Contrasting CS student and academic perspectives and experiences of student engagement

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ABSTRACT

There is widespread acceptance of the use of national benchmarks to measure student engagement, including the North American National Survey of Student Engagement (NSSE) in the USA and Canada, the Student Experience Survey (SES) in Australia, and the United Kingdom Engagement Survey (UKES). The performance of Computer Science (CS) on these benchmarks has generally been poor over a number of years and is consistently low across a range of instruments with little sign of improvement. It is difficult to argue that the technical nature of the CS discipline is the issue as related STEM disciplines consistently rate higher on many measures. Given the deteriorating performance of CS across multiple student engagement instruments, the urgency of addressing this issue is increasing. Missing from computing education research on this issue to date is the CS student voice and a deeper understanding of why CS students rate their experience so poorly. It is essential to seek the perspectives of both sides of the dialogue primarily responsible for creating the student experience. We carried out an in-depth analysis of student perspectives and experiences relating to their engagement in CS courses and compared it to the perspectives and experiences of CS academics. The outcome of this Working Group was a better understanding of areas of difference between CS students and academics on: what constitutes student engagement; who is responsible for student engagement; examples of both positive and negative engagement experiences in the classroom; and current initiatives to improve student engagement in their CS courses.

CCS CONCEPTS

• **Social and professional topics → Computer science education**;

KEYWORDS

Student Engagement; Computer Science; National Benchmarks; Student Experiences

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1 INTRODUCTION

A growing body of researchers, educators, and policy makers are highly focused on student engagement as the key to addressing issues such as poor attendance, substandard academic performance and student drop-out. Research points to the link between better engagement and improved attainment, increased learning, lower attrition and increased personal development [16, 23, 37].

Student self-report survey instruments are the predominant means by which engagement information is gathered. Prominent examples of instruments administered to students include the National Survey of Student Engagement (NSSE) in North America, the Student Experience Survey (SES) in Australia, and the United Kingdom Engagement Survey (UKES). These surveys are generally administered to first and final year students and examine the wider university experience rather than student satisfaction with individual units. Results from these student engagement surveys are widely publicised [3, 11, 33]. There are certainly many voices which are critical of the way that engagement is conceptualised in these instruments and skepticism of the claim that they represent proxy measures for learning gain [18, 34]. Nevertheless, these surveys have gained traction in many countries and are increasingly used as measures of performance in Higher Education.

Evidence is accumulating pointing to the fact that Computer Science (CS) students rate their courses extremely poorly on many of the engagement measures used in these national surveys [10, 30, 36]. By the term CS we aim to include all computing studies courses, such as Computer Science, Information Technology and Information Systems degree programs. While there may be some reservations about these instruments, it is a matter of concern that CS students feel they are not participating in many of the effective learning activities that the surveys cover. The findings raise many questions about the nature of CS, how it is currently taught and the learning strategies of CS students.

An ITiCSE Working Group was formed in 2017 to obtain some of the perspectives needed to address the challenge of low CS

scores in international engagement surveys [31]. The 2017 Working Group examined the trends and variations in the data for the computing discipline from several national student engagement instruments (NSSE, SES, UKES). An analysis also was carried out of current CS education research literature with specific focus on initiatives to promote student engagement. In addition interviews were conducted to examine the perceptions of CS academics regarding student engagement and their perspectives on the various survey instrument questions. Finally, suggestions were derived for ways in which the CS discipline could respond to the findings.

The current ITiCSE 2018 Working Group seeks to extend the previous work, in particular, by considering the student perspective and so developing an understanding of student engagement through the eyes of CS students themselves. The main research questions addressed by the ITiCSE 2018 Working Group are:

- *RQ1. What has changed since 2016 in terms of CS student engagement?*
- *RQ2. What is the alignment between CS student and CS academic perspectives on student engagement?*

The working group facilitated international input to the following activities in order to address these research questions:

- Further analysis of the latest data from international student engagement instruments (NSSE, SES, UKES).
- Comparison of NSSE with the Faculty Survey of Student Engagement (FSSE) to highlight contrasts between CS academic and CS student perspectives in the North American context.
- Further analysis of current CS educational research literature related to student engagement.
- Online surveys of CS student and CS academic perspectives and experiences.
- Interviews with CS students regarding study experiences related to engagement in CS courses.
- Further interviews with CS academics regarding teaching experiences related to student engagement in their CS courses.

This Working Group Report is structured into five sections.

Section 1 - Introduction, discusses the aims of the working group and provides an overview of the report.

Section 2 - Background, discusses defining the term 'student engagement' and explores approaches to investigation student engagement.

Section 3 - Methodology, discusses the research questions posed, gives an overview of the methods used to investigate these questions, and discusses the data collection instruments that were developed for this research.

Section 4 - Analysis and Results, presents the data collected and interprets the results of student and academic perspectives on engagement.

Section 5 - Conclusions and Further Research, draws together the findings from the different aspects of the study and discusses the implications of the results, summarises the contributions of the Working Group Report and suggests ways to proceed in addressing the issues raised.

2 BACKGROUND

This section discusses current understanding of the term 'student engagement' and explores differing perceptions and conceptualisations evidenced in the literature. Approaches to investigation of student engagement are considered and a brief introduction to the relevant international benchmark surveys is provided.

2.1 Defining engagement

Education practitioners and educational research literature often refer to 'student engagement', but the term frequently appears without clarification of its meaning. There is certainly no shortage of definitions to be found, and these have often appeared to differ and potentially conflict with each other [6, 7, 12, 22–24, 37]. The different perspectives are now often at least partially reconciled by viewing engagement as a meta-construct which incorporates a number of different dimensions including (at least) behavioural, cognitive and affective/emotional aspects [16]. Each dimension represents a distinct facet of engagement, and each can be evidenced independently. Here we briefly consider the three main contributing dimensions.

2.1.1 Dimensions of engagement. Behavioural engagement relates to what students do and the extent to which they participate in educational activities (such as attendance at class or participation in forums). The NSSE survey instrument (and other instruments which have used NSSE as a basis) attempts to identify educationally purposeful (high impact) activity selected as being positively linked to learning gains [6, 23]. The development of this approach contains an implicit acknowledgement of a close connection between the activities an institution provides and the potential for student engagement.

Cognitive engagement refers to the deployment of purposeful and strategic cognitive effort towards learning tasks. Students who are engaged in this sense make a significant cognitive investment in learning, engaging in metacognition and self-regulated learning. Definitions based on a cognitive conception of engagement are often associated with reflective, self-regulated learning, Student Contributing Pedagogy, and the effective use of deep learning strategies [8, 26]. The concept of 'pedagogies of engagement' [14] that encourage active learning, peer based engagement, and reflective work has also taken root.

The third dimension of engagement relates to students' affective or emotional investment in learning [27, 29] and may be evidenced by enthusiasm and interest in a subject. Definitions relating to this dimension also refer to students' sense of belonging to a learning community and constructing an identity within the subject and profession.

As noted above, the meta-concept of engagement cannot adequately be captured by assessment of a single dimension. A conception which embraces multiple dimensions is often referred to as 'holisitic' and can provide a more nuanced picture of students' participation in and attitude towards their studies [19, 37]. However, when assessing engagement it is more difficult to gain an accurate picture of cognitive and affective engagement, particularly for large cohorts. In contrast, behavioural aspects are easily captured in a quantitative survey which students can answer relatively quickly

and which can be analysed automatically. This dimension has therefore become the main aspect of the major survey instruments.

2.1.2 Engagement in relation to the current study. One of the aims of our work is to understand how students and staff understand student engagement. We therefore do not seek to present one standard definition or to limit the discussion by suggesting a 'right' or 'wrong' way for the concept to be viewed. We recognise that discussions of student engagement, the measurement of student engagement, and interventions to improve student engagement need to be well grounded in relevant student engagement literature. In each of the data collection exercises reported here we therefore seek to discover what definition or understanding of engagement the respondents evidence.

One interesting aspect of engagement which to some extent cuts across different dimensions is the issue of where responsibility lies. Whereas the term 'student engagement' may appear to relate to something which is squarely in the domain of the student, definitions have increasingly come to acknowledge the role and responsibility of the institution. For example, Trowler offers the following definition:

> Student engagement is concerned with the interaction between the time, effort and other relevant resources invested by both students and their institutions intended to optimise the student experience and enhance the learning outcomes and development of students and the performance and reputation of the institution. [37, p3].

This definition provides a very different perspective in which a partnership of provision (institutions) and participation (students) forms the basis of effective engagement. The question of responsibility provides one interesting area of investigation when comparing student and academic views.

2.1.3 Differentiating engagement. A number of other terms are often used informally as substitutes - or synonyms - for 'student engagement'. It is an area where much informal discussion (and even more formal publications) use terms with an assumption of a shared understanding or common meaning. In our literature review we have been as inclusive as possible in including work which relates informally to engagement or uses closely related terminology such as motivation, satisfaction and participation. However, the question arises as to whether these terms are indeed capturing different concepts and if so, how should they be differentiated? One approach we have found helpful is Kahu's conceptual framework of engagement which places engagement as the central point in related scale of sociocultural influences. On one side, the factors likely to precede engagement are divided between distal (distant) and proximal (near). These are likely to be influenced by (amongst other factors) the institution and environment and include concepts such as motivation and identity. On the other side of the engagement framework appear factors which are more likely to result from engagement such as learning gain and satisfaction which are situated more with the student. The relationship is not linear but indicates a likely progression. This conceptual framework shows a clear distinction between the concepts but also indicates their relationship. It also indicates the role of both student and institution.

2.2 Approaches to investigating student engagement

Education researchers, instructors and institutional policy makers, increasingly focus on student engagement as the key to addressing problems of low achievement, low motivation, alienation, and high drop out rates [17]. A number of different approaches have been used to assess student engagement, including self-report surveys, experience sampling techniques, teacher ratings, interviews and observations. However, because of the ease of data collection and analysis for large cohorts, the self report survey has become the predominant approach. This section introduces some of the survey instruments currently in use.

2.3 International benchmarks of student engagement

Many institutions have end-of-course surveys that are given to students to assess the teaching in a given course. This section focuses on national survey instruments which are conducted across multiple institutions and across successive years. In most cases, at least some of the resulting data is made available to the public. These surveys are generally Likert scale type questions which map the extent to which students participate in certain activities, the use they make of resources, and their ratings of a number of aspects of institutional service provision that contribute to their overall learning experience.

2.3.1 National Survey of Student Engagement (NSSE). First trialled in 1999, the North American National Survey of Student Engagement (NSSE) is now well-established as a measure of engagement in higher education and has influenced many of the other national benchmark instruments. In 2017, 725 colleges and universities participated and 517,850 students completed the survey [3].

The NSSE survey approach is widely documented in the literature. The survey aims to identify student activities both inside and outside the classroom which research has linked to high learning gains [3]. These are regarded as providing proxy measures for student learning, and effective teaching and support [23]. The resulting 48 questions are grouped to form ten engagement indicators, which are themselves aggregated into four engagement benchmarks or themes, that are used for reporting purposes:

(1) Academic Challenge: covers reflective and integrated learning, higher order learning, quantitative reasoning and learning strategies;
(2) Learning with Peers: examines collaborative learning and discussions with diverse others;
(3) Experiences with Faculty: consists of student-faculty interaction and effective teaching practices;
(4) Campus Environment: encompasses quality of interactions with non-academic staff and the extent to which the campus is a supportive environment.

First-year and senior bachelor degree students are surveyed, with results reported separately for each group.

2.3.2 Faculty Survey of Student Engagement (FSSE). This survey [1] was designed to parallel the NSSE survey of undergraduate students but is completed by academic staff. It focuses on faculty

perceptions of how often their students engage in different activities (lectures, teacher-led discussions, small-group activities, student presentations and experiential activities). It includes items about student workloads and levels of challenge at the institution, the importance faculty place on various areas of learning and development, the nature and frequency of faculty-student interactions, and how faculty members organize class time. This survey, to some extent, provides an opportunity to contrast student and academic perspectives on student engagement in the North American context.

2.3.3 Student Experience Survey (SES). The original student engagement instrument used in Australia (known as AUSSE) was commissioned in 2011 and at that time was based closely on the NSSE instrument. In addition to providing insight into student behaviour it was originally intended to inform funding allocation to universities, although this has not yet been implemented [35]. The instrument has since evolved, diverging from NSSE to include a wider range of questions relating to the student experience and student satisfaction. Since 2015 it has been known as the Student Experience Survey (SES) and is now also administered to students from non-university higher education institutions (NUHEIs). In the 2017 offering, data was collected from around 148,000 undergraduate students and 58,000 postgraduate coursework students from 41 Australian universities as well as 58 NUHEIs [11].

The SES incorporates aspects of Work Integrated Learning (WIL), such as in industry placements, industry experience studios, and capstone units. There are five benchmarks, each encompassing two or more indicators which are evidenced by a number of questions:

(1) Skills Development: looks at development of general skills such as critical thinking, ability to work with others, communication skills and knowledge of the field;
(2) Learner Engagement: covers belonging to the university, participation and interactions with other students;
(3) Teaching Quality: focuses on rating overall educational experience quality, as well as aspects such as quality of in-class experiences and feedback;
(4) Student Support: relates primarily to the university services provided;
(5) Learning Resources: rates a wide range of physical and virtual academic resources.

As with the NSSE, first and final year undergraduate students are surveyed and results reported separately for each group.

2.3.4 Other International Benchmarks. The UK Experience Survey (UKES) was also based closely on NSSE but has diverged following further development since its initial pilot by the Higher Education Academy in 2013. UKES is a national instrument, but institutional participation is optional rather than compulsory. In 2017, 42 UK institutions took part, with about 36,000 students responding [33].

The UKES covers the following benchmark areas:

(1) Engagement: covers critical thinking, learning with others, interacting with staff, reflecting and connecting, course challenge, independent learning, engagement with research and inquiry and staff/student partnerships;
(2) Skills Development, examines academic skills, career skills, active learner skills and civic skills;
(3) Time Spent on Academic Work;
(4) Extra-Curricular Activity.

2.3.5 Other engagement surveys. A number of other countries or individual institutions also undertake surveys which are solely or partially aimed at measuring student engagement. These are however less widely applied and reported on, and data has not been made publicly available. Some examples are given below.

Related to engagement (investigating a proximal concept) the Student Assessment of their Learning Gains (SALG) survey [4] asks students to report the extent to which they believe that specific aspects of a course have helped them learn. The Motivated Strategies for Learning Questionnaire (MSLQ) deals with the cognitive and affective dimensions of learning and relates to goal orientation and self-efficacy [2]. The Student Experiences Survey from the Wabash National Study of Liberal Arts Education gathers information about students' academic and co-curricular experiences and activities [5].

A number of STEM faculty and student surveys are also available. Some focus on faculty use of specific teaching strategies such as peer instruction [9, 13]. Other surveys focus on general teaching strategies of the faculty [21, 28]. The Teaching Behaviors Inventory [32] investigates teaching behaviors, such as instructor clarity, enthusiasm, organization and rapport. These surveys relate to, but are not directly aligned with, student engagement.

2.4 Student and Academic Perceptions of Engagement

Given that student engagement is seen as a critical component of improving student learning, recruitment and retention, a number of studies have investigated student and academic perceptions of engagement.

The Engineering Change (EC 2000) study [39] is one example of students and academics surveyed together. It was designed to describe several aspects of educational practices in U.S. engineering programs. EC 2000-related program changes reported by faculty and administrators were compared with student reports of their experiences and outcome measures.

A survey [20] of first and second-year engineering undergraduates and the faculty teaching them, found that students viewed engagement in terms of faculty enthusiasm for the subject and their availability for out-of-class interactions. The faculty members, on the other hand, believed that engagement was defined by students' actions such as participation in class discussions. Students also defined engagement as participating in student centred activities (projects, labs, simulations, discussions) and doing additional work for courses.

An investigation [25], of the relationship between faculty use of effective educational practices and student engagement in these activities, looked at student responses to the NSSE survey and also reviewed faculty responses to FSSE [1]. The NSSE and FSSE findings were compared to determine what faculty members expect and require students to do and what students report of their engagement in effective educational practices. The findings suggested that if faculty provide what is engaging, students will engage in their learning. Student scores tended to be higher where faculty

emphasised academic challenge, active and collaborative practices, diversity experiences, higher-order thinking, and student-faculty interaction.

Similar findings were reported by another study [38] that used two national data sets to explore the relationship between faculty practices and student engagement. The findings showed that faculty practices (e.g., active and collaborative learning techniques and higher-order cognitive activities) create an environment that related to student engagement behaviours, student perceptions of the environment, and student self-reported learning gains.

However, none of the studies reviewed in this section focused specifically on the CS discipline or sought to address the poor performance of CS on these student engagement surveys.

3 METHODOLOGY

The following section outlines the methodology adopted for this research. The research aims and questions are listed and an overview of the methods and data collection instruments is given.

3.1 Research Aim

The possible reasons for the poor performance of CS education in national engagement surveys appear to be varied and a combination of different factors that relate not only to the delivery of CS education, but also to perceptions of engagement by CS student and CS academics, and possibly the design of the instruments themselves [31]. In order to try and understand the reasons behind the systemic poor CS performance, it is important to try and understand the nature of the issues that result in the poor ratings of student engagement with CS studies. The results of student engagement measures are distributed and help students and parents to make decisions on which courses to study. If we are to improve the performance of the computing discipline on these national benchmarks, it is important to understand why CS students rate CS courses as not meeting their expectations.

Previous work [31] has suggested that CS academics have a wide variety of views on the nature of student engagement, address student engagement with a wide variety of strategies, and generally lack an awareness of underpinning theories and measures related to student engagement. In addition, CS academics have little knowledge of the specific national student engagement survey instruments used in their country or of the specific questions and measures they contain. What is missing from the research thus far is the student perspective and a deeper understanding of why students rate their CS experience as they do. To understand the issue, it is also vital to consider the views of CS students on student engagement and compare these with the views of CS academics. It is essential to seek the perspectives of both stakeholders primarily responsible for creating the student experience, CS students and CS academics.

3.2 Research Questions:

Given the research aim, the main research questions we are examining are:

- *RQ1. What has changed since 2016 in terms of CS student engagement?*
- *RQ2. What is the alignment between CS student and CS academic perspectives on student engagement?*

In order to examine the first research question we seek to understand:

(1) What has changed in terms of the data, indicators, and trends from the 2016-2017 data from the national engagement survey instruments?
(2) What has changed in terms of the CS educational research literature published since 2016 and how does it compare with the previous categorisation done by the 2017 Working Group?

