; economics; philosophy and related	-0.00314***	(-2.71)	-0.00630***	(-4.61)
Sport and recreation	-0.00115	(-0.47)	-0.00454***	(-7.72)
Other society and culture	0.00208	(0.76)	-0.00439***	(-6.03)
Arts; design; media studies and related	-0.00566***	(-6.23)	-0.00614***	(-5.65)
Other creative arts	0.00256	(1.58)	-0.00534***	(-3.47)
Personal services	0.0158*	(1.88)	-0.00383***	(-2.79)
Observations	**32 562**		**27 437**	

Notes: *** Significant at 1%, ** significant at 5%, *significant at 10%.
a Excluding student's own outcome.
b These headings reflect the 2-digit ASCED fields of study based on the 4-digit headings that makeup the 2-digit categories.
SLA = statistical local area.

Table D2 The ten most common general subjects taken by students who do and do not take a VCE VET subject

Students who take a VCE VET subject (treatment group)	%	Students who don't take a VCE VET subject (control group)	%	Matched control group	%
Further mathematics	19.81	Further mathematics	14.32	Further mathematics	16.19
Health and human development	7.66	Mathematical methods (CAS)	8.86	Business management	7.74
Business management	7.56	Psychology	7.09	Psychology	7.5
Psychology	6.35	Chemistry	5.8	Health and human development	6.43
Physical education	5.93	Health and human development	5.37	Physical education	5.83
Studio arts	4.17	Biology	5.33	Biology	5.24
Visual communication and design	4.08	Business management	5.1	Mathematical methods (CAS)	4.88
Media	3.64	Physical education	4.44	Studio arts	4.76
Mathematical methods (CAS)	3.58	Physics	3.81	Visual communication and design	4.52
Food and technology	3.23	Legal studies	3.76	Legal studies	3.93

Table D3 Estimated impacts from taking a VCE VET subject on university entry scores (out of a maximum of 205) of those who intend to go to university, alternative PSM methods

	Enrolled in a VCE VET subject		Did not enrol in a VCE VET subject		Difference (ATET)		Number of obs
	Avg. entry score	s.e.	Avg. entry score	s.e.	Avg. entry score	s.e.	
Unmatched	111.320	23.186	128.578	27.123	-17.257***	0.714	27 437
Kernel matching[a]	111.320	23.186	116.791	4.340	-5.470***	0.982	27 437
Nearest Neighbour, top 5 match	111.320	23.186	116.634	10.825	-5.313***	0.964	27 437

Notes: *** Significant at 1%.
a Estimated using a bandwidth of 0.2.

Table D4 Estimated total, direct and indirect impacts from taking a VCE VET subject university entry scores (out of a maximum of 205) of those who intend to go to university

	Enrolled in a VCE VET subject		Did not enrol in a VCE VET subject		Difference (ATET)		Number of obs
Total	Avg. entry score	s.e.	Avg. entry score	s.e.	Avg. entry score	s.e.	
Unmatched	111.320	23.186	128.578	27.123	-17.257***	0.701	27 437
Kernel matching[a]	111.320	23.186	116.791	4.340	-5.470***	0.982	27 437
Nearest Neighbour, one-to-one match	111.320	23.186	116.939	24.058	-5.618***	1.149	27 437
Direct effect							
Unmatched	19.311	13.480	25.628	5.430	-6.316***	0.161	27 437
Kernel matching[a]	19.318	13.486	23.266	0.870	-3.947***	0.376	27 437
Nearest Neighbour, one-to-one match	19.311	13.480	23.297	4.801	-3.985***	0.394	27 437
Indirect effect							
Unmatched	92.008	23.746	102.949	21.739	-10.941***	0.570	27 437
Kernel matching[a]	92.002	23.704	93.524	3.478	-1.522**	0.871	27 437
Nearest Neighbour, one-to-one match	92.008	23.746	93.641	19.306	-1.632***	0.994	27 437

Notes: *** Significant at 1%, ** significant at 5%.
a Using a bandwidth of 0.02.

Appendix E: Sensitivity analysis

Table E1 Estimated impacts from taking a VCE VET subject on university entry scores (out of a maximum of 205) under various assumptions

	Enrolled in a VCE VET subject		Did not enrol in a VCE VET subject		Difference (ATET)		Number of obs
	Avg. entry score	s.e.	Avg. entry score	s.e.	Avg. entry score	s.e.	
Standard results (from table 6)							
Unmatched	111.320	23.186	128.578	27.123	-17.257***	0.714	27 437
Nearest Neighbour, one-to-one match	111.320	23.186	116.939	24.058	-5.618***	1.149	27 437
Results with alternative assumptions							
Alternative results 1	111.3205	23.187	117.825	23.630	-6.505***	0.777	27 437
Alternative results 2	111.7403	22.809	116.220	22.857	-4.479***	0.785	21 516
Alternative results 3	111.3205	23.187	117.267	23.181	-5.946***	1.252	21 517
Alternative results 4	105.123	23.606	109.890	26.342	-4.766***	1.078	32 562

Notes: *** Significant at 1%.

The results presented in the main body of the report (table 6) hinge on key assumptions in the modelling. The most important assumption is that the counterfactual outcome (taking a VCE VET subject) can be constructed from the outcomes from a matched control group who do not take a VCE VET subject. Underlying this assumption is the notion that if they had not taken a VCE VET subject, students would have chosen a set of subjects that are, on average, the same as those taken by the matched control group. If, instead of choosing a VCE VET subject, students had chosen subjects that were completely different from their matched control group counterparts, then the counterfactual outcomes used here may not be valid. We test the robustness of our results by re-estimating the one-to-one Nearest Neighbour results presented in table 6, but with different restrictions on the choice of counterfactual outcomes. The alternative models and their added restrictions are:

Alternative 1: restrict each match (called exact matching) to the students who have exactly the same university field of education preference (ASCED 2-digit) and also are from the same area (either metropolitan or rural).

To the extent that there are regional differences in the availability of subjects, exact matching on region will help to ensure that the subjects taken by the matched control group reflect the alternatives foregone by the VCE VET student.

Alternative 2: include information in the standard one-to-one Nearest Neighbour matching on the preferred subject's required cut-off score from 2010. Generally speaking, the subject cut-off score from the previous year is a good guide to the performance needed to attain entry in 2011.

While in the standard results we have controlled for differences in the field of study of the student's university course of preference, we have not controlled for differences in the level of university subject aspirations. To the extent that students who aspire to a higher-ranked subject are more ambitious and more committed to hard work, they may attain a higher aggregate study score. If differences in aspiration level are related to taking a VCE VET subject, then such differences should not be causally attributed to taking a VCE VET subject, but to the differences in the preferences of the students who do and who do not take VCE VET subjects. This information is not included in the standard results because there is a large number of preferences for which no cut-off could be found.

Alternative 3: exclude all individuals from the counterfactual group who attended schools that did not offer VCE VET in school subjects.

An important assumption underlying the analysis is that there are no uncontrolled school-level factors that may explain the selection of a VCE VET subject and university entry scores. By excluding observations from schools that do not offer VCE VET, we are removing observations that may have different outcomes because of the nature of the schools these students attend.

Alternative 4: relax the sample restriction to those who lodge a first preference for a university course.

From the results presented in table E1, we can conclude that the results presented in table 6 are robust to the range of alternative assumptions underpinning the generation of counterfactual outcomes. There is only a noticeable fall in impacts under alternative 2, but this may be because there is a large number of missing observations under this scenario.

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