Identification of issues faced by international students in first year project-based engineering classes

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Structured abstract

BACKGROUND
Project-based courses building on teamwork, communication and collaboration skills are compulsory for all students at The University of Queensland (UQ) where 13% of first-year students identify themselves as international. Many of these students find difficulty in adapting to western culture, in particular the learning culture (Chang & Chin, 1999). Students are often accustomed to the Confucian system which commonly focuses on transmission-based learning (lectures) and assessment through technical competence (exams) and there is little to no team work in this system (Gorry, 2011).

Teamwork underpinning two compulsory first-year project-based courses is evaluated through Peer Assessment (PA). PA occurs 4 times in the first-year of study; PA results are returned to student teams via a mentor to aid team development, and are also used to scale assessment marks. However international students generally do not perform well in these courses project-based, attracting low PA and grades due to poor quality of work, lack of contribution and/ or poor engagement. In addition, domestic students have highlighted communication and lack of task understanding as problem areas for international students and domestic students often respond with discontent and resentment.

PURPOSE
The research aims to identify the subgroups within international students which struggle in these authentic team-based project courses. Furthermore, possible key factors which play a role in their academic performance will also be investigated.

DESIGN/METHOD
PA data was collected from 2010 to 2013. This was categorised using the country, language and age groups of the students; each category was analysed using analysis of variance to identify possible trends. Particular emphasis was placed on identifying cohorts with low PA and cohorts which showed similar distributions to domestic students.

RESULTS
Overall the international cohort received lower PA than domestic students. Arabic and Chinese students exhibited the worst performance and were statistically different ($p=0.00$) from domestic students. Students from the south-east Asian region performed the best out of the international cohort although still lower in PA than the domestic average. In particular Malaysian students showed significant improvement in PA scores over the period of semester 1. English as a second language was found to be the most significant factor as students from English as a first language background showed statistical similarities to domestic students ($p=0.45$). Maturity measured by age was not shown to be statistically significant in determining PA.

CONCLUSIONS
Whilst international students do show signs of struggle in achieving higher PA, not all students in the international cohort are academically disadvantaged to the same degree. Particular subgroups of students based on origin showed significantly lower PA whilst others achieved better. Further research is needed into how the factors of country and language affect students falling into these subgroups of interest.

KEYWORDS
Peer assessment, international students, first-year

Introduction

ENGG1100 – 'Engineering Design' (E1) and ENGG1200 – 'Engineering Problem Solving and Modelling' (E2) are two compulsory team-based courses run at a large research led institution for a large cohort of first year engineering students. These courses aim to introduce students to the community of practice and begin development of engineering competencies. This is achieved by placing a focus on teamwork to encourage peer learning, network building and offering large authentic projects that cannot be completed by one student. Furthermore, both courses feature an ill-structured learning environment to aid with transition and development of ownership of learning.

International students are known to struggle in these two courses achieving lower grades than domestic students on a 7-point scale (Queensland Tertiary Admissions Centre, 2013). In E1 and E2 international students averaged 5.0. In introductory Chemistry and Mathematics courses they averaged 5.5 and 6.0 respectively. This indicates that international students perform better in courses that favour traditional didactic teaching practices. Furthermore the failure and withdrawal rate (6%) in E1 is higher for international students than their domestic counterpart (4%). Based on previous course observations, existing support systems for these team-based courses are inadequate and therefore the factors which cause international students to struggle must be identified in order to provide the correct support.

This paper presents an investigation into the factors that affects international students' academic success within these two team-based courses.

Background

International students

At The University of Queensland (UQ), around 10 to 13% of each first year cohort in engineering are international students. The total number of students enrolled in engineering at UQ over the past 4 years is detailed in Table 1. This also represents the entire sample size of data collected.

Table 1: Number of students in first year engineering

Year	Domestic	International (%)
2010	880	117 (13)
2011	903	116 (13)
2012	868	113 (13)
2013	1044	103 (10)
Total	**3695**	**449 (12)**

The majority (87%) of international students are from the Asian region, in particular China and Malaysia as shown in Figure 1. Countries that had less than three students enrolled over the four year period from 2010 to 2013 are not shown in Figure 1.