In order to examine the second research question we seek to understand:

(1) How do CS students and CS academics view student engagement in general?
(2) How do CS students describe their own engagement experience in their CS subjects?
(3) How do CS academics describe the student engagement experience in their own CS subjects?
(4) What is the nature of activities where CS students have experienced being highly engaged from both student and academic perspectives?
(5) What is the nature of activities where CS students have experienced being highly disengaged from both student and academic perspectives?

3.3 Overview of Methods and Data Collection Instruments

In order to examine the issue of student engagement and the alignment of CS student and CS academic perspectives, we first examined the performance of CS courses on the latest student engagement survey data from 2017 to see if there had been a significant shift in performance. In the North American context we compared the results for NSSE and those for FSSE in 2017 to see if CS student and academic views were aligned. We also examined the latest computing education literature from 2017/2018 to see if significant new research on student engagement in CS had been published.

Few validated survey instruments are currently available to measure CS academic and CS student perceptions of student engagement. We are also aware that student responses to surveys about instructional practices could be influenced by previous experiences with instruction [17]. In order to address the issue of CS student and CS academic perspectives, we constructed an online survey examining student engagement issues for each group. We pilot tested questions and response options before releasing the surveys. The surveys invited both CS students and CS academics to participate in a follow up interview to explore their perspectives in greater depth. The development of these data collection instruments is detailed below.

3.3.1 Examining Trends in Student Engagement Survey Data. The working group had access to detailed data from the three major student engagement instruments (NSSE, SES and UKES) for the most recent offerings, along with a number of years prior. Also available was five years of data from the Faculty Survey of Student Engagement (FSSE), which is the academic perspectives of the

questions presented in the NSSE. This data could be used for a number of purposes.

To begin, we examined the latest data from 2017 for the NSSE, SES and UKES surveys to see if there were any recent trends in the performance of CS in these instruments. We also wanted to know if there had been a change in methodology in any of the survey instruments. The longitudinal data also allowed us to examine if there had been any significant shifts in the performance of CS in any of the instruments or on any specific benchmark measures.

While the data in each of the surveys is typically reported in aggregate form, the working group had access to responses to individual questions within each instrument. This would allow deeper analysis to be undertaken and identify specific areas of student concern.

Finally, the addition of the FSSE data allows a direct comparison between student and academic perspectives in the North American context. The FSSE data provides academic responses to the same questions as in the student NSSE, thus facilitating an analysis of how academics view the student experience and how that aligns with the students perspective.

3.3.2 Examining Recent Computing Education Literature. For this study, we replicated the analysis of Computing Education literature used for the 2017 Working Group [31] but looked at publications from the 2017 to 2018 period to see if there was any new work related to student engagement. Well established and highly regarded conferences were included, such as: ACE, ICER, ITiCSE, Koli Calling and SIGCSE; and similarly ranked journals, such as: Computer Science Education, ACM Transactions on Computing Education, and IEEE Transactions on Education. All full research papers from these publications were examined for the previous year (2017/2018) depending on the publication schedule at the time of the 2018 ITiCSE conference. In total, 352 papers were considered.

For the initial selection of publications, the title, keywords, and abstract were assessed by independent pairs of evaluators to determine relevance to student engagement, the higher education context, and computing studies. This resulted in an initial selection of 92 out of 352 computing education research papers related to student engagement for further analysis.

The papers were examined in detail using a form to assess the following characteristics:

(1) a significant focus on the issue of student engagement,
(2) the motivation or aim of the research;
(3) reference to research literature and theory relevant to student engagement;
(4) the dimension(s) of engagement covered (behavioural, cognitive, emotional);
(5) the introduction of teaching practices and pedagogy related to engagement;
(6) a specific research question and rigorous methodology;
(7) use of established student engagement measures and benchmarks in the evaluation; and/or
(8) collection and analysis of quality data related to student engagement.

The group discussed the detailed analysis of a number of papers using the form until a consistent analysis of papers was achieved. The remaining papers were analysed individually, with a final arbiter appointed if a coder was uncertain of the interpretation. After analysing 92 papers an additional 25 papers were removed from the analysis resulting in 67 papers (19% of the total published) that were analysed in detail.

3.3.3 Student and Academic Online Surveys. Surveys are often used to obtain information of instructional practice and compare the perspectives of both academics and their students [15]. In particular, online surveys provide a convenient method for collecting quantifiable data that can be imported into spreadsheets for statistical analysis.

To ascertain students' views on what constitutes student engagement, and to understand the level of engagement in their Computing studies, an anonymous online survey for CS students with 16 questions was developed by the 2018 Working Group. The questionnaire gathered demographic information such as country, degree program studied, year level, gender, citizenship status and country of origin, to help assess causal relationships to these factors. It asked the students to define their understanding of the term 'student engagement'. It also contained questions exploring study experiences which had resulted in high levels of engagement. We also gave the students the opportunity to discuss any study experiences that had resulted in high levels of disengagement. We also explored their awareness of any initiatives by their lecturers, department, or the institution that were aimed at improving student engagement. Finally, we invited them to share any ideas to improve engagement with their studies. The survey was approved by the Research Ethics Committees of Monash University and the University of Massachusetts Amherst.

Students at Australia and US universities were invited to complete the online anonymous survey, and we requested that CS academics advertise the survey in their classes. In total 142 students completed the survey at Monash University in Australia, and the analysis focuses on this cohort due to the low number of respondents from the US (3). A sample of the survey titled 'Computing Student Perspectives and Experiences of Student Engagement' can be found at: https://goo.gl/forms /ZsoKYamXXqN87WnD2.

A similar survey was developed for the CS academics and consisted of 17 questions. The main differences between the student and academic surveys related to what CS academics taught, how they viewed and rated student engagement by their students, and what student characteristics and computing specific issues they believed affected student engagement. The survey also contained questions about activities which had resulted in high or low levels of student engagement. The survey also gave academics the opportunity to describe how they encouraged student engagement, and whether they were aware of initiatives aimed at improving student engagement. Finally, we invited them to share any ideas to improve student engagement. This survey was also approved by the Research Ethics Committees of Monash University and the University of Massachusetts Amherst.

Academics teaching in CS internationally were invited to complete the online anonymous survey. In total 40 academics completed the survey, from North America, Australian, Europe and

the Middle East. The survey titled ''Computing Academic Perspectives and Experiences of Student Engagement' can be found at: https://goo.gl/forms/hQSDKx6J8xpBjMSb2.

3.3.4 Student and Academic Interview Protocols. Interviews are time and labour intensive and lead to limits on the number of respondents. However, semi-structured interviews allow the identification and illumination of actions and beliefs that may not be revealed in surveys [17].

The student interview format followed the protocol developed for the academic interviews carried out in the 2017 Working Group [31], and this will allow the input of the 2017 academic interviews to be incorporated into the analysis in further work. However, in this case, we also created a version of the interview protocol that was appropriate for the CS students.

To gain an understanding of the perspective of CS students on student engagement, our semi-structured interview contained 9 general questions and also examined response to 6 questions extracted from student engagement survey instruments (the NSSE and the SES). Interviews of students were obtained and analysed, providing a range of responses from students in the field. For the first section of the interview, issues covered included: where, what and how long they have been studying; how they viewed student engagement; what experiences in the classroom engaged or disengaged them; any initiatives they were aware of; and any unique characteristics of CS students and the CS discipline. The second part presented questions extracted from the international benchmark instruments for comment and discussion. At the end of the interview student were asked if there were any other issues related to student engagement that they would like to raise. Due to the semi-structured nature of the interview, if students raised issues of particular interest the interviewer had the flexibility to probe further to explore the concept.

The academic interviews followed a similar format of 9 general question and responses to questions extracted from the surveys. A key difference between the interview protocols was that where students were asked to describe any activities where they had experienced being either highly engaged or disengaged, academic were asked how they perceived engagement levels of students in their own classrooms, and what they had done in their teaching practice to promote student engagement.

Audio recordings, and brief notes taken during the interview, were available for further analysis. There were 28 interviews in total, 19 students and 9 academics. All students participants were from Monash University in Australia. Participants in the academic interviews were from two countries primarily, Australia and the US. At least two researchers reviewed each interview and compiled themes of interest that emerged from the recordings and significant quotes representing important concepts were also identified. Themes were then collated and refined across all interviews allowing the researchers to distil important insights into how the views of CS students and academics either aligned or differed.

4 ANALYSIS AND RESULTS

In the following sections, we start with reporting an analysis of the latest data from student engagement survey instruments and the FSSE data. We then analyse recent computing education literature, to assess if there have been any recent changes. Finally, focus is placed on reporting the views of CS student on student engagement and contrasting these with the views of CS academics. The two data sources on which the analysis is based are the online surveys and the semi-structured interviews with students and academics.

4.1 Recent Trends in Student Engagement Benchmark Data

In this section, we address *RQ1: What has changed since 2016 in terms of CS student engagement?* We look at the performance of CS in the 2017 data in comparison to the general mean of all courses and also in comparison to related STEM disciplines. We were also interested to see if the performance of CS in these instruments improved on the previous year. In other words, were there any areas in which efforts of the CSEd community to improve student engagement for our CS students showed signs of success?

4.1.1 NSSE. Tables 1 and 2 present First Year and Senior results (respectively) from the 2017 NSSE survey. In the first column the ten benchmark areas are listed, with the second column showing the mean scores for all teaching disciplines combined for each engagement indicator. This is followed by the maximum and minimum scores of any of the ten related majors. The mean score for the Physical Sciences and Maths group (that includes CS but not Engineering) is then shown, followed be the mean performance of CS on each measure. The CS category includes data for CS and related disciples, including: Computer Science; Computer Information Systems, Information Systems, Information Technology, and Other Computer Science and Technology. The Computer Science section represented the overwhelming bulk of the responses. For example for 2017 Higher Order Learning for 1st Year Computer science N = 5896 out of 7661. For comparison purposes, the final column shows the change in mean for CS between the 2016 and 2017 surveys.

Overall, the 2017 results for CS in the NSSE surveys were disappointing. CS performance was lower than the general mean for all benchmark areas for First Year students, with a particularly poor performance in Student-Faculty Interaction (-4.1/60) (see Table 1). The performance in several measures, including Learning Strategies (-2.8/60), Reflective and Integrative Learning (-3.1/60) and Supportive Environment (-2.8/60), was also poor. For the Senior CS students (see Table 2), a number of areas show very poor performance when compared to the general mean, including: Reflective and Integrative Learning (-5.6/60), Learning Strategies (-4.7/60) and Student-Faculty Interaction (-5.2/60). Also of note is the drop in student engagement measures between First and Senior years in several areas, particularly Supportive Environment (-4.3). Indeed, Senior CS students tend to be much more critical of their education experience than the First Year CS students.

Of additional concern was that CS performance was lower than the Physical Sciences and Maths group mean in all benchmark measures for both First Year and Senior CS students. The STEM group in NSSE includes the Physical Sciences, Maths and CS, so presumably CS is lowering the overall score of the STEM group. While the STEM grouping in general shares the same problematic indicators as CS, their performance is better.

Table 1: 2017 NSSE Data - First Years (Scores out of 60)

	NSSE Mean	Max	Min	Sci, Math & CS	CS (FY)	2016 to 2017 CS Change
Higher Order Learning	38.1	39.5	37.6	38.0	37	-0.5
Reflective & Integrative Learning	35.3	38.5	33.0	33.7	32.2	-1.1
Learning Strategies	38.3	40.2	36.4	36.7	35.5	-0.9
Quantitative Reasoning	27.3	30.9	24.7	29.6	26.8	-1.5
Collaborative Learning	32.2	36.0	29.6	32.7	31.7	1.6
Discussions with Diverse Others	39.6	40.9	38.7	39.3	37.8	-0.4
Student Faculty Interaction	20.7	22.8	19.3	19.7	16.6	-1.0
Effective Teaching Practices	38.9	40.3	37.7	38.9	37.7	-1.3
Quality of Interactions	41.6	42.8	41.0	41.9	41.3	-1.4
Supportive Environment	36.2	37.2	35.2	35.9	33.4	-1.6

Table 2: 2017 NSSE Data - Seniors (Scores out of 60)

	NSSE Mean	Max	Min	Sci, Math & CS	CS (SR)	2016 to 2017 CS Change
Higher Order Learning	40.1	42.0	37.9	37.9	36.0	-1.0
Reflective & Integrative Learning	38.1	42.2	32.8	33.2	32.5	-0.7
Learning Strategies	38.5	41.1	35.2	35.3	33.8	-1.8
Quantitative Reasoning	29.7	34.8	21.5	33.0	27.5	-1.6
Collaborative Learning	32.4	39.0	29.0	34.6	32.1	1.3
Discussions with Diverse Others	40.5	42.0	39.1	39.1	37.7	-0.4
Student Faculty Interaction	23.8	27.6	21.4	23.7	18.6	-1.2
Effective Teaching Practices	39.7	41.9	36.5	38.1	36.0	-1.2
Quality of Interactions	42	43.2	40.3	41.1	41.1	-1.6
Supportive Environment	32.1	33.6	30.1	31.3	29.1	-1.3

It should be noted that the 2017 overall mean results for NSSE dropped slightly when compared to the results for 2016 overall, -0.33/60 for First Year students and -0.51/60 for Senior students. In comparison however, the 2016 to 2017 drop in CS ratings was larger, indicating a deteriorating performance relative to other disciplines. For CS First Year students, there was significant drop on average of -0.81/60, -0.48 on the average mean. This was also reflected in a lower average for CS Senior students of -0.96/60, -0.45 when compared to the average mean. This general trend of lower performance on the NSSE survey when compared to other disciplines is a major concern with the performance of CS in the North American context.

The deteriorating performance of CS is clear in the North American context and the gap between the CS performance and other disciplines is increasing. Either, current initiatives to address the situation are ineffective or indeed counter productive, or there are other external factors impacting on the rating of CS students of their studies.

4.1.2 SES. Table 3 provides a summary of the Australian SES results for 2017, but unlike NSSE, the results for First Year and Senior students are combined. All measures are scored out of 100 and there are five engagement benchmarks and a score for overall experience. The results are presented in the same format as the NSSE data to facilitate comparisons. The first column lists the benchmark areas, the second column provides a mean across all 21 study areas, followed by the minimum and maximum of any individual study area on each benchmark. The next column gives the mean for the Science and Maths study areas combined, (note that this excludes CS and Engineering to align with the NSSE data). The individual mean for CS is then presented, followed by the change for CS from 2016 to 2017.

In 2017, CS was below the general mean for all areas by a significant margin, with Skills Development (-6/100), Teaching Quality (-6/100) and Entire Experience (-8/100), being areas of significant concern. CS was also lower than the Science and Maths group in all categories, with Skills Development (-7/100), Teaching Quality (-9/100) and Entire Experience (-10/100), being particularly problematic.

The trend between the 2016 and 2017 data was generally negative for CS. Only one area, Student Support (+2/100) showed any improvement in the CS measures. Again like the NSSE, for SES the average of means across all disciplines dropped between 2016 to 2017 overall by -0.83/100. Disappointingly, the average change for CS across all benchmark areas was greater with a drop of -1.83 between 2016 and 2017. In 2016, CS was highlighted in the SES Report as being last of all 21 discipline areas in Entire Experience. In 2017, this situation improved slightly with CS being listed in equal last place jointly with Dentistry.

Again, the trend for CS is negative with significant gaps emerging between CS and other disciplines. Student Support was the one area to show improvement. Again, it is reasonable to question the efficacy of current initiates to improve student engagement in CS.

Table 3: 2017 SES Data (Scores out of 100)

	Mean	Max	Min	Sci & Math	CS	2016 to 2017 CS Change
Skills Development	81	90	73	80	73	-2
Learner Engagement	60	80	50	61	57	-3
Teaching Quality	80	89	73	83	74	-2
Student Support	73	79	68	73	71	2
Learning Resources	83	88	72	87	82	-3
Entire Experience	79	87	71	81	71	-3

4.1.3 UKES. The UKES is a voluntary survey and so captures less data than the other two surveys. Again the data is presented in a similar format to facilitate comparison (see Table 4), with 7 benchmark areas and all scores out of 100. There are 19 subject areas in the UKSES for which minimum and maximum scores are shown. Unlike the the NSSE and the SES, there are 4 broad discipline clusters given, such as STEM which includes CS.

The results for CS in the 2017 UKES survey are slightly more mixed than for the other two instruments, with one benchmark above the general mean, Learning With Others (+2/100). Again, several areas perform particularly poorly, including: Critical Thinking (-10/100), Interacting With Staff (-5/100), Reflecting and Connecting (-9/100) and Research and Inquiry (-7/100). The performance of CS compared to the broad STEM group is mixed, with four benchmarks below the STEM mean, two above the mean, and one result equal to the STEM mean.

In terms of the change in rating from 2016 to 2017, four areas increased in rating: Interacting With Staff (+1.35/100), Reflecting and Connecting (+0.28/100), Research and Inquiry (+1.48), and Staff-Student Partnerships (+1.30). The scores for the three remaining areas dropped. In general, the average of means across all disciplines rose between 2016 and 2017 by 1.4 out of 100. The average mean score of CS also rose, but at a lower rate of 0.22 out of 100. These mixed results for UKES suggest not only areas where improvements in CS can occur, but also importantly potential strategies to address the deteriorating performance of CS in other contexts.

In summary, the performance of CS across all three survey instruments, NSSE, SES and UKES, is poor when compared to the general mean of all disciplines and in comparison to other technical disciples such as Physics and Maths. Of greater concern is that CS appears to be falling further behind the performance of other disciplines in terms of student engagement.

4.1.4 SES and NSSE Trends. We wanted to assess the long term trends in student engagement data for CS. This proved to be problematic due to some early data being unavailable for NSSE and due to the short life of the UKES instrument. The SES survey provided the longest data set with a significant volume of data on which to assess the long term trends for CS. Figure 1 shows the trends between 2013 and 2017 for the SES data. It shows the results for the Entire Educational Experience of all disciplines, the maximum and minimum scores for any discipline, the results for the Science and Maths group and the Engineering group, and finally the results for CS.

Table 4: 2017 UKES Data (Scores out of 100)

	Mean	Max	Min	STEM	CS	2016 to 2017 CS Change
Critical thinking	79	85	67	75	69	-1.10
Learning with others	56	68	39	56	58	-1.28
Interacting with staff	37	52	24	30	32	1.35
Reflecting and connecting	67	74	47	60	58	0.27
Course challenge	91	93	84	90	87	-0.50
Research and inquiry	66	75	38	64	59	1.48
Staff-student partnerships	42	48	35	38	38	1.30

Unfortunately, the trend for CS is dire. In 2013, we were above the minimum mean but by 2015 had reached the minimum for entire educational experience overall. Note that Engineering, which was below CS in 2013, substantially improved its position in 2014 to be above CS and has maintained this position for several years. Of greater alarm is the fact that the rate of decline for CS seems to be accelerating and that by 2017 there was a large gap between CS and the general mean.

For the trend analysis of NSSE data, there is no specific question regarding overall experience (like the SES), therefore we took the average of all benchmarks to generate maximum and minimum values for caparison with the average CS result. Note that the average minimum and maximum value for a single discipline, such as CS, may be lower or higher than the minimum or maximum value for a discipline group.

As can be see in Figure 2 the trend for First Years CS overall is negative, with CS falling below the minimum of other discipline groups. The gap between the CS mean and the 'Phys Sci, Maths and CS' group has been increasing since 2015. There was a slight improvement in performance in 2014 but this was not sustained.

It is a similar story for the Senior group (Figure 3), however the overall rating is lower than the First Year measure and the rating is consistently poor. Again, the performance is at the minimum of all discipline groups by 2017 with an increasing performance gap to the 'Phys Sci, Maths and CS' group.

4.2 Specific Areas of Concern

In order to understand the primary concerns of the students, as reflected in the national engagement benchmarks, a more detailed analysis of the results of each instrument was conducted. The nature

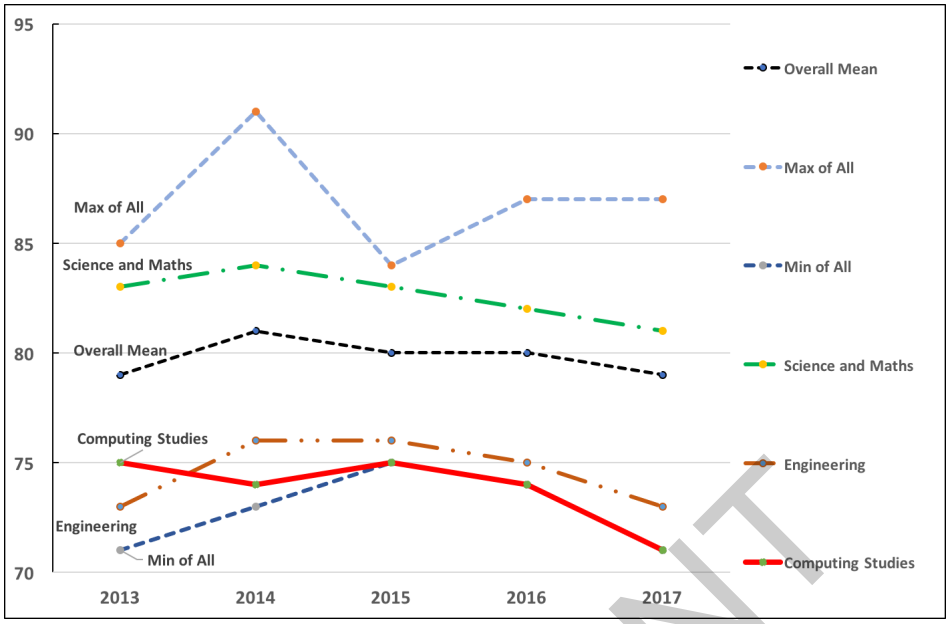

Figure 1: Trends in SES Data 2013 to 2017

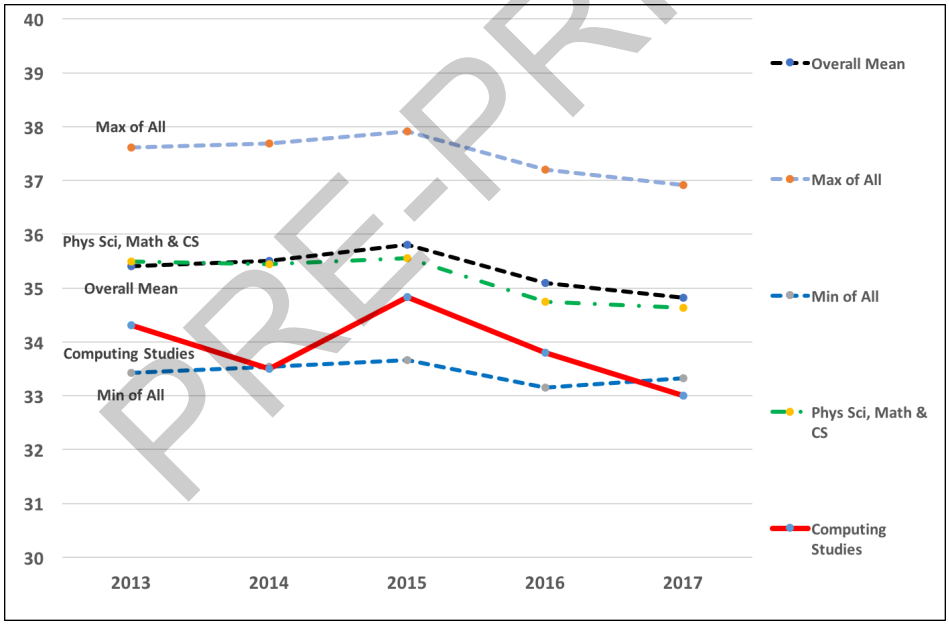

Figure 2: Trends in NSSE First Year Data 2013 to 2017

of this analysis was to drill down into the data to the finest detail possible, for example at an individual question level. This aimed to identify the specific concerns dragging down engagement results and to see if they were common themes across national instruments. These could also be used during the thematic analysis of student and academic survey and interview data.

Each instrument had a different level of detail available for analysis. As such, each instrument will be discussed individually, including the data available, the analysis method used, and the specific problem areas examined. Common themes that were identified will be discussed afterwards.

4.2.1 NSSE. The NSSE online report builder offers the ability to extract results to all survey questions for a specific discipline area

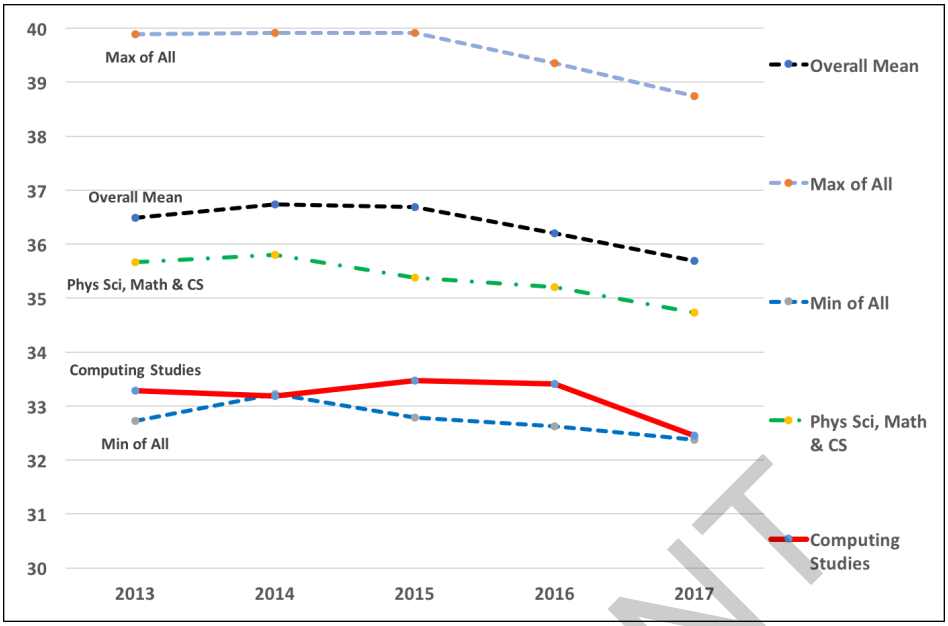

Figure 3: Trends in NSSE Senior Data 2013 to 2017

in the current year (2017). Therefore, we were able to extract out the question responses for Computer Science (one set for First Years and one for Seniors) and identify specific areas that have led to the poor engagement indicator results. Each question is phrased asking how often the student did the particular activity, and is answered using a 4-point scale, such as; "Very little", "Some", "Quite a bit", and "Very much". An alternate scale was; "Never", "Sometimes", "Often" and "Very often". For each question, a count of the CS responses at each scale was provided. Responses for the entire cohort for each question were unavailable. Therefore, for the first pass of identifying problematic areas, any question that had over 50% total for the lower two responses (such as "Very little" + "Some"), in either the First Year or Senior data sets, was identified, as shown in Table 5.

While the main problematic engagement factors identified include Reflective and Integrative Learning, Learning Strategies and Student-Faculty Interaction, individual questions of concern were evident throughout most engagement indicators. It is noteworthy that all questions in the engagement factor of 'Student-Faculty Interaction' met this criteria of being questions of concern. As Student-Faculty Interaction performs poorly for all study disciplines, it has not been included here. However, it is worth noting that the worst performing question in this factor is 'Worked with a faculty member on activities other than coursework'.

Areas of strength were also identified. For the first pass of this, any question that had over 75% total for the higher two responses (such as "Quite a bit" + "Very much"), in either the First Year or Senior data set, was identified, as shown in Table 6. This indicates that our courses are relatively well organised and generally concepts are explained well with practical examples and placed in context.

4.2.2 SES. The Australian SES does not publicly provide the ability to examine any data at an individual question level. Data can be made available to participating Australian institutions that includes survey responses to every question for every participant. Therefore, this data set can be used to identify the questions within the broader engagement indicators that are of significant concern. It should be noted that while the previous subsections have reported 2017 results, the detailed data set was only available for 2016 at this time for the 2018 Working Group analysis.

Like NSSE, each question is phrased using a scale, but unlike NSSE, three different scales are used for different questions: a 2-point (agree/disagree), a 4-point scale and a 5-point scale. All questions used to build the aggregated engagement benchmark factors are either 4 or 5 point scales. The detailed data obtained was unprocessed, requiring each scale to be converted to a numeric value. These were then averaged within each of the 21 study areas to facilitate comparison and identification of CS weaknesses and strengths.

For the first pass of identifying detailed problem areas, any question with a CS result 0.1 or more lower than the mean was identified. As can be seen from Table 7 the area of Teaching Quality was problematic with 8 questions in the list, along with Skills Development with 7 questions represented.

Unfortunately there is only one question in which CS performs well, 0.1 above the mean, which was 'Computing/IT resources - quality' in the 'Learning Resources' benchmark area.

4.2.3 UKES. Similarly, the UKES also does not provide an online tool to interrogate the survey response data. On request, a detailed dataset can be provided reporting results for individual questions at a discipline level. This facilitates being able to identify the specific questions that are leading to the poor engagement factor results. This dataset includes a result (out of 100) for every question for

Table 5: NSSE Questions with Over 50% Low Rating Responses

Specific Questions	Benchmark Areas
Evaluating a point of view, decision or information source	Higher Order Learning
Combined ideas from different courses when completing assignments	Higher Order Learning
Connected your learning to societal problems or issues	Reflective and Integrative Learning
Combined ideas from different courses when completing assignments	Reflective and Integrative Learning
Included diverse perspectives in course discussions or assignments	Reflective and Integrative Learning
Reviewed your notes after class	Learning Strategies
Summarised what you learned in class or from course materials	Quantitative Reasoning
Evaluated what others have concluded from numerical information	Quantitative Reasoning
Asked another student to help you understand course material	Collaborative Learning
Prepared for exams by discussing or working through course material	Collaborative Learning
Encouraging contact among students from different background	Supportive Environment
Institution helping you manage your non-academic responsibilities	Supportive Environment
Attending campus activities and events	Supportive Environment
Attending events that address important social, economic or political issues	Supportive Environment

Table 6: NSSES Questions with Over 75% High Rating Responses

Specific Questions	Benchmark Areas
Applying facts, theories, or methods to practical problems or new situations	Higher Order Learning
Clearly explained course goals and requirements	Effective Teaching Practices
Taught course sessions in an organised way	Effective Teaching Practices
Used examples or illustrations to explain difficult points	Effective Teaching Practices

each of the 19 study areas (as well as reporting question results based on demographic information). For the first pass of identifying detailed problem areas, any question with a CS result 10 points less than the mean was identified. Areas also exist where CS performs well, 10 points above the mean and were again identified.

For the UKES data the picture is mixed, as shown in Table 8 and Table 9, with Learning Skills and Creative and Social Skills rating poorly in 6 questions but Learning Skills rating well in 2 further questions.

Table 7: SES Questions with 0.1 or More Lower than the Mean Response

Specific Questions	Benchmark Areas
Online or face-to-face discussions	Learner Engagement
Student interaction outside study	Learner Engagement
Interacted with different students	Learner Engagement
Quality of teaching	Teaching Quality
Course well structured	Teaching Quality
Course relevant to education overall	Teaching Quality
Teaching staff actively engaged students	Teaching Quality
Teaching staff concerned about student learning	Teaching Quality
Teaching staff provided intellectual stimulation	Teaching Quality
Teaching staff provided constructive feedback	Teaching Quality
Teaching staff were helpful and approachable	Teaching Quality
Textbooks and learning resources - quality	Learning Resources
Induction / orientation activities relevant / helpful	Student Support
Academic or learning advisors available	Student Support
Academic or learning advisors helpful	Student Support
Critical thinking skills developed by course	Skills Development
Teamwork developed by course	Skills Development
Confidence to learn Independently developed by course	Skills Development
Written communication developed by course	Skills Development
Spoken communication developed by course	Skills Development
Knowledge of study areas developed by course	Skills Development
Work readiness developed by course	Skills Development

4.2.4 Emerging Themes of Concern. Each question presented above is a component of an engagement factor within each of the instruments. While there is some overlap of engagement indicators between instruments, each instrument presents its own unique perspective of engagement. Therefore, when conducting an analysis of problem areas, it is best to disregard the indicator from which a question comes, and construct a set of consolidated themes.

All questions identified as being problematic from the three engagement instruments were placed into a common pool and then grouped by shared characteristics and focus. From this, a set of seven initial themes began to emerge. The same process was undertaken for the areas performing well. After the first iteration of thematic analysis, the following themes emerged:

(1) Developing Broader Skills
(2) Direct Engagement by Staff
(3) Interactions and Perspectives

Table 8: UKES Questions with 10 Points or More Lower than the Mean Response

Specific Questions	Benchmark Areas
Analysing ideas or theories in depth	Critical Thinking
Evaluating or judging a point of view, decision or information source	Critical Thinking
Asked questions in taught sessions or contributed to discussions about course material in other ways	Interacting with Staff
Connected your learning to real-world problems or issues	Reflecting and Connecting
Tried to better understand someone else's views by imagining how an issue looks from his or her perspective	Reflecting and Connecting
Learning about methods of research and analysis in your subject	Research and Enquiry
Learning about the outcomes of current research in your subject	Research and Enquiry
Writing clearly and effectively	Learning Skills
Speaking clearly and effectively	Learning Skills
Developing or clarifying personal values or ethics	Creative and Social Skills
Understanding people of other backgrounds (economic, racial/ethnic, political, religious, nationality, etc.)	Creative and Social Skills
Exploring complex real-world problems	Creative and Social Skills
Being an informed and active citizen	Creative and Social Skills

Table 9: UKES Questions with 10 Points or More Above the Mean Response

Specific Questions	Benchmark Areas
Worked with other students on course projects or assignments	Learning with Others
Explained course material to one or more students	Learning with Others
Analysing numerical and statistical information	Learning Skills
Acquiring employability skills (e.g. skills to help you get a job such as CV writing or career planning	Learning Skills

(4) Analysing Information
(5) Course Structure, Organisation and Resourcing
(6) Apply Knowledge to Real World Problems
(7) Study Techniques

All seven themes have identified problematic aspects, while four of the themes also demonstrated some areas of strength.

1. Developing Broader Skills

This theme relates to the development of non-core CS skills. It comprises the largest number of problem questions identified (13 questions), and includes questions from all three engagement instruments. It also includes one question of strength from the UKES.

Problem questions within this theme relate to, unsurprisingly, communication skills such as writing and speaking, but they also relate to the development of personal ethics and values. This could be in explicitly indicating how often students have developed or clarified personal values, but also about their levels of engagement in activities that address them. Given the current societal concerns about the impact of technology, this appears to be a significant gap, however the current trends for the consideration of values within software design may lead to greater consideration of these issues in the CS curriculum.

Encouragingly, one area of strength is present in this theme. The UKES has a question relating to the development of employability skills in which CS students highlighted good performance.

2. Direct Engagement by Staff

The direct engagement of staff was another theme that emerged, and comprises 9 problem questions. No areas of strength were identified across any of the three instruments in this theme. This theme relates to the direct actions of academic staff, both teaching and advisers, and judging of the quality of academic performance. Questions showing problems ask students to report on such areas as teaching quality, intellectual stimulation, provision of feedback, and general support. It should be noted that all questions in this theme come from the Australian SES. While the SES is the main instrument of the three that asks more "direct" questions regarding engagement (for example, asking to explicitly comment on 'teaching quality', how often teaching staff 'actively engaged students', or 'intellectually stimulated' them) this may be a particular area of concern for Australia.

3. Interactions and Perspectives

This theme relates to how students interact with each other, both in formal classroom settings as well as outside. It encapsulates not only study activities, but also interactions that involve diversity and different perspectives. 8 questions identified problematic areas, while there were 2 questions that highlighted strengths.

The problem questions contain an even spread of questions from all three instruments. No questions regarding in-class collaboration (such as working on group assessment) were poor performers. Indeed this is an area of strength in the UKES (highlighted below). Rather questions that rated poorly were focused on either how students worked together outside the classroom, or encouragement of diversity in their interactions. For example, questions relating to how often they interacted with their peers on reinforcing concepts or preparing for exams rated poorly, as did questions relating to how often they interacted with people of different backgrounds. Given acknowledged issues regarding diversity in CS (particularly gender), these areas may not seem surprising.

As suggested, two questions were identified as strengths, both from the UKES. These related to working on team projects and assignments, as well as working in situations being able to explain course material to other students.