Differences in educational background

The two major learning paradigms found in tertiary education are the Socratic and Confucian systems (Gorry, 2011). These key differences in the two systems are summarised in Table 2.

Many international students find difficulty in adapting to western culture, in particular the learning culture (Chang & Chin, 1999). Asian students have experienced education mostly through the Confucian system which focuses on transmission-based learning (lectures) and assessment through technical competence (exams) resulting in surface approach learning which causes problems in team-based courses (Gorry, 2011).

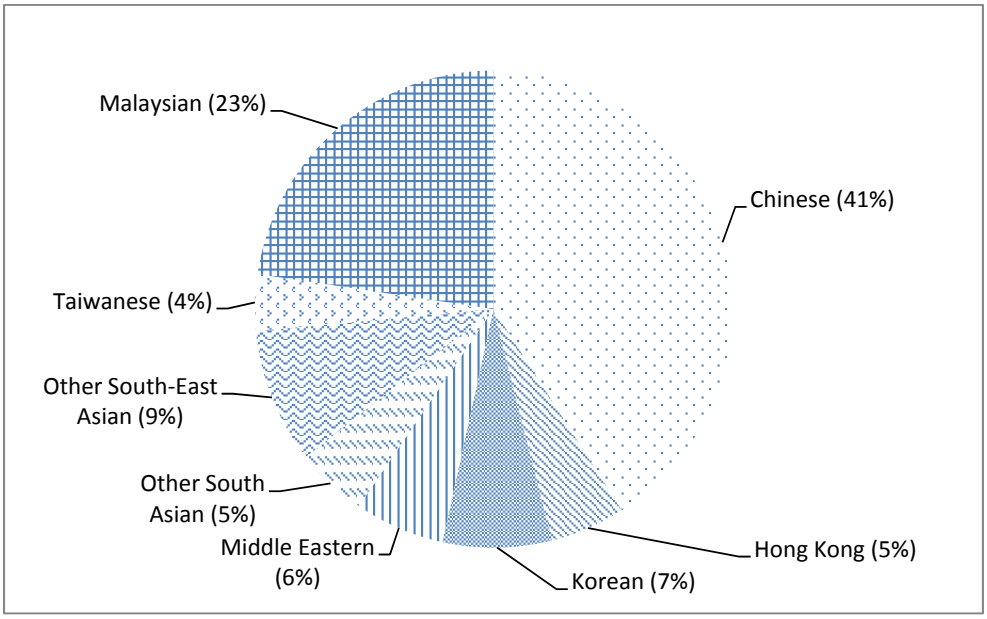

Figure 1: International students' country of origin (%)

Table 2: Summary of differences between Socratic and Confucian education systems

	Source of knowledge	Teacher	Learning Style	Commonly observed learning techniques
Socratic	Self-developed, aided by teacher	Guidance, facilitator	Mostly deep-based, learning through questioning beliefs and establishing links.	*Teamwork, group discussion, tutorial based classes, independence.*
Confucian	External or more 'knowledgeable' source	Authoritative, manager	Mostly surface-based, emphasis on repetition and memory. Didactic teaching.	*Rote learning, lectures, text book.*

E1 and E2 operate under a Socratic framework with a heavy emphasis on problem-solving skills and professional skills in an authentic (real-life) learning environment. Eastern cultures such as those in the Asian region are of great importance in this research as the international student cohort consists of over 85% Asians (N=110+) each year. These students commonly attend institutes that are more closely affiliated with the Confucian system and many do not exhibit learning objectives that aid in development of these skills (Gorry, 2011; Mori, 2000). Furthermore the lack of tutorial experience has been previously recognised as a problem for international students (Samuelowicz, 1987). In addition both courses require students to engage in reflective writing and self-guided knowledge acquisition which may be difficult for Asian students as challenging information presented by an academic is seen as disrespectful and may also be considered embarrassing. However it has been demonstrated that these barriers can be successfully overcome through the implementation of collaborative learning in a project-based course (Willey & Gardner, 2010).