4. Analysing Information

Analysing information includes questions relating to critical thinking, analysing ideas, and judging different points of view. It comprises of 7 problem questions drawn from each of the three

instruments, as well as 2 areas of strength drawn from two of the instruments.

In general, CS performs reasonably well in engagement indicators relating to quantitative analysis, as one may expect, however it appears that what does not perform as well is in applying these techniques to evaluating points of view or analysing ideas. For example, both the NSSE and UKES have problem questions relating to "Evaluating or judging a point of view, decision or information source".

Questions highlighting strength come from the NSSE and UKES. One relates to quantitative analysis, and a second, encouragingly, shows strength in "Applying facts, theories, or methods to practical problems or new situations". This sends somewhat of a mixed message. It may suggest that while students are able to conduct quantitative analysis, they are not confident to apply these methods in critical analysis. They do however indicate that they may be able to apply their knowledge to new problems.

5. Course Structure, Organisation and Resourcing

This theme includes questions that relate to how our programs are organised and delivered, and is the most positive of the seven themes. It includes 7 problem questions from the NSSE and SES (none from the UKES), as well as 5 questions demonstrating strength from the NSSE and SES. Contrasting these questions presents an unclear picture of student engagement in this area.

Within this theme, strengths are highlighted regarding clear course goals and good organisation of content. This is evidenced by questions such as "Taught course sessions in an organised way". Also of note is that one positive question related to how often they "Connected ideas from your courses to your prior experiences". While this is reported in the NSSE, there are problem questions present in this instrument as well, for example "Combined ideas from different courses when completing assignments". Similarly, the SES reported problems with "Course well structured", while the NSSE indicated a strength in this area. It is clear that there is wide variation internationally on how courses are structured, possibly exacerbated by the difference between the programs offered by North American and Australian institutions.

6. Applying Knowledge to Real World Problems

The sixth theme relates to the opportunity that is afforded to students to apply their knowledge to different contexts, especially real world examples. No areas of strength were identified across any of the three instruments in this theme. While this has strong links to theme 4 (Analysing Information), four questions of concern relate directly to this issue, so it was seen as strong enough to be a distinct theme. The questions come from the NSSE and UKES, and specifically ask about connecting learning to societal problems, and exploring complex real-world problems. Prior research relating to issues around lack of gender diversity in CS have hinted that the inclusion of more examples of CS for social good may help address this gap, a sentiment echoed by the engagement issues identified in this theme.

7. Study Techniques

Study techniques comprised only 3 problem questions, drawn from NSSE and UKES. No areas of strength were identified across any of the three instruments in this theme. This theme embodies questions relating to how often students indicate they review notes, summarise material, or ask questions in class. The higher focus on practical activities in CS (such as programming) may be a factor for this poor performance, however it should be examined as to why students do not engage in educational activities that have demonstrable benefit.

These seven themes begin to identify very specific areas that students have identified as being problematic with regard to their engagement with CS. By identifying these problem areas, they may be able to be correlated with qualitative student survey data to arrive at a more definitive list of student concerns. As such, it is hoped to open up opportunities to consider specific interventions that may begin to reverse the downward trends evident in engagement benchmarking data.

4.2.5 Summary. The trend analysis from all three surveys indicates that CS is falling further behind other disciplines in scores for student engagement. Regardless of the survey instrument, and the way in which student engagement is measured, we perform more poorly than other STEM disciplines. The decline in CS performance seems to be accelerating over the last few years and it is important to understand why this is occurring at a time of increasing enrolments.

Detailed analysis at a question level uncovers a significant number of specific areas where CS under performs. Areas of particular concern for students relate to their perceived opportunity to develop skills outside the CS context, have academic staff genuinely interested in creating stimulating environments, be able to analyse complex information and ideas, and also apply their knowledge to problem areas of meaning. There is an urgent need to understand this better and see if our efforts align with CS student perspectives.

4.3 FSSE Data

The Faculty Survey of Student Engagement (FSSE) sits alongside the NSSE, and provides an opportunity for academic staff to respond to the same question set as the students. The survey captures academic perceptions of the extent they believe students engage in different activities at their institution. As the questions are predominantly the same as the NSSE, this allows calculation of scores for the same engagement factors, as well as direct comparison of views.

Similar to the NSSE results, an online tool is made available for people to interrogate the data set. Like the NSSE tool, it provides access to summarised responses at the engagement factor level, although it is somewhat more restrictive in only providing responses at the broader discipline group level. On request however, data can be obtained for specific sub-disciplines, and for this research results for computing studies were obtained from the FSSE administrators for the years 2013-2017. Data obtained included the scores for all engagement factors for all computing studies programs, including Computer Science, Information Systems and Information Technology, for academics teaching both first year students and also seniors.

In isolation, this data does not provide a particularly meaningful insight into the student experience, as it is solely from the academic perspective. While this is interesting, it has most benefit when directly compared with the student responses from the corresponding years. Therefore, the academic responses to each engagement factor can be contrasted with the student response. As academics are asked to respond to the questions in the context of either a first

year or senior student, they can also be directly compared with the equivalent student cohort.

Analysis of each year from 2013 to 2017 shows very similar trends, therefore discussion will focus on the results from the most recent 2017 FSSE and NSSE surveys. Table 10 contrasts academic and first year student responses, while Table 11 shows the same comparison for senior students.

Table 10: Comparison of 2017 FSSE and NSSE Responses - First Years - Academic Vs Student

	FSSE	NSSE	Difference
Higher-Order Learning	38.0	37.0	-1.0
Reflective and Integrative Learning	31.7	32.2	0.5
Learning Strategies	34.6	35.5	0.8
Quantitative Reasoning	32.2	26.8	-5.5
Collaborative Learning	37.0	31.7	-5.3
Discussions with Diverse Others	27.5	37.8	10.4
Student-Faculty Interaction	32.8	16.6	-16.1
Effective Teaching Practices	47.5	37.7	-9.8
Quality of Interactions	38.1	41.3	3.2
Supportive Environment	36.0	33.4	-2.6

The comparisons between students and academics fall into one of four broad categories:

(1) Responses are approximately the same;
(2) Students feel they are more engaged than academics report;
(3) Students feel they are less engaged than academics report similarly for both first years and seniors; and
(4) Student engagement starts similarly or less than academics, with the gap increasing from first year to senior year.

Unfortunately, only 1 of the 10 engagement factors falls into the first category. While there is some minor difference, the score for Learning Strategies is fairly consistent between students and academics. This may be considered the ideal result of comparison, whereby there may be a mutual understanding of what the engagement factor represents and a shared view of the quality of experience.

Table 11: Comparison of 2017 FSSE and NSSE Responses - Seniors - Academic Vs Student

	FSSE	NSSE	Difference
Higher-Order Learning	41.7	36.0	-5.7
Reflective and Integrative Learning	37.4	32.5	-4.9
Learning Strategies	35.1	33.8	-1.3
Quantitative Reasoning	36.4	27.5	-8.9
Collaborative Learning	37.3	32.1	-5.1
Discussions with Diverse Others	27.0	37.7	10.7
Student-Faculty Interaction	32.2	18.6	-13.7
Effective Teaching Practices	48.1	36.0	-12.1
Quality of Interactions	38.3	41.1	2.8
Supportive Environment	36.7	29.1	-7.6

In two factors, academics report a lower score than the students. These are Discussions with Diverse Others and Quality of Interactions. While one view of this may be positive, in that students self report a higher engagement level than we expect, it may also be an admission by academics that they feel they do little to promote this kind of engagement. This may especially be the case for Discussions With Diverse Others. While academics may be understandably unaware of the interactions with broader faculty staff as captured by Quality of Interactions, that academics believe their students do not engage in diverse discussions may reflect on their own teaching practice. It may also reflect an inherent lack of diversity in the classroom, and students seek these interactions outside of their computing studies.

The majority of engagement factors fall into category 3 or 4 above, in that academics have an inflated perspective of the engagement level of the students. In two factors, Collaborative Learning and Student-Faculty Interaction this gap is somewhat consistent for both first years and seniors. Student-Faculty Interaction is the factor of biggest concern, as it has the largest divide between academic and student score (-16.1 - First Year and -13.7 - Senior Year). This is of significant concern, as the interactions measured by the instruments relate to broader aspects of the computing discipline not covered by coursework, such as general academic performance and career plans. This suggests that the nature of the interactions provided by academics relating to this are not meaningful to students.

The five remaining engagement factors show a divide between perceptions that gets markedly wider as students move from first year into their senior years. This is demonstrated in Higher Order Learning, Reflective and Integrative Learning, Quantitative Reasoning, Effective Teaching Practices, and Supportive Environment. The first three of these factors may have a larger cause for concern. All of these represent skills that academics would expect to be highly developed in later years of study. That academics and students have such a large difference of opinion on engagement with these factors in the senior year is an issue that demands further investigation. It is also of concern that senior year students are reporting these gaps, as presumably those students who in first year chose a course that did not suit them would have already dropped out in first year. Senior students reporting these results have persisted in the course, indicating an interest in the CS discipline, and have also progressed through the course, demonstrating the requisite aptitude to pass the course.

Effective Teaching Practices is of note due to the fact that, while the divide between student and academic perspective does increase in senior year, it is very big for both student cohorts. This factor encompasses such elements as explanation of course goals and the provision of feedback, so it is curious that there could be such a difference of opinion. This may suggest different understandings of these elements, in particular the nature of feedback.

The final factor, that may be somewhat expected to have a higher discrepancy in senior year, is that of Supportive Environment. Faculties often put significant resources into ensuring smooth transition from secondary schooling into higher education for first year students, so it may be unsurprising that senior students feel a significant drop off in this factor. While a higher focus on first year

students may be appropriate, these results still indicate that more support could be provided for seniors.

What this comparison highlights is that academics do not share the same perspectives on engagement as students as it is captured in the NSSE. Further research should investigate the reasons for these differences, for example whether they relate to different understandings of what the engagement factors represent, or simply if students are less satisfied with experiences being provided by academics and institutions than academics think they are.

4.4 Recent CSEd literature

In 2017, a review of Computer Science education literature was performed encompassing major journals and conferences in this field and covering a time span of five years [31]. The purpose was partly to discover the current understanding of student engagement in relation to Computer Science, but also to determine to what extent research in CS education aligned to the conceptual perspective of the national benchmarks. To update this review, we have considered all papers published during the year 2017-18 in the same journals and conferences covered by the previous review. These publication outlets are: ACE, ICER, ITiCSE, Koli Calling, SIGCSE, Computer Science Education, ACM Transactions on Computing Education, and IEEE Transactions on Education. The full methodology for the review and the instrument used are given in the earlier report [31]. Briefly: a first, high-level pass of all papers published was conducted independently by two researchers to determine which papers appeared to relate to student engagement in CS Higher Education either explicitly or indirectly (for example, by addressing initiatives which relate to engagement survey measures). Following this, each of the selected papers was considered in detail by a further independent researcher to map how engagement was addressed, the conceptual approach used (if any), and the relationship to national student engagement survey instrument measures.

4.4.1 Findings from the literature in the current year. Overall, in the conferences and journals considered, a total of 352 full research papers were published in the 2017-18 review period. Of these, 92 were selected in the first pass. On closer inspection at the second stage, a number of these were rejected as failing to meet the criteria for our review (for example, because on closer inspection they were found not to relate to student engagement or were not in the context of Higher Education). This left 67 papers (19.0% of those published) which were subjected to the full review process. Of these papers, 31.3% referred explicitly to student engagement. A further 19.4% used terms such as "motivation", "satisfaction" and "identity" which are proximal to engagement in Kahu's conceptual framework [22] and are often used informally as interchangeable terms for engagement. Of the remaining papers, 28.4% focused on learning or satisfaction outcomes resulting from interventions aimed at improving engagement-related factors. Despite the relatively frequent positioning of papers in the area of engagement, only two (3.0%) attempted to provide a definition of the term "student engagement". We also considered whether a theoretical framework other than engagement had been used, and discovered that this was the case for 10 (15.0%) papers. A wide variety of conceptual models were referenced, including Cognitive Load Theory and Self-Determination Theory.

We further investigated the nature of the research presented by looking at the research methodology and the evaluation conducted. In most cases (95.5%) at least some data was collected, with the remaining papers presenting an experience report or literature review. The majority of evaluations (61.3%) were conducted with a single class of students or with part of a class. Fewer studies (34.3%) extended the evaluation across different modules or cohorts. Some papers (59.7%) did not have a focused research question or objective, but were presented more as a narrative description of an intervention. Further, 53.7% did not have a clearly articulated research methodology

By considering each paper in detail we were able to determine to which dimension(s) of engagement the work related. For example, an initiative that monitors student participation in a particular activity relates to (at least) the behavioural dimension. We found that 11.9% of the papers addressed behaviour alone, 34.3% considered just cognitive aspects while 10.4% related solely to affective engagement. Multiple dimensions of engagement were evidenced in 39.0% of the research papers surveyed. This accords with a more holistic view of engagement which suggests that the concept can be defined across multiple dimensions.

Relating the topics covered in the research papers to the broad benchmark indicators contained in the national surveys, indicates that the most often represented areas are: Effective Teaching practices (80.6%), Active Learning (38.8%) and Collaborative Working (34.3%). At the other end of the scale, the least represented are: Quantitative Reasoning (1.5%), Work Integrated Learning (7.4%) Discussion with Diverse Others (9.0%), and Quality of Interactions (9.0%).

4.4.2 Comparison to previous findings. The proportion of papers relating to engagement in the past year was 19.0%, and this was similar to that found in the 2012-17 review at 22.8%. This indicates a similar level of focus on engagement by the CSEd research community to that previously observed. The rigour and scope of evaluation is comparable to the findings from 2012-17, with most trials relating to a single class of students. Dimensions of engagement were also addressed in broadly similar proportions.

In the current year's publications, a higher proportion (28.4% compared to 7.2%) did not explicitly refer to engagement but addressed engagement-related objectives via an intervention, such as seeking to improving attainment through encouraging reflective learning. It is unsurprising that there are year to year fluctuations in focus, for example, with special editions of a publication that might focus on a particular topic. Fewer papers this year (18.0% compared to 49.5% previously) appeal to theory, either engagement or other. This may relate to the previously-noted increase in intervention-based and practice-oriented papers.

Overall, the picture for this year is broadly similar to our previous findings, with an even greater trend within engagement-related literature towards atheoretical research and an increase in practice-based publications.

4.5 CS Student vs Academic perspectives on engagement from the online survey data

In this section, we address *RQ2: What is the alignment between CS student and CS academic perspectives on student engagement?*

Survey data was collected from 142 students online from Monash University, female 54 (38%), male 85 (59.9%), and 3 other. With regard to year level, 59 (41.5%) indicated that they were First Year students with the remaining participants a mix of other year levels. The students surveyed were made up of domestic students (77 - 54.2%) and international students (65 - 45.8%) from countries such as China, India, and Malaysia. Survey data was also collected from 40 academics, female 10 (25%) and male 30 (75%). The academics were from a range of regions around the world, including North America 18 (45%), Australia 16 (40%), and Europe and the Middle East 6 (15%).

The following discussion first addresses the issue of how CS students define engagement, which will then be contrasted with the views of CS academics. Next, the issue of how CS students rate their level of engagement with their current course will be explored and again contrasted with the views of CS academics. Particular focus will be placed on why students rated their engagement experience in the way that they did. In contrast, CS academics views on how they rate the engagement of their students will be examined. The next two sections will focus on CS student experiences with their courses that either resulted in high levels of student engagement with their studies or which disengaged them. The aim here is to determine what aspects of our practice are working well and that CS students would want to see more of, and what areas need attention. The views of CS academics on what is and is not engaging for their students will also be discussed. We will then focus on CS student and academic awareness of any initiatives to improve student engagement from either their lecturers or from their institution.

From the analysis of the online survey data we hope that a detailed and comprehensive description of the views on CS students on their engagement with their courses will emerge. We will seek to examine if there are any areas where there is a misalignment between the views of CS students and CS academics that might result in the ratings that we see in the national student engagement survey instruments.

4.5.1 CS Student Perspectives on Defining Student Engagement. CS students were asked to describe what the term 'student engagement' meant to them. In order to align the analysis with previous work we decided to examine the definitions expressed by the students firstly by whether they addressed any of the three 'dimensions of engagement' discussed in the literature: Behavioural; Cognitive; Affective; or a mixture of these dimensions. We then examined if the responses indicated who they believed was 'responsible' for engendering student engagement: the student; the academics and the institution; or a combination of these. Finally, we carried out a thematic analysis of the responses to see if any significant themes emerged. For each of these issues, we contrast the view of CS students with those expressed by the academics, seeking any areas of alignment or misalignment.

With regard to defining the dimensions of engagement given by the students, the dimensions mentioned or implied by the students were more varied than the academics, as shown in Table 12. While the academics tended to imply a Behavioural or Cognitive view of engagement, the students focused more heavily on aspects related to the Affective domain of engagement. Affective aspects, such such as enthusiasm for the subject, a sense of belonging to a learning community, good relationships with academic staff, construction of a professional identity, the social aspects of university and enrichment activities, were mentioned most often in 35 out of 142 student responses and in combination with other dimensions in a further 54 responses. Typical comments related to enthusiasm and interest, social activities and participation in wider university experiences included: *"Keeping students interested in their education."* -S12, *"Participating in university life and study."* -S20, and *"The commitment of a student to university life, whether it be club activities, social gatherings or academics,"* -S24. Comments related to an inclusive atmosphere, good relations with academic staff and formation of professional identities, included: *"A highly interactive and healthy atmosphere built for a student."* -S57, *"The school or a teaching group interacting with students."* -S7, *"How faculty stays in touch with students and attempts to know individual at a more personal level"* -S92, *"How much the curriculum involves the student for his development professionally and personally."* -S117, and *"A team that facilitates events (usually social) and provides services for students that gets them engaged with the faculty and the IT industry. A service might be an industry night or information/educational session."* -S25.

The following comment sums up the Affective aspects of engagement highlighted by students and the wider 'university experience' view of engagement evidenced by a number of student comments: *"Student engagement is involvement beyond what is required of a student in respect to their studies (i.e. Building relationships with professors and department faculty, joining clubs, doing research, interning, helping other students."* -S7. Clearly from these student responses, students see the Affective dimension of engagement as an important aspect of their experience. Therefore, initiatives to increase a sense of belonging to a community of learners, encouraging positive interactions with approachable staff, facilitating participation in university activities and clubs, and the development of a professional identify as CS professionals, are likely to have a high impact in increasing the rating of CS students of their experience on engagement measures.

Responses related to the Behaviour dimension were the second most frequent, with 32 out of 142 responses and a further 34 responses in combination with other dimensions. Behavioural type responses by the students included comments such as: *"Participation and involvement, finding a genuine interest in the subject being learned and dedicating time to it."* - S115, *"It means to me that spending more time studying and solving questions to prati[c]e the skills learnt in lectures."* - S120, *"Being engaged. As a student. Paying attention."* - S137, and *"It means that students participate well in their classes and are invested in learning the content."* - S124. Clearly, a significant portion of students view engagement in terms of participation in class activities. Initiatives that encourage time on task and active participation are likely to support students with this view of engagement.

The Cognitive dimension of engagement was mentioned least often by students, with 6 out of 142 focusing on it, with a further 42 responses in combination with other dimensions. Comments related to the Cognitive dimension included: *"Students interested in more than just the semantics of studying - wanting to learn beyond the course."* - S112, and *"Involving students in meaningful content, where they can interact/argue/discuss/have input on."* -S16. Perhaps a reliance on the inherent interest of the subject matter of CS or

in new topics is not the most effective strategy when it comes to student perceptions of engagement.

The CS academics tended to be focused on the Behavioural dimension of engagement, such as participating in classes and completing quizzes. The Behavioural dimension was implied by 18 (45%) out of 40 responses, with a further 30% in combination with other dimensions. Typical responses related to this dimension included: *"making sure students actively follow (and are able to do so) the course"* - A3, *"Active participation in teaching and learning during scheduled class meeting times"* - A4, *"Students are doing activities like: (1) problem solving among themselves, (2) presenting their solutions to the class verbally or using the black/white boards or slides. (They are not just sitting and listening to the lecture, which is sometime regarded as a passive activity although I don't agree with it; the students are supposed to be fully engaged mentally in the lecture material and in taking notes.)"* - A18, and *"students are attending to material I have provided in a manner that facilitates their learning."* - A35. The focus here is clearly on the student engagement with the content of the course and on observable behaviours that signal to the academic participation in class. There is less emphasis on forming a relationship with the students and the wider aspects of the university experience.

One of the few academic response that focused on the Affective domain was: *"Daily interaction with students - in person, via email, phone, recorded videos etc"* - A25, suggesting a need for a personal relationship between academics and students was needed to provide a supportive learning environment. In fact, an Affective perspective was implied in 61.1% of the student responses, even if combined with Behavioural or Cognitive aspects of engagement. In contrast academics only provided responses related to the Affective aspects of engagement in 22.5% of responses, every if combined Behavioural or Cognitive aspects of engagement. This implies that academics may need to pay more attention to the Affective dimensions of engagement in their classes and more generally.

Table 12: Dimensions of Engagement

Students		**%**	**Academics**		**%**
Beh	32	22.5	Beh	18	45.0
Cog	6	4.2	Cog	3	7.5
Aff	35	24.6	Aff	3	7.5
Cog/Aff	26	18.3	Cog/Aff	4	10.0
Beh/Aff	18	12.7	Beh/Aff	2	5.0
Beh/Cog	12	8.5	Beh/Cog	10	25.0
Beh/Cog/Aff	4	2.8	Beh/Cog/Aff	0	0.0
NA	9	6.3	NA	0	0.0
	N=142			N=40	

With regard to the locus of responsibility for engendering engagement there was a marked difference in the responses of the students and academics, as shown in Table 13. Students responses tended to imply a mixed view of responsibility for engagement with equal numbers imply the student (59 - 41.5%) or the academics (59 - 41.5%) were responsible for engendering engagement. In addition, approximately 16 - 11.3% of students implied that engagement was a shared responsibility.

Responses related to the student being responsible for engagement included: *"Enthusiasm, whilst as a student, towards the opportunities offered to you as a student of an institution."* - S100, *"actively participating/attending classes. Contacting staff and asking questions in and out of class time. Showing an interest to learn."* - S18, *"How well a student pays attention to the course and its materials and how much information the student retains."* - S39, and *"How well students make the most of their time at university"* - S34. In this regard a significant number of students recognised that they had a responsibility to engage in their studies and to make the most of the opportunities offered to them.

Responses by students related to academics being responsible for engagement included: *"How the students of a university are being engage by the staff in terms of academic material and extracurricular activities."* - S106, *"Being provided an learning environment that keeps me focused and interested in the topic being discussed."* - S140, *"Providing opportunities for the students to understand their courses better and giving them an insight about their future in the industry."* - S123, and *"Interacting with students meaningfully and keeping them involved"* - S27. Here there is an implication that academics have a responsibility to provide an interesting study environment that is relevant to their needs. Interestingly, this implies that academic staff may potentially have a big impact on this segment of the student cohort if the nature of the content and its delivery is effective.

A number of student responses acknowledged the 'shared' responsibility between students and academics for engendering engagement, such as: *"Staff actually TRYING to help students and students subsequently responding. If staff show little interest in students, particularly in tutorials, students will clearly not be engaged."* - S13, *"Students being active and involved in Faculty and Social events/programs"* - S91, and *"Sense of belonging amongst students, overall positivity of thought towards faculty, participation in faculty-related events"* - S108. These responses implied a shared responsibility for engagement but also implied that the nature of the relationship between students and academics was important in this regard. Academics needed to show enthusiasm and commitment to their teaching, to be approachable and to have a genuine interest in the students.

In contrast academic comments overwhelmingly implied that students were responsible for engagement, with 85% categorised as representing this view. Only 10% suggested Academics were responsible for engagement and a further 5% suggested a shared responsibility. Typical responses suggesting students were responsible include: *"Student interest in the discipline and attention during class time."* - A1, *"Students actively participating and/or listening. Read the book not just rely on slides and/or lecture."* - A8, *"I think of students being engaged meaning that they are actively participating – thinking about what they are learning, asking questions, trying examples, answering questions from the teachers or from their fellow students."* - A38, *"Students are interested and paying attention."* - A36, and *"Students care about the questions they are addressing, beyond their desire for a grade."* - A39. One of the few responses suggesting academics had responsibility for student engagement was provided by A17: *"Making learning subject matter an exciting and appealing experience for all students no matter what level and backgrounds they have got."* This misalignment between the responses of CS students

and CS academics in regard to who is responsible for engagement may be one area that needs to be examined further.

Table 13: Who is Responsible for Engagement?

Students		**%**	**Academics**		**%**
Academic	59	41.5	Academic	4	10.0
Shared	16	11.3	Shared	2	5.0
Student	59	41.5	Student	34	85.0
NA	8	5.6	Student	13	86.7
	N=142			N=40	

Finally, with regard to themes that emerged from their definitions of engagement, we identified 4 themes emerging from the student responses, and a further four themes emerging from the academic comments defining student engagement.

Themes emerging from the student responses included:

Theme 1: Student and Academic Relationships.

The first theme identified related to the relationship between students and academics, with students wanting more feedback and personal interaction with staff. Typical examples of this type of response were: *"The school or a teaching group interacting with students"* - S7, *"Very frequent communication (Not E-Mail or SMS etc.)"* - S48, *"Feeling been an important part of the university and faculty"* - S71, *"Promoting an active culture between students and between students and staff."* - S103, *"Getting the students opinions, inspiring them by creating a wonderful learning culture, keeping them informed"* - S25, *"Interacting with students meaningfully and keeping them involved"* - S27, *"Engaging with the Faculty and the Faculty community outside of classes"* - S31, and *"Students actively take part in and contribute to the ecosystem of the IT faculty student community."* - S46. Clearly, students saw personal interactions with academics as a critical aspect of engagement. They also wanted more input into shaping their experience and for their feedback to be noted.

Theme 2: Active learners and Collaboration.

The next theme related to the idea of active learners and student collaboration. Examples include: *"Making students active learners "* - S121, *"Involving students, giving them an active role to participate in the activity"* - S40, *"Interacting with my fellow students and collaborating in class."* - S88, *"It means that students regardless of their backgrounds and cultures reach out to one and another to help each other for the betterment of each individuals. This can be in form of student discussions, study groups, events, etc. to help with the learning or making friends with other students."* - S87, *"To be involved and participate with peers and your course"* - S134, *"Being able to discuss with other students about a certain topic, where everyone is engaged and can learn together."* - S142. Clearly, students want to be active in class and doing tasks. In addition, they suggest that working with others can promote their sense of engagement.

Theme 3: Skills and Real World Relevance.

The third theme to emerge was the idea of skills development, relevant content, links to industry and real world applications. For example: *"Involving students in skill enhancements activity or pointing them towards right direction from research perspective"* - S56, *"A team help students solve problems"* - S107, *"For me, it means helping students improve soft skills through activities outside their academic lives."* - S84, and *"Engaging the student in ways that make learning fun and provides insight into real world applications"* - S15. A focus on the relevance and practical application of what they are learning may be beneficial in this regard.

Theme 4: The Wider University Experience.

The final theme related to the wider university experience, not just activities in the classroom. A variety of comments related to this: *"Something that engages student with the culture of the university"* - S122, *"Encouraging students with similar interest to meet up and socialize"* - S83, *"It means engagement with the discipline beyond minimal course project requirements; clubs, research, internships, or other cs related work"* - S82, and *"The commitment of a student to university life, whether it be club activities, social gatherings or academics."* - S24. Here, students indicated that the wider university experience was part of how they viewed engagement. Here a focus on wider personal development could be beneficial rather than a narrow focus in specific course content and skills acquisition.

Themes emerging from the academic responses were quite distinct from the student themes, and included:

Theme 1: Passive vs Active Learners.

The first theme related to the idea of Passive vs Active participation by the students in class. The concept of participation was mentioned be a number of academics but their concern was that some students' participation was passive, attending lectures and tutorials but not interacting with the content, with the academic or with their peers. They were present in body but not in spirit. Academics saw active participation as desirable with students asking questions in class being mentioned often. A typical response was: *"Lots of things. Attendance, interest, asking questions, engaging in groups, ..."* - A11. In a sense, participatory behaviours are the most easily noticed way of assessing engagement. An academics' sense of identity as a teacher and sense of self-worth may be validated to some extent by active student participation and enthusiasm in class. Indeed, some academics noted that they tended to interact more with active students and found it hard to engage with more passive students.

Theme 2: Classroom versus University Experience.

The classroom versus wider university experience theme, captured the idea of differentiating engagement in the classroom and engagement with the content outside the classroom or with the wider university experience. A typical response was: *"A range of student participation and interest in class is a primary aspect. Over time, engaging students in the classroom has evolved to mean more active participation in learning rather than passive attention to lecture. Outside of class it ranges from commitment to quality completion of assignments to participation in co-curricular clubs and organizations."* - A11. Several academics acknowledged that the wider university experience was important but this view was less prevalent for academics than for students.

Theme 3: Surface vs Deep Learning Strategies.

Surface vs Deep Learning related to the idea that some students did not engage deeply with the content. Comments suggested that academics were looking for cognitive approaches to learning. A typical quote: *"To me, engagement is a measure of student interest in material. It's related to curiosity and exploration, and I tend to think of it as being demonstrated when students act (perform, rather*

than reading or watching)." - A13. This theme was often associated with academics expecting that students would have the interest and motivation to learn the material beyond the basic level required to pass the unit, that the would do further readings and independent work outside class to understand concepts and practice skills.

Theme 4: Intrinsic vs Extrinsic Motivation.

This theme related to the underlying motivation of the student, with the implication that some students were motivated by grades or careers rather than an interest in the discipline. A typical comment: *"Students choosing to dig into course content. Comes out in asking exploratory questions and working hard on assignments, more than just to get a grade."* - A5. Several academics were concerned that students put in only the minimum effort required to pass, were only there to get a qualification, or were only interested in a job after their studies, resulting in poor levels of engagement.

When comparing the themes emerging from student and academic responses there were some similarities in terms of recognising the importance of the wider university experience and active learning. The most important difference was that the students were very focused on the importance of relationships, with both academics and with their peers. Engendering a supportive learning community was seen as important by students and they expressed a desire to have input into shaping their study experience.

4.5.2 CS Student vs Academic Perspectives on Rating their Engagement with their Current Studies. We asked students to describe their level of engagement with their computing studies. We then asked them to rate their level of engagement on a seven point scale from Poor to Excellent. In order to probe further, we then asked the students the reasons for their ratings. We categorised the responses into several main themes as discussed below.

On average the students tended to rate their experience well, with a mean of 5.03 (N=142) on a 7 point scale. This is more positive than the results reported in several national student engagement instruments, such as NSSE and the SES, and it would be interesting to know if this was due to the nature of the sample or to the way that the rating question was asked. The academics, on average, rated the level of the engagement of their students slightly lower at 4.73 (N=40) on a 7 point scale. It should be noted that this is a small sample but, when combined with the comments provided, CS academics seem to be less satisfied than the CS students with student engagement, participation, and interest with their courses.

Several themes emerged from the student discussion of their level of engagement with their courses. There were a number of positive comments which we will summarise first. We have also identified three main themes related to the problematic aspects of the student's engagement with their courses.

There were a lot of positive comments about rating their student engagement with their studies. For example: *"Majority of units are well-designed and some are taught by exceedingly knowledgeable teaching staff."* - S30, *"I am very invested in achieving good results, but my interest varies between subjects."* - S34, *"I feel deeply engrossed with my academic routine and am satisfied of my academic progress."* - S39, *"Depends on the unit and the teaching staff but generally I have a high level of engagement"* - S44, *"Engaged well with units I really enjoy and are teaching useful skills"* - S59, *"I've been provided heaps of great opportunities to enhance my study experience at Monash. ... It has been a great year for me."* - S67, *"Excellent, loads of opportunities are shared, it's also a caring culture. ... People are very responsive, knowledgeable and helpful."* - S68, and *"I love IT, if that's what you mean. Most of my units are very interesting."* - S72. Clearly, many students rate their experiences highly and are enjoying their studies.

However, several themes related to problematic issues also emerged from the student description of their level of engagement and the justification for their ratings.

Theme 1: Too Much Content and Assessment.

The first theme related to the idea of engagement for learning versus engagement for completing course requirements. Students indicated that they felt that there was too much content and assessment and that this lead to a shallow approach to learning. A typical and well articulated comment was:

> Too many dry and unexplored topics. .... In general, I think the comprehensive scope and shallow depth in my current semester 1 units is really bad. I would prefer that really interesting areas are explored in depth, and that students are able to choose these areas either as units or within their units. The current approach makes it seem like there is an overwhelming amount of content to learn. I think there should be a balance between the conciseness and depth of the topics taught in the unit and overall, the unit should aim to make students good at the topics covered and not flood them with knowledge and hope that they pick up on the important concepts. - S97.

There was a sense that due to the volume of the content that needed to be covered, there was little time left for actual learning: *"Pretty involved and tiring"* - S1. A similar comment was expressed by: *"Average. Enjoy what I am learning, but I feel like I don't have enough time."* - S51. In relation to the flipped classroom approach the following view was expressed: *"Too many information needed to read/understand prior for the week. Causing confusion and feeling demotivated."* - S71.

Several students suggested that they thought that there was too much focus on assessment and not enough focus on learning: *"I think the course doesn't give us time to actually apply what we learned. We learn only through our assignments."* - S49. In particular, the practice of continuous assessments was seen as problematic: *"I also disagree with continuous assessments throughout the semester (i.e. weekly assessments are bad), because they shift the focus on learning to just getting the marks."* - S97, and *"Average - with assignments being piled up on us, there is only a little time to do anything else"* - S123. There may be a belief by some academics that attendance can be increased by having weekly in-class assessment activities and that students working on assessment tasks indicates a high level of engagement, but this may be problematic if adopted in several courses simultaneously.

Another student indicated that the volume of work tended to interfere with their involvement with the wider university experience: *"I have always wanted to be more engaged in events and activities but I'm always feeling stuck with assignments and stressed when I feel like I don't have enough time for my study."* - S46. This is problematic in terms of the national student engagement surveys, as NSSE in particular, assesses elements of the wider university experience. Another student indicated that as the semester progressed there

was less time available for participation in enrichment activities: *"I tend to engage in events between week 1-6 enthusiastically, but get busy with uni work during the semester. During these times I feel less engaged, I am studying, yes, but have less time to commit to other avenues of learning (industry nights, hackathons, robogals) , which I find just as valuable as studying."* - S66. From other responses in the survey, these types of enrichment activities are precisely the types of activities that lead to high levels of engagement for students. In addition, several students expressed the view that if they missed any content or activities that they would be left behind. A typical comment was: *"Challenging, feel like ill be left behind if i miss a class"* - S19. Several students indicated that it was demotivating to be in a situation where if they missed a week or fell behind that they had no chance to catchup and complete the course.

In summary, the students expressed the view that the volume of work and the volume of assessment were tending to crowd out opportunities to learn in depth and to engage deeply with their studies.

Theme 2: Staff/Student Interactions.

The second main theme related to the quality of interactions with teaching staff, both lecturers and tutors. The relationship with tutors was seen to be particularly problematic by some students: *"Tutors are horrible, coursework is poorly distributed both content and mark wise."* - S8, *"I appreciate certain activities that make each unit I've undertake unique and interesting. However, engagement can often feel lacking if tutors from tutorials/labs are disinterested."* - S86, *"Tutors are often unintelligible and standoffish...."* - S103, and *"Tutorials could be a bit more informative and engaging."* - S140. The variable pace and quality of deliver was seen as problematic in regard to tutors also, for example: *"4/10. I believe tutors should be more enagaged with students, be more understanding and helpful, and be able to articulate themselves clearly. Myself, a beginner program, finds it very difficult to understand my tutors, as they move at a rapid pace without checking if even the majority of the group understand."* - S37. From these responses, an increased investment in tutor training and selection would be likely to increase student engagement ratings.

Problems with engaging with lecturers were varied. One issue raised was differences in approaches between tutors and lectures, which results in confusion for the students: *"Discussions with some tutorials in one or two units have revealed quite a disappointing disparity between tutors and lecturers, leading to issues for those trying to learn the content."* - S45. Academics were either seen as unapproachable: *"Most teacher would not engage with you unless you're extraordinary good or you engage with them yourself."* - S11; or as having a negative attitude towards students who are struggling or asking questions: *"I try and get slapped down."* - S24. In fact, the lecturer attitude towards struggling students generated strong student responses: *"Bit slow sometimes lecturer treats us like we can either be dumb as shit or smart af, but usually thinks of us as kids –> degrading and discouraging."* - S15, and:

> Staff make or break a students reasons for involvement. In tutes or labs, a student can be motivated. A teacher unwilling to clarify content, or teacher confident in their abilities to explain, a teacher who repeats rather than adjusts is completely deflates a students hope and willingness to be involved. It follows pessimism and the attitude that nothing much can be gained it done. No efforts by student will be heard because staff [are] confident and stubborn. Worse if staff are quiet, hard to reach, confident in their abilities and HARSH MARKERS. - S133.