Both paradigms exist in every country but for the purposes of this research it is assumed that students' educational experience stem from the single major education system found in their country. As the number of international students from western cultures is scarce, all the students analysed are assumed to have studied under a predominately Confucian system. In contrast, the majority of domestic students have completed primary and secondary education in Australia and are assumed to have studied under a Socratic system.

English as a Second Language

88% of incoming international first-years are from non-English speaking backgrounds and may be severely disadvantaged by this. The language barrier has been identified to be the most significant problem for international students with many students struggling to understand accents and local expressions (Mori, 2000). A low proficiency in English hinders their ability to develop cohesive arguments and write structured reports such as those required throughout engineering courses. Furthermore, this limits a student's ability to integrate and converse with fellow team members.

Students enrolling into engineering are required to pass either the Test of English as a Foreign Language (TOEFL) with an overall score of 87 or the International English Language Testing System (IELTS) with an overall score of 6.5 (The University of Queensland, 2013). In addition, students must also demonstrate competence via a minimum score of 6 (IELTS) or 21 (TOEFL) in each individual test category. However these tests are thought to be an inadequate measure of English oral and written proficiency as students are assessed under specific conditions and are not well equipped to tackle social norms needed to communicate effectively (Pedersen, 1991). In particular, TOEFL does not require a conversation with a person (Educational Testing Service, 2013). This is supported by a case study conducted by Wait and Gressel (2009) showed that TOEFL score cannot be used as an indicator for GPA of engineering students in a western university.

Age and previous experiences

Student conceptions of learning play a critical role in knowledge retention and acquisition. These conceptions are largely influenced by past educational experiences and age. In addition, age has also proven to be a strong factor in affecting student motivation, approaches to study and teamwork ethic (Hoskins, Newstead, & Dennis, 1997) which affect their academic performance (McDonald & KnightS, 1979).However the previous highest level of qualification of students was unavailable to the author thus only the objective variable of age will be investigated.

Several studies have been done around age effects on academic performance and these were summarised by Hoskins et al. (1997). As teaching has changed significantly since this time, it would be beneficial to re-investigate current age trends especially as past studies look at institutional wide data and did not focus on team-based project courses like E1 and E2.

The majority (71%) of domestic students at UQ are from 17 to 20 years of age. International students typically are older with 69% of this cohort falling in the 19-22 age bracket. This age difference is mainly due to 2 factors:

Pre-tertiary study – Diplomas, non-traditional qualification or work experience, this exposure could lead to different learning styles and adapting to identity (Ternel, 2000).

Military conscription – 19% of international Asian male students are affected by enforced conscription as they originate from countries in upper south-east (SE) Asian region (Vietnam to Burma region) as well as bordering islands near China such as Taiwan. Service impacts leadership, teamwork, obedience and respect to superiors.

Information on these 2 factors was not available to the author but it is acknowledged that there may be correlating effects on these factors and age. Thus this paper will only be considering students based on maturity. Whilst the definition of mature age student varies across studies (Hoskins et al., 1997), this research will use the most common definition of 21 and over as a mature aged student.

International Student Performance

Students are awarded a grade based on a 7-point scale based on the Queensland tertiary award system (Queensland Tertiary Admissions Centre, 2013). The lowest score of one indicates a student with a final mark of less than 20%; the highest score of seven is a final

mark greater than 85%. Students who withdrew or submitted no/partial course work and as a result did not complete the course are given a grade of 0 in this study.

A significant proportion of international students struggle with authentic project-based courses such as E1 and E2 as observed through higher attrition rates and lower results on specific outcomes such as grades and peer assessment. The same level of concern is not observed in courses where students are predominantly individually assessed and the course follows a more didactic style of teaching such as first-year chemistry and mathematic subjects. These findings are similar to course comparisons conducted at other tertiary institutions (Fuligni, 1997).