In addition, academics were not seen as very responsive to student concerns: *"I am happy with Monash's facilities and student help services. However, I found out that if the students want to make an enquiry or request to the teaching staffs including lecturer or tutor, they have to wait such a long time to see a change or response from the faculty or school."* - S79, and:

> Some units does not allow for fe[e]dback to lecturers, even if the lecturer is being u[n]responsible, we are unable to complain because there is no one to complain to. Tried writing to sslc form but it just makes the lecturer treats the the students worse. Since this experience, the only way for students, is to remember not to take any units taught by the lecturer in the future. - S101.

Tutor quality and academic staff attitudes, particularly towards students who may be struggling, are issues that generate strong responses from the students and therefore result in lower student experience ratings.

Theme 3: Nature of Content.

The third theme related to the nature of the content and relevance of the material. Material that was heavily theoretical without a clear practical application were seen as problematic: *"It's just okay. Lecture notes filled with theory but no practical or real world example are provided. At least put more links that can simulate the computing practical instead of giving just one. Practical class was just okay."* - S16. Lecture content was seen as dull if it was theoretical whereas tutorials were often seen as more engaging: *"Some are better than others - I find a large majority of theory lectures dull and not engaging. Practical > Theory."* - S62. Students expressed the desire to be able to apply what they had learned or to see where it could be applied in the real world: *"I think the course doesn't give us time to actually apply what we learned. We learn only through our assignments. ... More practical experience needed."* - S49. A related issue with the content was the pace of content delivery. Some students indicated that lecturers and tutors were going too fast but some indicated that in the first year they were repeating content they had already mastered. For example: *"An awful first year program that compulsorily goes from the very basics of programming"* - S64. Techniques for student self-paced progression through the content could be explored to address this issue.

In summary, students wanted the content that was delivered to be more strongly linked to real world practical applications and examples.

The above discussion focused on the positive and negative aspects of how students rate their engagement with their studies. This can be contrasted with academic perspectives on how engaged students are in their studies.

There were a number of positive comments by academics about their perception of the engagement of their students in their courses. For example: *"Students show up, work hard, and ask good questions."* -

A1. In addition, several indicated the role they took in encouraging the engagement of their students in their studies: *"With the flipped-classroom model, quite high."* - A29. For example: *"I believe I bring enthusiasm for the content, examples of my research and active learning opportunities for students to the courses I teach. I am available outside of the classroom and a very active supporter in women in CS"* - A7. One academic indicated the workload associated with facilitating high levels of student engagement: *"I think I do a pretty good job keeping on top of pedagogical shifts. But revamping courses to address issues of student engagement can be time-consuming and difficult work. So there is always room for improvement."* - A11. Another academic indicated the effort they put into creating an inclusive and inviting learning environment: *"We put every effort to create an open, respectful learning environment while delivering on the learning outcomes of the units."* - A25.

However, the general response of CS academics on rating the level of engagement of their students in their courses was more negative than the students themselves. Several themes were identified from the academic responses, such as: the Range of Engagement in Class, Assessment or Activity Driven Engagement, the Impact of Class Size on Engagement, and Lectures Verses Tutorials.

Theme 1: Range of Engagement in Class.

One issue that emerged very strongly in the academic responses was the issue of variable levels of engagement with a class. Several responses highlighted this issue: *"Most often about 10% of the class is highly engaged, 40% is moderately engaged, 20% is slightly engaged and 10% is disengaged."* - A5, *"its an average of the extremely bi-modal engagement"* - A22, and *"Best I could do to "average" a highly engaged cohort, the many moderately engaged, and the unengaged subpopulation."* - A37. Academics struggled with finding an approach that would engage all of the class: *"Well, a simple rating doesn't work. With 100+ student classes, there is a massive range of engagement from none (not present) to very engaged. Few read the book, and most simply Just Google It and lose all context of concepts. I see this a lot when they argue for credit on a question. There are some who are eager to learn and apply everything they learn. There are also many who try to do the absolute minimum."* - A8. There was some agreement that tutorial and practical activities were more engaging than lecturing: *"Depends, huge range. Active guided exercises has highest, or in-class exercises worth credit. Mostly get only 10% showing up to class (from intro through grad-level)."* - A8. For some academics, students tended to lack independence and engaged only at a shallow level with their studies: *"Some students seem to want a recipe to follow. Anything that requires some more thinking and experimentation overwhelms them or at least makes them unhappy. They then make negative comments in the student evaluations that the teacher asked them to do things that they were not previously taught."* - A9.

A telling response regarding different levels of engagement within the class was: *"As I said above, different cohorts of students are engaged in different ways. They're all motivated, but some by fear rather than love."* - A39.

Theme 2: Assessment or Activity Driven Engagement.

The second main theme derived from academic responses related to the idea of using assessment or practical activities to drive engagement, in particular to encourage attendance. Some responses indicated that that assessment promoted attendance: *"Generally very good when present, but only present for assessed classes. Most of our classes are assessed except for lectures. We also have video content which is rarely watched except where it directly relates to assessment (at which point it is effectively engaged with)"* - A30, and *"Participation is not by enough students. When forced in group exercises, it's better, but I know some students are just going through the motions."* - A4. A contrasting view on the impact of assessment and engagement was also provided indicating that this approach could be counter productive: *"Student engagement can be seen from different prospects. The engagement via many assessment won't give the student the good experience."* - A21. There was also a some what cynical view that many students only engaged in order to get marks: *"Some students are self motivated, but most become engaged only when they feel they need to in order to do well on an assignment, project or test."* - A38, *"Some really great engagement, but the majority is pretty instrumental: get grades and walk away."* - A2, and *"sometimes it is quite good, often engagement falters when grades must be assessed."* - A40. Clearly, the issue of students being interested only in assessed activities is a 'share' responsibilities. Some students have an instrumental approach to learning motivated by grades and jobs, but some academics are clearly using assessment to promote attendance rather than to assess learning gains.

Theme 3: Impact of Class Size on Engagement.

Several academics commented on the impact of class sizes on engagement, indicating it was hard to motivate and interact with large groups of students: *"The incentives are all in place, but the large number of students means that many do not really become involved."* - A3, and *"Some are motivated, some are not. There are so many students it's almost impossible to keep track of everyone."* - A6. This issue may become more problematic as class sizes grow rapidly. In fact this may be one external factor in the decline in student engagement ratings in CS across several national survey instruments.

Theme 4: Lectures versus Tutorials.

The final theme related to the shift away from lectures, which were seen as problematic for engagement, to more practical tutorial-based classes. For example: *"It's an average, more traditional lecture style courses are more challenging, but I also teach hands-on classes with student defined projects and no exams...students routinely engage admirably in these courses"* - A40, and *"We have changed the courses quite a lot over the years from previously having many lectures and few labs, to very few lectures and very many labs with many TAs. Students always say that it's during labs they really learn. They are also free to discuss with other students the assignments, even if they have to report them individually but verbally w[h]ich makes it easier for us to check whether they know the subject or not."* - A12. Practical hands on exercises were regarded as being inherently more engaging:

> Most students are most engaged when they can do something themselves, which mainly happens in the lab. I find it very difficult to engage students during lectures. The engagement in the lab is mainly that they write code themselves and also that they discuss with peers and teachers. In the lab it seems as some students change their attitu[d]e to programming from "not interesting or relevant" to interesting, fun and

> relevant. Sometimes you see their self esteem change a lot from "very difficult, don't understand at all" to "I can do it!". It can be very emotional, up or down, and for most students a vari[e]ty of feelings. - A12.

To summarise the negative attitudes of academics to engagement the following three responses are illuminating. CS Academics tended to see engagement as highly variable, depending on the student cohort and the subject that needed to be taught. For example: *"Sporadic/patchy at best; generally well-below what I would expect/hope for; extremely variable from unit to unit, from student-to-student and from time to time during semester and even within a class"* A23, and;

> As indicated in my answer to question 6, the engagement levels vary enormously, so this is some kind of average. For the majority of my students in the majority of my classes for most of the time I would rate their levels of engagement as generally poor - low attendance levels at lectures, reluctance to do anything more than is demanded of them, reluctance to discuss issues, etc etc. On this basis I could go for a '1'. But there are always some exceptions within units and within classes - regular attendees, enthusiastic contributors, etc who I would rate as a '7'. During sem 1 I would probably have given a '3', for this answer, because I was teaching a unit with a class which had a significant cohort who generally appeared to be very engaged, but this semester I have two units in which the number of students in that category is much lower, so I went for a lower number. I would also note that my perception of engagement is relative to my previous experiences, and without seeing past classes through rose-coloured glasses, my feeling is that engagement levels are generally lower than in the past. - A23.

One implication of the above response is that the academic has little control over these issues. However, a number of student responses have indicated that an enthusiastic teacher can make any content engaging. In addition student responses indicate that an approachable and support academic can engage and motivate struggling students. Finally, student responses also indicate that students will engage with highly theoretical and technical content if they can see the relevance and practical application of it.

From experienced academics, the responses indicate that they believe that engagement with students is declining and is a wider societal problem with the education system as a whole, as shown in the following response:

> As much as I as a teacher can try to make the students to be more engaged, but the real progress is to be made by changing the whole social culture among students (starting in middle and high school) instead of trying to correct the problem the at the college level. I have been teaching for a long 37 years and I am seeing an increasing rate of decrease in students' attention in classroom and background preparations. Much difficulties lie with the teachers also in a way. The publisher has to provide the slides for the teacher to adopt its books for a course so that the teacher does not have to prepare for the lectures and can come to the class "sleeping"" and turning on the power-point slides to be read by the students until he/she is awakened by a student's question (which is not likely to happen often). - A18.

Again, the impact that the academic thinks that they could have on this situation seems to be limited, but they do in fact control how much effort the put into teaching and the teaching approach that they adopt for their own classes.

The final response indicates how academics may respond and adapt to poor engagement with their classes. This may often be by focusing on those students who demonstrate aptitude and are more willing participants:

> In my opinion, if I'm not wrong, students in my institute are indifferent. They tend to cancel classes and dismiss doing their homeworks. However, I followed a teaching style to handle this in the following manner: I reward those who attend classes by extra quiz points, I usually include quiz questions in exams, I form groups within each class to work on problems so that they secure their answers and feel they are learning from their peers, and I tend to cherish students and push them to work hard. But there must be some students who stay indifferent. - A17.

The above response tends to indicate that to some extent the academic has given up on part of the class and is focusing on those who they perceive as receptive. Clearly, academics have an obligation to reach out to all students in their classes and to try to improve situations where there is a lack of engagement. In contrast, some academics have expressed the view that the students that are struggling in their classes receive the majority of the time and attention and that high achieving students are not receiving the attention needed to extend their abilities.

From the above responses, it is clear that CS academics are at least as concerned with poor levels of student engagement as are CS students, and that for a number of them a lack of student engagement is extremely discouraging.

4.5.3 CS Student vs Academic Perspectives on Engaging Experiences. In this section of the survey we sought to identify activities and educational strategies that the students thought were particularly engaging. With regard to elements that students report as facilitating high levels of engagement, we identifying three general areas; Quality of lecturing, Events and Extension Activities, and Practical Tasks and Real World Applications.

Students reported finding expert and committed lecturers engaging, with the following observations: *"The lecture and teacher are friendly and professional"* - S16, and *"Good lecturers who are able to connect with the students and provide high-level technical knowledge while also providing understanding and relevancy of the unit(s)."* - S30. Courses that were well organised and that built skills incrementally were also highlighted: *"Well written and structured coursework always keeps me highly engaged. Knowledgeable and intelligent lecturers and staff. Hands on practicle activities as an individual or in a small group"* - S44, and *"Weekly graded labs show*

incremental learning which was good, and having lecturers that don't just read off the slide is also engaging" - S71.

A number of specific events and activities proved memorable and engaging for students, including industry events, guest speakers, bootcamps, hack-a-thons, competitions, scholarships and industry sponsored evenings. A sample of the types of events mentioned includes: *"Participating in industry information events and seminars on related courses by guest speakers"* - S1, *"NRC, FIT PMP, FIT SEC, Clubs and Societies, MSA, Work at Monash, miscellaneous events (FIT Programming Bootcamp, FIT Industry Night etc.)"* - S13, *"Hackamon, Peer Mentorship"* - S52, *"Unihack and Unihack mini. Student cluster competition. Research Summer Scholarship"* - S61, and *"All of the ACM events that I go to - both professional development and purely social ones"* - S84. Clearly, events with industry relevance or speakers were highly regarded. These events perhaps take students out of the traditional classroom and often involve interacting with external people or competing with other students.

The final area that was prominent in the student responses concerned learning activities where they could practice skills and apply them to real world problems. For example: *"Making projects"* - S21, *"Workshop environments where we directly apply what we've learnt in lectures and can experiment to produce different results (e.g. manipulating code)"* - S25, and *"Activities where I have been highly engaged have all been when I am completing a practical task that requires challenge and effort and results in something virtual/physical being created."* - S29. Students mention 'legitimate' projects, real-world problems, and industry-based projects. Comments related to this area included: *"Constructing a project with code - it feels like you're actually working in a legitimate project."* - S47, *"When I participated in a team programming competition, creating my own application to solve a real-world problem in my databases course"* - S77, and *"Challenging, practical assignments - while frustrating - are the most engaging and rewarding experiences I have had strictly in relation to course work. The Monash Industry Based Learning program is an initiative that has also given me a lot of motivation to perform well academically, and to seek experience outside of just my university study - like attending outside events, seminars and club meetings."* - S85. Linking concepts and skills to real world tasks and problems was seen by students as being highly engaging.

CS academics were also asked to nominate experiences where they thought the students had been highly engaged in their classes. In comments, academics often mentioned specific topics or activities related to the actual content they taught, for example 'SQL injection attacks'. Academics also often referred to general teaching strategies, for example 'pair programming', 'live coding', 'code reviews' and quizzes. However, a number of distinct areas emerged that academics thought promoted engagement, such as: End of Semester Capstone Projects, Student-led projects, and Real-world Projects.

End of semester or capstone projects were seen as particularly motivating for students, where they could implement a range of skills that they had learned in other units and work with other students on a major project. Sample comments related to this theme included: *"I see the most engagement in our end-of-semester, self-designed projects in the introductory courses."* - A1, and *"Somewhat open ended final course projects, where they get to decide on defining aspects of the project."* - A9.

A related idea was the discussion of Student-led Projects, where students were given the autonomy to design their own solution to an open-ended problem. Academics suggested that giving student autonomy to shape the direction of the project led to deeper learning and that students often surpassed the expectations of the academics. For example: *"Our final lab at the CS 1 course involves implementing a full-fledged game, with a lot of leeway given for "their own" design and individual ideas (by a team of 4). I am always amazed and proud by what they come up with, above and beyond what I have taught or actually "demanded" in the task."* - A3, *"Working on their own ideas for a project (esp CS0/1/2) ..."* - A8, *"In the upper year courses, giving students the opportunity to select a project results in students selecting ideas that are meaningful to them. I've had students being wildly creative with compiler projects, for example."* - A13, and *"Open ended assignment questions tend to engage the brightest. Some applications (eg robotics) also engages some."* - A15. This was noted to be particularly successful for the more able students.

Like the students, academics also thought that linking content and skills to real world problems and contexts was engaging for students. Examples of this include: *"Real experience (such as real projects), group activities with links to real world"* - A14, and *"...providing real-world examples from my industry experience"* - A8.

Clearly, students and academics share a number of common views on what is engaging, including practical activities and relating content to the real world and industry. Students did tend to focus on relationships with teaching staff, quality of instruction and special events. In contrast academics tended to focus on specific topics, capstone units and student autonomy.

4.5.4 CS Student vs Academic Perspectives on Disengaging Experiences. In contrast to the previous questions in the survey, this question sought to identify any aspects of the course or their classroom experience that the CS students and academics thought lead to disengagement with their studies. A number of issues identified in the student responses related to Teaching Quality in general, the Nature of Content, Ability Levels and several Other issues that could not be grouped into a single theme.

The main issues with teaching quality was a perceived lack of effort by teaching staff and this issue generated a lot of comment. This theme manifested in a number of ways, including how lecturers presented content with little effort in lectures. How the lecturer presented the content in the lecture and what was presented was directly linked by a number of students to the effort that lecturers put in. For example: *"When the subjects are 'boring' because they are taught with little effort."* - S34, *"Lectures where the teacher just drones on and on and doesn't attempt to make it fun"* - S94, *"Lecturers that just read off lecture slides, of which the information has just been copied off the text books (for example FIT1[XXX], which was a good subject, but not taught well)."* - S72, and *"Few units where the lecturer reads off slides, taken from the textbook, for 2 hours with no break, going through 60-100 slides v quickly so what is read is barely understood. Little point in attending these. Also tutorials where it is just a list of 20-30 questions."* - S62. The students indicated that they saw little value to the lecturing experience if the lecturer was not adding value to the experience.

The second major criticism of teaching quality related to the competence and focus of the lecturing staff. If the lecturing staff

did not display strong skills this tended to disengage the students, for example: *"When teaching staff are not knowledgeable, not able to connect with the student, read off the slides, provide contradictory statements regarding questions."* - S30. A similar issue emerged when lecturers did not stick to the unit content and lost focus of the needs of students, for example: *"Lecturers who don't teach. Who focus too much on their philosophies, personal experiences and politics rather than un[i]t content. Those who get distracted, or allow themselves to be distracted. Lecturers who are overconfident in their abilities to teach. Unhelpful tutors. Vague tutors, lecturers. Staff that ramble.* - S133.

The third area of criticism related to teaching quality, involved tutor willingness to help and a lack of teaching expertise. Students were looking for tutors that were willing to engage and help them, criticising a lack of effort, for example: *"Most tutorials and consultations. Tutors seem tired, lazy and unwilling to help."* - S37, *"workshops with shitty TA's that appear to not wanting to help"* - S141, *"Listening to the tutor continuously talk and not making an effort in facilitating class discussions. No rapport between staff and student was formed, and they expect students to engage."* -S140, and *"Lack of enthusiasm from tutors and classmates."* - S38. These responses emphasise the critical role that tutors play in engaging students and argues for an increased focus on tutor selection and training.

Another main area of concern raised in student responses related to the nature of the content delivered and the assessment for units. In terms of the content there was a general criticism of too much theoretical content and repeated delivery of the same content, for example: *"Lots of reading. Long theoretical lectures or labs"* - S46, *"Lectures and prereading and tute being the exact same thing but repeated 3 times"* - S15, *"When learning is too repetitive. Same questions asked during lectures and tutorials."* - S51, and *"When there is a disconnect between the tutor/lecturer and students which can happen with long lectures which often seem u[n]neccessary as it becomes the lecturer just reading from the long winded lecture slides"* - S59. A related view was when there was no clear link between theoretical context and practical or industry application of that content, for example: *"I have been disengaged when there is no clear connection between theory being learned and practical applications in modern society."* - S29, *"Just too much theorectical knowledg[e] eis being taught which we will never use it in the industry."* - S49, *"Studying units that are heavy in content and lack practical assignments tend to be very disengaging."* - S85, and *"Ones that just require to talk about the answers instead of doing something more"* - S111. Clearly students wanted the theory presented to have demonstrated relevance to future practice and the opportunity for hands on experiences.

Students also had a few comments about assessment, particularly if the assessment criteria were unclear, if the nature of the task was unclear, or if there were high workloads. For example: *"doing any assessment without clear marking criteria - concepts introduced without examples or practice questions"* - S6, *"When I has to answer stupidly simple quiz questions, or when questions in assignments are badly worded. If the lecturer just reads off their slides. If the lecturer shows no interest or enthusiasm in the topic they are presenting."* - S7, and *"When I have too high a workload to feel enjoyment in what I'm learning"* - S77.

Several comments related to pace of instruction and mixed ability levels within classes. Students felt it was demotivating if progress was too slow or they already knew the content taught, for example: *"I feel slightly disengaged in my intro to java classes because all CS majors are lumped together from those who have no programming experience to people who already know other language (like me). I often skip lectures because I get bored and distracted listening to questions I do not have and moving at a pace I deem too slow, even for beginners."* - S83, *"During tutorials, tutors sometimes spend too many times on simple questions. It feels like a waste of time to wait for them to proceed to the next one."* - S104, and *"during group works when my team mates cannot keep up with me"* - S87.

Three other responses were of interest in terms of issues that students reported had disengaged them. In the first response, gender issues related to male staff were highlighted: *"Slight gender discrimination from male staff members and sometimes the teaching staff have poor English skills which makes it hard to understand"* - S121. There have been extensive efforts to increase female participation in CS so it is disappointing that a female student still reports some level of 'gender discrimination'. Another student suggested that they did not feel confident in contributing in class: *"Hesitate to contribute due to worrying of the wrong answers"* - S74. This response indicates that some students do not feel the classroom environment is a safe place to make a contribution and to express an opinion. The final response of interest focused on how a student responded to struggling to complete work either individually or in a project group: *"I'm feeling demotivated when I feel like I can't deliver the things required in an assessment or project because of my abilities or the students I'm working with."* - S46. This feeling is perhaps natural, but it is important to support these students so that students have a chance to improve their performance. There is some evidence from the responses in previous sections that CS academics may not be as supportive as they could be of students who are struggling.

The above discussion highlights student perspectives on what disengaged them, we also asked CS academics what they thought disengaged their students. Like the students, academics suggested that lectures were problematic however academics tended to focus on the fundamental nature of the lecture format itself and while the students tended to focus on the way that lecturers approached and delivered lectures. Lecturers pointed to the fundamental nature of lectures as being disengaging: *"In general, lectures are the worst, in that a high percentage of students appear to turn off immediately, and do not want to engage, no matter how the lecture is organised and run. But even here I should note that there is usually a small but significant group who seem to enjoy lectures and dislike more interactive forms of teaching where they are more conspicuous."* - A23, *"Lectures, hard to get them to attend"* - A14, *"boring lectures, tough topics, hard programming assignments."* - A15, and *"Both Didactic lectures and, flipped lectures which are not directly assessed"* - A30. The effect of large class sizes on engagement was noted by several academics: *"Large-scale lectures introducing Java are extremely boring to those who (at least feel they) "know Java"* - A3, and *"lecture classes over 400-500 with little interaction/discussion and no hands-on projects"* - A34.

Academics also noted the importance of the relevance of content to engagement issues. Relevance of content was related to practical applications and the real world use of concepts and skills: *"I find disengagement to be less related to activities than content. I try to make the content relatable and relevant, but it doesn't always work.*

In general, I suppose that more rigid structures – weekly readings and quizzes, for example – would result in lower engagement." - A13, *"Students are often disengaged if they feel lost or don't directly see how what they are reading or listening to will help them."* - A38, and *"simply lecturing, not answering the "Why" - (related to JITL), ..."* - A8.

Like the students, there were several other additional comments of interest that were identified that could not be neatly categorised. Academics also identified that students who did not feel confident to speak up and contribute in class tended to become disengaged: *"Those who ask for help usually stay engaged, but some are afraid of asking for help and are more likely to become disengaged."* - A6. On the issue of student presentations, one academic noted that sometimes student presentations are not engaging for other students: *"Death by power-point and surprise - presentations by other students. The language is limited, the voices soft and who knows why else"* - A7. Again like students, academics noted that excessive workloads tended to disengage students: *"Hard programming assignments. Limited and short deadlines. Not involving them in class discussions"* - A17. Unlike the students, one academic suggested that gaining important pre-requisite knowledge was inherently disengaging: *"Boring "nuts and bolts" parts of some classes. No surprises that they're not exciting, but they're necessary."* - A36. Finally, one academic suggested that some academics and tutors were not competent to teach in an engaging manner: *"Teaching staff that are not equipped to be in front of students, often when we use ex-students as tutors. More importantly, the students' poor command of English means they cannot follow conversations let alone abstract concepts."* - A25. In addition they suggested that some students, due to language issues, were not equipped to fully engage and follow the learning discussion.

4.5.5 CS Student Perspectives on Academic and Institutional Initiatives to Improve Engagement. We asked the students if there were any initiatives that they were aware of or would like to see that would increase their engagement with their studies. Many of the responses highlighted issues that have already been covered in the previous sections, for example more engaged teaching staff, content relevance, difficulty level and more approachable lecturers, so we will focus on a few important responses that encapsulate significant themes.

The first issue to highlight, related with the volume of work in units crowding out learning opportunities. Of interest in this regard are two responses. The first suggests that too much work restricts the students ability to get help when they are struggling and to engage with the content deeply:

> I think there is a good amount of initiatives already, but not enough time to get involved because of the large number of topics (some not being essential and could be placed into a unit of its own to be more worthwhile) covered over a short period of time. But, I would suggest having assignment/homework/study clubs for every unit, run many times during the week, in order to provide the opportunity to get help, work with new people and improve the students' learning (like PASS, except just a place to study and get help from tutors). - S96.

The second response indicates that the volume of content and assessment reduces the time available for more meaningful and significant extra-curricular activities that they find engaging: *"Reduce the amount of assignment and make involvement to hackathons and other computing competitions part of the studying experience."* - S94. The CS discipline is evolving rapidly so it is always tempting to add the latest content into courses however this may be counter productive. In a sense in a rapidly changing discipline we need to teach students to be able to independently master new knowledge as life-long learners. This is especially true in a context where there are readily available online resources that can assist students to gain new skills.

The second issues of interest to emerge from the student responses was the idea that available initiatives for research and industry engagement needed to be better advertised to undergraduate students:

> I think we already have many initiatives with good intentions, however I don't think they are publicized as well as they could be. Many students don't know about certain opportunities and with such a tight partnership to industry undergrads often fallback on research as second choice for summer activities. During the school year there is a single day for students to learn about research happenings, but after that its like they missed the bus on research opportunities as very few more are advertised. - S75.

In the past undergraduate opportunities for research and industry engagement have tended to be restricted to high achieving students. It may be appropriate to extend these opportunities to a wider range of students and to build them into the normal CS study program. In addition, industry and research initiatives have tended to be delayed to capstone units towards the end of a program of study. There may be some benefits to introducing these elements earlier in the course of study to promote student engagement.

The final issue to emerge from the student responses related to the issue of the ability of teaching staff to engage students and the effort they put into teaching. Monash University promotes itself as a research intensive university and hiring policies emphasise research track record. There is a tension between the research and teaching functions of a university, as shown in the following response: *"Don't employ staff based on their academic knowledge, but also their ability to teach and engage with students."* - S139. Students value staff who display a high level of commitment to their education and are willing to engage with them on a personal level: *"show more enthusiasm when teaching, show that they truly enjoy teaching me, and relate the teaching materials to interesting things in the world, and go the extra mile to students who can keep up by showing some advanced things in addition to the "lecture notes" or "tutorial notes"* - S86. While a number of research intensive academics are excellent teachers, high and increasing demands for research performance may limit the time available for teaching and the important of teaching practice to an academics' career progression. Research expertise does not always equate to the ability to engage others in your area of research expertise.

Academic responses to the question of initiatives to engage students contrasted strongly in some cases. For example the following

response: *"There are many usual run of the mill stuff that the University does to show that it really cares for the students and it works for the good publicity! I believe much of these only make things worse by "feeding" the academically poor students and telling them the University will "feed" them as long as needed, instead of telling them to wake up and to behave like grown up college students."* - A17. This response indicates some cynicism regarding student engagement initiatives, places the responsibility for engagement firmly on the student side, and shows a lack of willingness to engage with students who are struggling. A number of academics indicated that they were not aware of any initiatives, *"Unfortunately NO"* - A16 and *"Not that I am aware of."* - A19, or the activity was of a general nature: *"nothing formal. our faculty frequently share and discuss techniques related to this issue"* - A34. Another academic suggested that workload issues constrained their involvement in engagement initiatives: *"Yes, but couldn't name them. They keep me too busy so I can rarely attend."* - A3. Common responses regarding engagement initiatives cited by academics included: *"peer mentoring, peer assisted study, blended learning, flipped classrooms, generous consultation sessions and times"* - A21, and *"We have been redesigning our entry level courses to incorporate more active learning and use techniques that are shown to engage a broader demographic in computing. Our foundations course was redesigned this past year and our intro programming course will be the focus of redesign over this summer/"* - A9.

In summary, there even though students appreciated and were aware of some initiatives in terms of student engagement they highlighted issues with workload, extending engagement opportunities to all, and engagement with teaching staff. The academic perspective contrasted with the students, with many academics being unaware of initiatives or to some extent being cynical regarding student engagement initiatives.

4.6 CS Student vs academic perspectives on engagement from the interview data.

Interview data was collected from 19 students, all undergraduate students were from Monash University, 7 female and 12 male. The student interview recordings totalled over 9 hours, with an average time of approximately 28 and a half minutes, with one interview recording cut short due to technical issues. In addition, there were 9 academic interviews, all male with 4 from the US and 5 from Australia. The academic interviews recordings totalled over 4 hours, also with an average time of approximately 28 and a half minutes.

Due to the rich data collected from both the on line surveys and interviews, we decided to focus on highlighting any new and interesting perspectives emerging from the interviews that were not covered in the discussion of the survey data. We also highlighted any conflicting views between student and academics in response to the interview questions. The aim was to seek an in depth understanding of a few significant issues, rather than to represent the board view of each group.

Disengaged students

From the student interviews it was clear that the students themselves were aware of a large group of disengaged students and this was reinforced by this student response: *"I also meet a lot of people who just got lost along the way. In the computing subject ... They kind of have this 'I've given up' vibe around them."* - IntSt15. The students noticed this lack of engagement in their peers and the academic noticed it also. Students acknowledge that a lack of engagement by their peers also tended to decrease their own motivation and engagement. So the question becomes why is this lack of engagement occurring and what can be done about it?

CS course content

There was some conflict between students and academics on what should be taught in CS courses and how this might relate to engagement in their studies and the careers the students were training for. Some students suggested that due to the dynamic nature of the discipline, learning how to learn new material was more important than learning specific pieces on content that may be soon out of date: *"What I find really frustrating sometimes, is that University, I reckon, should be teaching you how you should learn not the actual theoretical components of it because, especially in the field of computing or IT, it drastically changes at different paces. Like its teaching you stuff from like two years ago may be out of date already."* - IntSt11. Having content that was up to date and industry relevant was also seen as being important by the students: *"A company came to talk about recruitment and stuff, and when, I have heard things like, anything that I was studying right now, they want something else that is in that field, but it is just not related to the software that I was using at school. And that was a little bit frustrating, because even though I know the software now I have got to relearn a new software ..."* - IntSt14. Clearly, students want industry relevant and up to date content. With many academics having extensive teaching careers and so having long periods out of the IT work force, strategies need to be put in place to address the relevance and recency issue.

Academics were also aware of this issue: *"There was just an article that one of my colleagues sent out to the faculty where there was an executive in the programming industry who was complaining that the things that we were teaching where not the things that students needed on the job. ... I know that some students have shared those complaints. Why am I learning this when I could be learning that, which would make me more money immediately."* - IntAc9. However, some academics suggested that they needed to teach a fundamental understanding of the computing discipline, rather than pandering to industry requirements and student career aspirations: *"I think also that there is a tension between those who come into computing because they want to go into the gaming industry and work for Pixar or some company like that, whereas we train in the basics, not in how to go work for Pixar. And so there is a tension there that may put students off. Our curriculum is also front loaded with basics and such, which may have an effect of turning students off or dimming their enthusiasm."* - IntAc2. In fact, some academics suggested that the problem was that students had a poor understanding of the nature of CS and when they found out what it was really about they were some what disillusioned: *"When I had Engineering students, they knew what Engineering was going to be about, they had a very good understanding and a very clear perception of what was going to be involved. IT students don't! And often when they find out, they are a bit horrified."* - IntAc8. In general, academics could be more responsive to the career aspirations of students and also ensure that students have a clear understanding of the nature of the course before they enrol or at least early in their course. Alternately, a more realistic marketing of CS degrees, or indeed a redesign of the actual courses, would be beneficial.

Motivations to study CS

There was a variety of comments by both students and academics regarding the motivations of students to study CS and how this in turn influenced their level of engagement. Students recognised that some of their peers were studying CS due to a genuine interest in the discipline, however they acknowledged that for many of their fellow students, CS study was just a means to a high paying career or immigration: *"I think it is because a lot of people take IT knowing that, that is what is going to get me a job. Not because they are interested in IT. Actually, a lot of people that I have spoken with, they just want to find the easiest units to get the easiest grades, and to leave university with a good grade and get a good job. Whereas I know a few people like me, we may go for the harder units but we find them so much more interesting and that is why we go for them because we are more curious I guess."* - IntSt12. The consequence of this type of extrinsic motivation was an expedient approach to studies, taking the easiest path and engaging at a minimum level required to pass. In addition, seeing CS studies as a means to an end, suggests that they are not familiar with the discipline before they commence studies and have little background knowledge, and therefore have trouble adapting to CS studies at the start: *"In Australia only, I have noticed that there is quite a number who are studying computing in Australia for the PR, so they are not actually interested in programming. They are here because they see some long-term benefits and then, quite a lot of them have never seen code in their lives until they came here. Which is quite a desperate thing for me because that means they are going to struggle. ... Its not that they don't want to be there. Its more of that they are there for other reasons."* - IntSt15. It should be noted that 'PR' is part of the process of applying for permanent residency in Australia for international students. Poor preparation for studies may lead to students struggling early in the course and falling behind other students. This may rapidly demotivate students, and many students have suggested that when they fall behind in CS studies they find it difficult to catch up. It would benefit these students to do more to prepare and induct them into their CS studies. It would also be of benefit to them to increase support and monitoring for them early in the course.

An academic suggests this focus on high paying careers, rather than an intrinsic interest and genuine affinity for the CS discipline, can have serious consequences for the students' self-esteem. Students come into the course with an expectation of a high paying career, but have little understanding of the skills require to achieve this, and consequently struggle: *"With Computer Science students, maybe they have a little bit of a chip on their shoulder coming in, or an expectation that they will be able to understand and be able to succeed. And when they don't, there could be some psychological impacts to that ... [I am] talking to a lot of students about how that impacts their lives and how their parents push them to go in a direction that their interests are not ..."* - IntAc4. In fact, high paying jobs in the industry are very competitive and require a specific skill set that is difficult to master. When students have difficulties it can impact their self-esteem leading to decreased motivation, but also many international students in particular have significant pressure from their families to succeed in their studies.

Another student, who had studied with business students in the past, noted that CS students often did not have the competitive nature seen in other disciplines like business, and that general IT student were less competitive than Computer Science students: *"The IT students and not Computing Science; they lack the drive to score better on their computing studies. ... its more likely the Computing Science students would do better, even when they are struggling with that unit ... I realise it is because the IT students are always just like 'Oh, its OK I passed', they are mostly targeting for Cs and Passes. They lack the competitiveness I suppose."* - IntSt14. The sense was that a pass was good enough and that they did not have to push themselves to the limit. A focus on completing sets of clearly defined exercises in their studies would tend to promote this mind set. Competing approaches to change this mindset would be to set open-ended tasks, extension activities, to focus on problem-based learning, to foster student-directed learning, and to integrate research=based experiences. This may foster a more engaged and self-directed group of learners.

Sources of CS content

A big factor regarding engagement evident in the interview responses revolved around the source of the content studied. There was some suggestion by students that much of the content delivered could be gained from other sources. Indeed, why should they pay for materials that they could download from the internet. There was the suggestion that some lecturers took the easy option and adapted existing materials rather than put in the time to develop their own relevant materials: *"You have got some subjects where it is just like a copy-paste off the internet, sort of thing, so all the information is from someone else like another academic and they are just using it and if you just search up like a specific question they give you, you can just find it on the internet. You get me, its like from a textbook and someone has already answered it. ... Cos you don't do the work you just go to class to submit the questions but you will not actively try to find the answer. You will just get it and copy it in and reword it."* - IntSt13. This approach by academics tended to disengage the students.