Table 3 shows the difference in grades between the international and domestic cohorts for a variety of first year courses. A negative value indicates that the international cohort performed worse than the domestic cohort. The worst results for each year are shaded. Table 3 clearly shows that international students consistently perform worse than domestic students each year in E1 and E2. Both these courses recorded the worst average difference in grades between the 2 cohorts and in 3 of the 4 years studied E1 had the worst international to domestic grade difference. In 2013 Chemistry1 incurred a single assessment change; the course introduced peer assessment and as a result saw a severe drop in international student grades. Therefore it is hypothesised that the team-based framework upon which E1 and E2 are built are difficult for international students to adapt to.

Table 3: Average grade difference between international and domestic students

Majority of Assessment	Course	Total No. of Students	Year				Average
			2010	2011	2012	2013	
Team/Project	E1	4088	-0.43	-0.65	-0.67	-0.58	-0.58
	E2	972	-	-	-0.67	-	-0.67
Individual	Chemistry1	242	-	1.00	0.10	-1.60	-0.17
	Chemistry2	906	0.92	0.11	-0.03	0.78	0.45
	Mathematics1	1305	1.02	0.62	0.41	1.79	0.96
	Mathematics2	3012	0.56	0.10	0.27	0.06	0.25
	Physics1	240	0.48	-0.34	0.46	0.47	0.27

Figure 2 show the grade distribution of ENGG1100 students from 2010 to 2013 inclusive. Although it is apparent there is a difference between the two cohorts in the percentage of 5's and 6's obtained, statistical analysis indicates that this slight right skew is not significant ($p = 0.4$).

E1 and E2 – an overview

E1 is offered in semester 1 only and was offered from 2010 to 2013 inclusive. E2, which builds on the engineering competencies learnt in E1, runs in semester 2 and has only been offered since 2012.

A large portion of assessment tasks in E1 and E2 are based on team-based activities as shown in Table 4. This is quite different to other first year course as shown in Table 4. In this table N is the number of assessment pieces and W is the total percentage weighting these assessment pieces contribute to the final course grade.

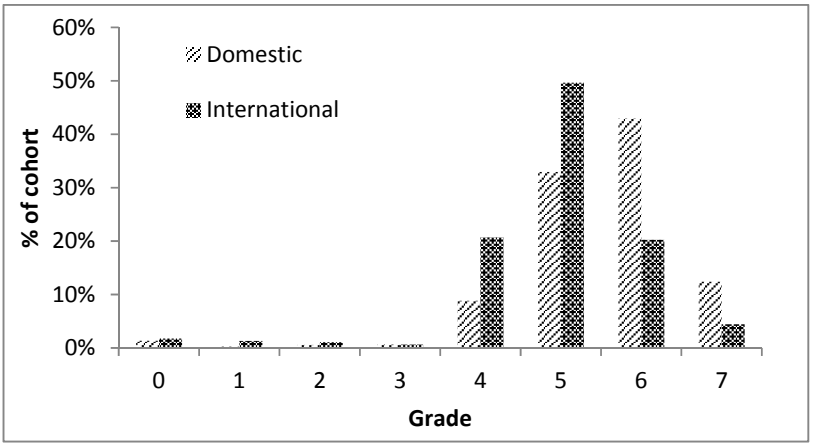

Figure 2: Grade distribution for ENGG1100 students, 2010 to 2013

Table 4: Types of assessment items in E1 and E2

	E1		E2		Chem1		Chem2		Math1		Math2		Phys1	
Assessment	**N**	**W%**	**N**	**W%**	**N**	**W%**	**N**	**W%**	**N**	**W%**	**N**	**W%**	**N**	**W%**
Individual	3	40	3	45	3	77	5	88	4	100	4	100	4	90
Team-Based	3	60	4	55	1	23	1	12	0	0	0	0	1	10

Team-based assessment in E1 and E2 takes the form of both prototypes and reports.