Another student suggested that the only real benefit that the university delivered in CS was the conferral of the degree: *"A University is really the only place you can go if you want to get ... the skills necessary to be a say be a Lawyer or a Doctor. But if I wanted to be a web developer I could go to Google or Khan Academy, or some online resource and I could get a lot of the skills there. ... I don't imagine that there are many second-year law students who have skipped the majority of their classes, but I think there are a higher proportion of Computer Science students that have done so or have managed to be able to do so. I think the problem is that they can get the education elsewhere, and they are here for the degree that they cannot get elsewhere. Not everyone, some people though."* - IntSt10. A worrying implication of this response was that students were not only skipping classes, but were still progressing in their studies. If they can pass the course with little or no attendance, what is the course contributing to their learning? In fact CS academics in a rapidly changing higher education landscape need to carefully consider what unique contribution they are making to the students learning and to communicate this clearly to the students.

Academics were also aware that often students felt that they could learn most of the skills required from external sources and that this resulted in low attendance and engagement: *"It does not matter how engaging the lecturer is a certain percentage will not attend. ... It is just a general feeling that they could learn the material*

elsewhere. ... Just the idea that I could get this information elsewhere and this is not necessarily the most effective way for it being taught to me." - IntSt7. While academics recognised that learning CS from online sources was not a good idea and something that they would not recommend, they also acknowledged that the traditional lecture was not a particularly good method either. An emphasis on the wider benefits of the university experience outside the classroom may help justify the role of attending the university as part of a quality learning experience.

Other issues

There were several other interesting responses that emerged from the interviews. In terms of gender issues, the following response from a female students was interesting: *"I went into a tutorial and to be honest I was not listened to for the first week, I was sort of blocked out. And then I did a good proof ... and then they were like 'She actually knows stuff' and then I was welcomed into the family. I guess it kind of sucks that I had to prove myself before I could like do stuff."* - IntSt4. The student pointed out that academic staff have been fine but that some male students in some classes, particularly in technical areas, did not view female students as being as capable in terms skills like mathematics as male students. It was disappointing, being one of the one or two female student in the class, to have to prove their ability before they were listened to and accepted by other students.

Another female student also emphasised the importance of a welcoming learning environment: *"Some units [are] really interesting and I really enjoy taking them. ... I feel like when I try to ask questions, the lecturer is really welcoming, and he did not try to put me down.* - IntSt17. A contrasting view of academic engagement was provided by another student:*"he seemed like he sort of hated everything, so that's an extreme, actually disdain towards the students"* - IntSt5. In general, many students indicated that academics who were approachable, who engaged with students on a personal level, and who appeared to care about the students learning, were highly engaging. If academic displayed a lack of empathy and respect for students, this was highly disengaging.

In fact, students indicated that they were most engaged when academics went the 'extra mile' for students and communicated their passion for the subject to the students: *"He has gone and put on an optional tutorial with relevant but not assessable material, and he has really encouraged students to come along and get involved in discussions in that sort of a setting. And that to me really makes me feel like I am part of a community within my faculty and within that class, and that sort of thing to me is a fantastic example of when I have felt engaged as a student."* - IntSt10. This effect of the enthusiasm of the academic increasing the engagement of the students seems to occur regardless of the actual subject matter being taught.

In summary, many of the responses from the students and the academics reinforced the points covered during the analysis of the survey data. Students had a mixed view of who was responsible for engagement while academics mainly suggested that it was primarily a student responsibility. Interesting issues did arise that were not identified in the survey data relating to the nature of the content covered and in particular the industry relevance of the material. Another surprising issue related to motivations for taking the course and how this impacted engagement. There was a consensus between students and academics that many students did not really understand the nature of CS and were disillusioned when they found out. The finial issue of note related to the idea of the unique contribution from studying CS at university, with both students and staff suggesting that many of the skills needed for CS could be acquired from other sources. This point was particularly concerning as it suggested that the CS study experience did not add value for many students.

5 CONCLUSIONS AND FURTHER RESEARCH

5.1 Conclusions

The evidence presented above allows us to answer the research questions that we set for the study.

With regard to the first research quest: *RQ1. What has changed since 2016 in terms of CS student engagement?*

It is clear that the performance of CS on the NSSE and SES survey instruments decreased markedly between 2016 and 2017. The results for UKES were slightly more mixed, but are poor overall. The trend analysis for the NSSE and SES data for 2013 to 2017 paints a dire picture where CS is declining at a faster rate than other disciples in terms of student engagement. We were able to identify a number of problematic areas across instruments, and responses to address student engagement in these areas could form the basis of a systematic attempt to address these issues. Significant difference between CS student and CS academic ratings of student engagement in the North American context emerged when we compared NSSE and FSSE data, with students rating their experiences significantly lower in a number of benchmark areas. Finally, an analysis of recent CS educational research literature suggested that research into this issue had not increased in the past 12 months. Recent research addressing student engagement in CS has tended to be more 'atheoretical' and practice based. In summary the situation in regard student engagement in CS has deteriorated further since 2017.

With regard to answering the second research question: *RQ2. What is the alignment between CS student and CS academic perspectives on student engagement?*

Many areas of common understanding between CS students and CS academics emerged from the survey and interview data. There were however several areas of divergent views with students focusing more on the affective dimension of engagement and academics more on the behavioural dimension. Students had a more balanced perspective on who was responsible for engagement, with an equal number of responses suggesting either students or academics were responsible. An area of concern was that academic responses suggested that engagement was mainly the responsibility of students. Major differences of perspective emerged in the area of what content should be taught in CS units, with students suggesting that practical and industry relevant content would increase engagement. Students also highlighted the impact of engaged, enthusiastic and approachable teaching staff on their engagement. In contrast, academics highlighted the importance of enthusiastic and active students, who engaged with the content deeply. Students were particularly critical of academics who put in little effort, were not willing to help, and who were dismissive of struggling students.

The interview data flagged several unanticipated areas of concern regarding student engagement. In particular, the ability of

students to gain content and skills for CS from other sources was a concern, meaning that many students thought that they did not have to attend or engage with their studies. The other main issue to emerge from the interview data related to students being motivated by careers in IT rather than a genuine interest and aptitude for the subject. Indeed, it was suggested that many students had little understanding of what CS actually involved and so struggled early in their studies, since they lacked adequate preparation and realistic expectations for their studies.

Clearly, these differences in perspectives between CS students and CS academics warrant further investigation.

5.2 Limitations of study

There are several limitations for the study. The most important limitation of the study is that data collected from the students, both for survey and interviews, was restricted to Monash University in Australia due to time constraints and teaching periods in various countries. While Monash University has the largest CS student group in Australia, with many international students, other student groups may provide different perspectives on student engagement. We intend to collect further data from both the US and the UK when student participants are available but this could not be completed in time for this report. In order to fully represent the CS student perspective on engagement, it would be necessary to collect further student data from a wider range of students and geographic regions, such as the Middle East and Asia.

The second limitation of the study was that we were only able to collect data from a small group of CS academics. Due to time constraints we were not able to integrate the interview data from the 2017 data collection. All academics interviewed for this report were from the US and Australia and all were male. A number of the interviewees were very experienced, with 25 years or more of teaching experience, and so may have different views to younger and less experienced academics. Including a greater range of CS academics in the data collection would strengthen the results.

An additional limitation was that due to the richness and volume of the data collected for this study we were unable to report on all aspects of the data and explore all the issues that emerged. For example, we did not report CS student and academic responses to questions extracted from the national survey instruments.

5.3 Further work

There are several issues that warrant further research related to this project. The rapid decrease in the performance of CS on student engagement measures in several national survey instruments should be investigated. It is important to understand why CS student engagement is decreasing. A wider range of student participants is needed to represent the CS student perspective on student engagement. We aim to collect further data from the US and the UK. Surveys and interviews of students in a wide range of countries and institutions would strengthen the analysis, as would a focus on female perspectives and minority groups. In a similar way we intend to collect data from a wider range of academics. We also intend to include the 2017 academic interview data in further analysis.

Several themes have emerged from the analysis that warrant further investigation. Themes related to the nature of the content, practical and industry relevance, and engagement with staff seem to be important issues in term of engagement for CS students. The divergence of preservatives between student and academics on what dimensions of engagement were important, affective vs behavioural, and who was responsible for engagement, need further investigation. An important issues emerging from the interview data related to student motivations for studying CS and their understanding of the nature of the CS discipline. This issue was seen to have major impacts on student engagement and could be further investigated.

Finally, we identified a number of issues regarding student engagement. It would be interesting to plan and evaluate interventions aimed at addressing these issues. What is clear, is that student engagement is a major issue for CS that needs to be addressed urgently. Only a major, systematic and sustained response by the entire CS education and research community will turn this issue around.

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A APPENDICES

A.1 Student Survey Questions

*Required

(1) What country are you studying in? *
(2) What degree program are you studying? *
(3) What year are you in? *
- First Year
- Second Year
- Third Year
- Fourth Year
- Post Graduate

(4) What is your gender? *
- Female
- Male
- Other
- Prefer not to say

(5) Are you studying in your own country? *
- Domestic student
- International student

(6) Are you studying in your own country? *
- Domestic student
- International student

(7) What does the term 'student engagement' mean to you? *
(8) How would you describe your engagement with your current computing studies overall? *
(9) How would you rate your engagement with your current computing studies overall? *
- Poor 1 2 3 4 5 6 7 Excellent

(10) Can you explain the reasons for your rating of your engagement with your computing studies? *
(11) Please describe any activities where you have experienced being highly engaged in your computing studies? *
(12) Please describe any activities where you have experienced being disengaged in your computing studies? *
(13) What do your teachers do that tends to encourage you to engage with your computing studies? *
(14) What do your teachers do that tends to disengage you from your computing studies? *
(15) Are there any initiatives, by your university or your teachers, that you would like to see that would improve your engagement with your computing studies? *
(16) Are there any other issues you would like to raise regarding with how you engage with your computing studies?
(17) If you are willing to be interviewed about your responses, please enter a contact email address and the researchers will be in contact (note, you are under no obligation to do so).

A.2 Academic Survey Questions

*Required

(1) What country are you teaching in? *
(2) How many years have you been teaching? *
(3) What is your gender? *
- Female
- Male
- Other
- Prefer not to say

(4) What do you teach? *
(5) What does the term 'student engagement' mean to you?' *
(6) How would you describe your CS student's engagement with the computing courses you teach? *
(7) How would you rate the student engagement experience in the computing courses you teach? *
- Poor 1 2 3 4 5 6 7 Excellent

(8) Can you explain the reasons for your rating of your student's engagement with the computing courses you teach? *
(9) Please describe any activities where you have experienced students being highly engaged with their computing studies? *

(10) Please describe any activities where you have experienced students being disengaged in their computing studies? *
(11) What do you do to encourage your students to engage with your computing courses? *
(12) Are there any aspects of your courses that tend to disengage your computing students? *
(13) Are you aware of any initiatives in your department/faculty/university to promote student engagement? *
(14) Do you believe computing students in general have any specific characteristics compared to other students? *
(15) Do you believe there are any computing specific issues related to student engagement? *
(16) Any other issues you would like to raise regarding with how your students engage with their computing studies?
(17) If you are willing to be interviewed about your responses, please enter a contact email address and the researchers will be in contact (note, you are under no obligation to do so).

A.3 Student Interview Questions

General Questions To Ask All Participants

(1) What country do you study in?
(2) What degree program do you study
(3) How many years have you been studying?
(4) What does 'student engagement' mean to you?
(5) Please describe any activities where you have experienced being highly engaged in your computing studies?
(6) Please describe any activities where you have experienced being disengaged in your computing studies?
(7) Are you aware of any initiatives in your department/faculty/university to promote student engagement?
(8) Do you believe computing students in general have any specific characteristics compared to other students?
(9) Do you believe there are any computing studies specific issues related to student engagement?

Go on to response to 9 questions extracted from Student Engagement Surveys.

Obtaining Insight Into International Experience Surveys: Please provide comment on a series of questions extracted from international surveys of student experience.

As a set comment on any of the following aspects:

- How would you interpret these question?
- How relevant are these questions to your computing studies?
- How much of this do you do in your computing studies?

Questions Extracted From International Surveys of Student Experience:

(1) During the current school year, about how often have you done the following?
  - Combined ideas from different courses when completing assignments
  - Connected your learning to societal problems or issues
  - Included diverse perspectives (political, religious, racial/ethnic, gender, etc) in course discussions or assignments
  - Examined the strengths and weaknesses of your own views on a topic or issue
  - Tried to better understand someone else's views by imagining how an issue looks from his or her perspective
  - Learned something that changed the way you understand an issue or concept
  - Connected ideas from your courses to your prior experiences and knowledge
(2) During the current school year, about how often have you done the following?
  - Talked about career plans with a faculty member
  - Discussed your academic performance with a faculty member
(3) During the current school year, about how many papers, reports, or other writing tasks of the following lengths have you been assigned? (Include those not yet completed.)
  - Up to 5 pages
  - Between 6 and 10
  - 11 pages
(4) Which of the following have you done or do you plan to do before you graduate?
  - teaching, or clinical placement
  - Participate in a learning community or some other formal program where groups of students take two or more classes together
  - Participate in a study abroad program
  - Work with a faculty member on a research project
  - Complete a culminating senior experience (capstone course, senior project or thesis, comprehensive exam, portfolio, etc.)
(5) About how many of your courses at this institution have included a community-based project (service-learning)?
(6) How much has your experience at this institution contributed to your knowledge, skills, and personal development in the following areas?
  - Writing clearly and effectively
  - Speaking clearly and effectively
  - Thinking critically and analytically
  - Analyzing numerical and statistical information
  - Acquiring job- or work-related knowledge and skills
  - Working effectively with others
  - Developing or clarifying a personal code of values and ethics
  - Understanding people of other backgrounds (economic, racial/ethnic, political, religious, nationality, etc.)
  - Solving complex real-world problems
  - Being an informed and active citizen
(7) During 2015, to what extent have the lecturers, tutors and demonstrators in your <course>:
  - engaged you actively in learning?
  - demonstrated concern for student learning?
  - provided clear explanations on coursework and assessment?
  - stimulated you intellectually? commented on your work in ways that help you learn?
  - seemed helpful and approachable?
  - set assessment tasks that challenge you to learn?
(8) During the current school year, about how often have you done the following?
  - Ask questions or contribute to course discussion in other ways

- Prepared two or more drafts of a paper or assignment before turning it in
- Come to class without completing readings or assignments
- Attended an art exhibit, play, other arts performance (dance, music, etc.)
- Worked with other students on course projects or assignments
- Given a course presentation

(9) During the current school year, how much has your coursework emphasized the following?
- Memorizing course material
- Applying facts, theories, or methods to practical problems or new situations
- Analyzing an idea, experience, or line of reasoning in depth by examining its parts
- Evaluating a point of view, decision, or information source
- Forming a new idea or understanding from various pieces of information

A.4 Academic Interview Questions

General Questions To Ask All Participants

(1) What country do you teach in?
(2) What units/topics/subjects do you teach?
(3) How many years have you been teaching?
(4) What does student engagement mean to you?
(5) What have you done in your teaching practice to promote student engagement?
(6) Are you aware of any initiatives in your department/faculty/university to promote student engagement?
(7) Are you familiar with the Student Experience/Engagement survey used in your country?
(8) Do you believe computing students in general have any specific characteristics compared to other students?
(9) Do you believe there are any computing studies specific issues related to student engagement?

Go on to response to 9 questions extracted from Student Engagement Surveys.

Obtaining Insight Into International Experience Surveys: Please provide comment on a series of questions extracted from international surveys of student experience.

As a set comment on any of the following aspects:

- How would you interpret these question?
- How do you think CS students would interpret/answer these questions?
- How relevant are these questions to the CS domain?
- How much of this do you include in your own teaching? Provide an example if possible.
- Do you think that CS students do less of this than other students - and is that legitimate?
- Is this something CS faculty should be doing (or why not)?https://v2.overleaf.com/15137946gxdppqtgsywjhttps://v2.overleaf.com/15137946gxdppqtgsyw
- Can you suggest more relevant areas for CS to assess student engagement?

Knowing that these questions are used to measure and report on the engagement of our students, would this prompt you to reconsider your teaching methods or content or context? Questions Extracted From International Surveys of Student Experience:

(1) During the current school year, about how often have you done the following?
- Combined ideas from different courses when completing assignments
- Connected your learning to societal problems or issues
- Included diverse perspectives (political, religious, racial/ethnic, gender, etc) in course discussions or assignments
- Examined the strengths and weaknesses of your own views on a topic or issue
- Tried to better understand someone else's views by imagining how an issue looks from his or her perspective
- Learned something that changed the way you understand an issue or concept
- Connected ideas from your courses to your prior experiences and knowledge

(2) During the current school year, about how often have you done the following?
- Talked about career plans with a faculty member
- Discussed your academic performance with a faculty member

(3) During the current school year, about how many papers, reports, or other writing tasks of the following lengths have you been assigned? (Include those not yet completed.)
- Up to 5 pages
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(4) Which of the following have you done or do you plan to do before you graduate?
- teaching, or clinical placement
- Participate in a learning community or some other formal program where groups of students take two or more classes together
- Participate in a study abroad program
- Work with a faculty member on a research project
- Complete a culminating senior experience (capstone course, senior project or thesis, comprehensive exam, portfolio, etc.)

(5) About how many of your courses at this institution have included a community-based project (service-learning)?

(6) How much has your experience at this institution contributed to your knowledge, skills, and personal development in the following areas?
- Writing clearly and effectively
- Speaking clearly and effectively
- Thinking critically and analytically
- Analyzing numerical and statistical information
- Acquiring job- or work-related knowledge and skills
- Working effectively with others
- Developing or clarifying a personal code of values and ethics
- Understanding people of other backgrounds (economic, racial/ethnic, political, religious, nationality, etc.)
- Solving complex real-world problems
- Being an informed and active citizen

(7) During 2015, to what extent have the lecturers, tutors and demonstrators in your <course>:
- engaged you actively in learning?

- demonstrated concern for student learning?
- provided clear explanations on coursework and assessment?
- stimulated you intellectually? commented on your work in ways that help you learn?
- seemed helpful and approachable?
- set assessment tasks that challenge you to learn?

(8) During the current school year, about how often have you done the following?
- Ask questions or contribute to course discussion in other ways
- Prepared two or more drafts of a paper or assignment before turning it in
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- Given a course presentation

(9) During the current school year, how much has your coursework emphasized the following?
- Memorizing course material
- Applying facts, theories, or methods to practical problems or new situations
- Analyzing an idea, experience, or line of reasoning in depth by examining its parts
- Evaluating a point of view, decision, or information source
- Forming a new idea or understanding from various pieces of information