Peer Assessment

To assess team based performance, peer assessment (PA) is used in both E1 and E2 as a sound principle which assess the individual's learning (Dochy, Segers, & Sluijsmans, 1999) and aid in team skills development. In each PA activity, students are asked to distribute 100 points between all group members including themselves for a number of difference criteria. Scores are totalled for each student and the Peer Assessment Factor (PAF) is calculated by:

$$PAF = \frac{\sum PA}{100 \times No.of\ Criteria}$$

PAFs typically lie between 0.9 and 1.2 with an average contributing student receiving unity (1.0). Students who receive a PAF less than 0.9 are perceived as at-risk students who may fail the course due to their lack of involvement in the team as perceived by their teammates. Students with a PAF greater than 1.2 are generally high achievers who may be taking on an excessive workload with an unfair task distribution in the team.

PA is used twice in E1 and twice in E2 with differences listed in Table 5. Final course grades are multiplied by summative PAFs.

Table 5: Types of Peer Assessment used ENGG1100 and ENGG1200

Course	Timing in Semester	Type	Completed Team Assessment	Abbreviated
ENGG1100	Week 6	Formative	-	PAF1
	Week 13	Summative	Report (30%) Prototype (30%)	PAF2
ENGG1200	Week 6	Formative	Memo (15%) Workshops (5%)	PAF3
	Week 13	Summative	Report (15%) Prototype (30%)	PAF4

It is important to note that PAF2 is a better indicator of team performance as team members have been subjected to team-based assessment tasks whereas the timing on PAF1 only considers individual assessment pieces and team meetings.

In each of the PA activities, the stimulus questions vary slightly depending on assessment completed leading up to PA. However the key focuses of the questions are:

- Contribution to the project,
- Quality of work submitted,
- Project management, and
- Performance.

These criteria are similar to those successfully used by Gentle (1994) for student self-assessment.

In order for students to achieve academic success, certain skills need to be developed. Table 6 shows the skills required to succeed in each specific outcome as well as possible factors which may hinder the development of each skill for international students. Common observed issues faced by international students in E1 and E2 are shown in Table 7.

Table 6: Skills needed for E1 and E2

Skill Required	Possible Hindrances	Method of assessing evidential outcome	
		Grades	PAF
Written English	Language Barrier	Report language	Not directly assessed
Communication	Language Barrier, Cultural Norms	Not directly assessed	Group-work contribution
Team-working	Educational Difference, Age-Maturity	Reports and prototype production	
Problem Solving	Educational Difference	Contribution of ideas to novel problems	Not directly assessed
Critical Thinking	Educational Difference	Report content	Not directly assessed
Leadership	Language Barrier, Educational Difference, Age-Maturity	Not directly assessed	Self-direction and team-management

Table 7: Staff observations of common issues in international students

Skill	Common issues observed
Written English	Poor spelling and grammar, Illogical sentence and paragraph structure.
Communication	Quiet students with little to no contribution in meetings. Afraid to voice opinions.
Team-working	Social loafing, little to no contribution to report writing and prototype construction.
Problem Solving	Unable to formulate solutions to problems encountered unless previously taught.
Critical Thinking	Inability to look at the big picture. Written analyses in reports contain mostly surface observations.
Leadership	Very few, if any international students are nominated as team leader. Unsure how to complete required tasks.

Methods

PAF were collected for 2010 to 2013 inclusive for all first year engineering students enrolled in at least one of the courses E1 or E2 totalling 4144 records. These records were identified as domestic or international and then 3 groups of data were formed under the headings Country, Language and Age. A sampling frame of a minimum 10 students was used; any countries or languages falling under this number were aggregated with nearby countries or

similar languages. If this result was still less than 10 students, the group was excluded from the study. Less than 20 records had missing PAFs, these were also excluded. Figure 3 shows a graphical representation of this process.

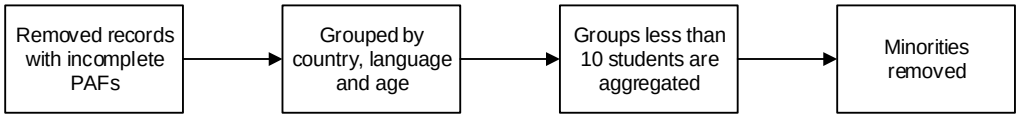

Figure 3: Classification process for country, language and age

In each of the 3 categories (country, language and age) analysis of variance of variation in performance will be performed followed by the appropriate 2 tailed t-test to check for statistical significance.

Results

In the first instance, PAFs of domestic students were compared against those of international students to determine if there was a difference. It was found that international students as a cohort received more PAFs of less than 1 than domestic students and less PAFs of greater than 1 than domestic students especially in the region of 1-1.05. These results were consistent for PAF1-4 (Table 5). Therefore in the interest of clarity, the average percentage is shown in Figure 4.

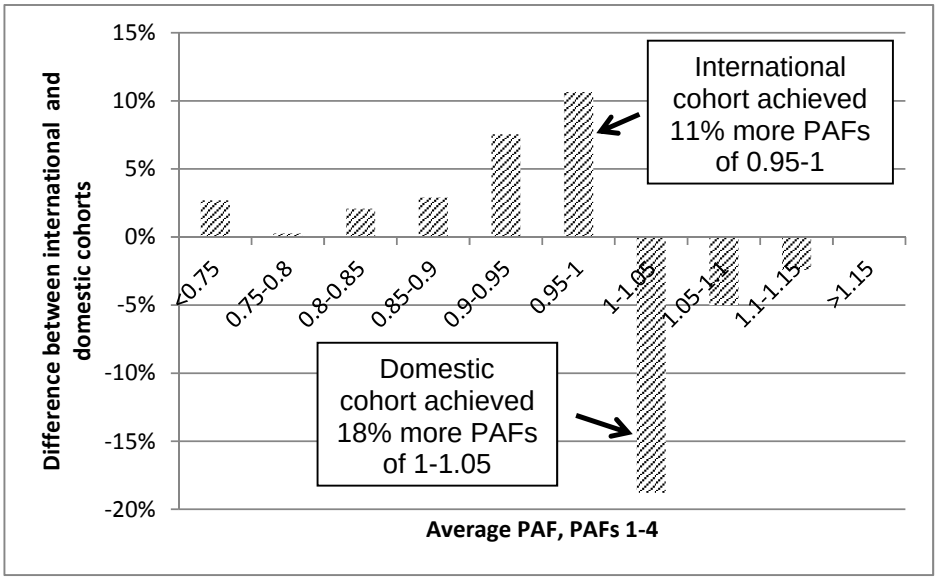

Figure 4: PAF comparison of international and domestic students

In the following results only PAF1 and PAF2 are considered as insufficient data is available for PAF3 and PAF4. In a 2 tailed t-test comparing the distribution of international students PAFs to those of domestic students, it was found that the *Other South Asian*, *Other SE Asian* and *Taiwanese* cohorts had an acceptable probability (>0.05) that distributions were similar in both PAF1 and PAF2. Also of interest is the strong correlation seen in PAF2 for *Malaysian* students which were not seen in PAF1 suggesting possible better acclimatisation leading to a significant improvement. *Chinese* and *Middle Eastern* cohorts showed distributions that were completely different from domestic students with $p = 0.00$. These points of interest are shaded in Table 8.

In Table 9, *Chinese* and *Middle Eastern* cohorts who statistically have different means, clearly exhibit the lowest PAFs whilst *Other SE Asian* and *Malaysian* students score the best. As these 2 groups also shared similar distributions with domestic students as highlighted in Table 8, it would be worth further investigating the factors contributing to their success.

Table 8: Country – probability value in a 2 tailed t-test, tested against domestic student data

Country	PAF1	PAF2
Chinese	0.00	0.00
Hong Kong	0.01	0.05
Korean	0.13	0.01
Malaysia	0.01	0.37
Middle Eastern	0.00	0.06
Other South Asian	0.11	0.10
Other SE Asian	0.23	0.31
Taiwanese	0.09	0.12

Table 9: Average PAFs by Country

	PAF1		PAF2		Δ in
Country	Average	StDev	Average	StDev	average PAF
Domestic	1.01	0.09	0.99	0.14	-0.02
Chinese	0.96	0.06	0.95	0.11	-0.01
Hong Kong	0.96	0.08	0.96	0.10	0
Korean	0.99	0.07	0.95	0.09	-0.04
Malaysian	0.99	0.05	0.99	0.07	0
Middle Eastern	0.95	0.08	0.93	0.17	-0.02
Other South Asian	0.97	0.07	0.95	0.10	-0.02
Other SE Asian	1.00	0.07	0.98	0.19	-0.02
Taiwanese	0.96	0.07	0.96	0.04	0

In the language analysis under the same statistical test, it was found that *English*, *European*, *Other South Asian* and *Other SE Asian* exhibited probabilities greater than 0.05 in both PAF cases. However of more interest is the low probabilities (<0.05) in both cases for *Arabic*, *Cantonese*, *Chinese* and *Mandarin* students which are shaded in Table 10. In contrast, the two western language cohorts *English* and *European* showed statistically similar means with high probabilities of 0.45 and 0.98 respectively.

Table 10: Language – probability value in a 2 tailed t-test, tested against domestic student data

Language	PAF1	PAF2
Arabic	0.00	0.07
Cantonese	0.00	0.04
Chinese	0.00	0.00
English	0.08	0.45
European	0.05	0.98
Korean	0.13	0.01
Malay	0.03	0.28
Mandarin	0.00	0.03
Other South Asian	0.05	0.10
Other SE Asian	0.38	0.30

In Table 11 it was found that the languages *English* and those originating from *Other SE Asian* regions achieved the best results in the international cohort. Low performing results are seen for *Arabic*, *Chinese* and *Korean* cohorts. It was therefore hypothesised that the lack of English language may be a major barrier in receiving high PAFs. To confirm this a 2 tailed t-test was performed comparing English as a second language students to English as a first language students and produced a p-value of 0.00 suggesting 2 different samples, i.e. they do perform differently.

Statistically the performance of the different age cohorts by origin were found to be different ($p = 0.00$) but there was no statistical different between age cohorts within the same origin

Table 12. The author is aware of the limitations in using chronological age as a measure of maturity, however given the absence of other age contributing factors this was the only analysis able to be performed.

Table 11: Average PAFs by Language

	PAF1		PAF2		Δ in
Language	**Average**	**StDev**	**Average**	**StDev**	**average PAF**
Domestic	1.01	0.09	0.99	0.14	-0.02
Arabic	0.94	0.09	0.91	0.18	-0.03
Cantonese	0.97	0.08	0.96	0.11	-0.01
Chinese	0.96	0.06	0.94	0.11	-0.02
English	0.99	0.06	1.00	0.06	+0.01
European	0.98	0.05	0.99	0.06	+0.01
Korean	0.98	0.07	0.95	0.09	-0.03
Malay	0.99	0.05	0.99	0.09	0
Mandarin	0.96	0.05	0.97	0.07	+0.01
Other South Asian	0.96	0.06	0.96	0.09	0
Other SE Asian	1.01	0.08	0.97	0.23	-0.04

Table 12: Average PAFs by Age

Statistically different ↗↘

	PAF1		PAF2	
Country	**Average**	**StDev**	**Average**	**StDev**
Domestic Non-Mature	1.01	0.08	0.99	0.14
Domestic Mature	1.01	0.19	1.00	0.14
International Non-Mature	0.97	0.06	0.94	0.18
International Mature	0.95	0.17	0.95	0.17

⇐⇐ Not statistically different

Conclusions and recommendations

International students struggle in authentic team-based project courses such as E1 and E2. It was found that not all international cohorts underperform and the subgroups of interest have been identified. Students from south-east Asian countries showed the most promise with high PAFs. Malaysian students initially started off poorly but showed a significant performance increase, inferring a particular ability to adapting to the western learning environment. Arabic and Chinese cohorts perform particularly poorly in comparison with domestic students and other international cohorts. The next step would be to identify the factors which can be attributed to the success and failures of these subgroups, in particular how the learning paradigm, English education and age affect students in these countries.

The author acknowledges that other factors such as motivation which is not investigated in this research may play a critical role in students' teamwork performance. Currently fellow researchers are investigating reflective writing tasks completed by students. These results will be used to inform further research once they become available.

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