Research Conference 2019

Preparing students for life in the 21st century: Identifying, developing and assessing what matters

PROCEEDINGS AND PROGRAM

4–5 August 2019

Melbourne Convention and Exhibition Centre

Australian Council *for* Educational Research

ACER

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ISBN 978-1-74286-554-6

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Design by ACER Creative Services
Edited by Kylie Cockle

ABN 19 004 398 145

Acknowledgement of Country
The Australian Council *for* Educational Research acknowledges that we are meeting on the traditional land of the Kulin Nation. This special place is now known by its European name of Melbourne. Today, Melbourne is one of the great multicultural cities of the world, a significant meeting place. For the Kulin Nation, Melbourne has always been an important meeting place and location for events of social, educational, sporting and cultural significance. We acknowledge the Wurundjeri people of the Kulin Nation, Traditional Owners and Custodians of the land on which we gather for Research Conference 2019. We pay our respects to Elders past, present and future. We acknowledge the Aboriginal and Torres Strait Islander people who contribute to educational research and development, including work to improve Indigenous learning.

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Foreword

Preparing students for life in the 21st century

In a rapidly changing world, there is widespread agreement that students require new levels of skill in collaborating, communicating, thinking critically, innovating, solving problems and applying what is learnt in new contexts, underpinned by values and dispositions that include a commitment to social inclusion, responsible citizenship and respect for human rights.

So how do we best prepare young people and equip them to survive and thrive in the unpredictable world of the future? Research Conference 2019 will profile research around innovative ways of conceptualising, developing and assessing this broader range of priorities for student learning and development in the 21st century. It will bring together teachers, policymakers, researchers and academics to share a wide range of perspectives about how to approach this ongoing and multi-faceted challenge.

Professor Geoff Masters AO
CEO, Australian Council *for* Educational Research

Keynote papers

Educational reform – Scottish style!

David Leng
Scottish Government Learning Directorate

David Leng has been professional adviser to the Scottish Government Learning Directorate since 2016, supporting the Scottish educational reform program. The Scottish Government agreed upon a new National Improvement Framework (2015) with the explicit aim of increasing excellence and equity for children and young people. David led extensive engagement with teachers, schools, local authorities and other key partners during the trialling, testing and launch of the Scottish National Standardised Assessments (SNSA) and works closely with the Australian Council for Educational Research and a wide range of stakeholders as part of the ongoing support and continuous improvement of the SNSA. David was a secondary school teacher, school manager and local authority officer for many years in Aberdeen City and North East Scotland. In particular, as Head of Schools (2007–2012), he oversaw strategy for curriculum, assessment and school improvement.

Abstract

The government in Scotland has made education their defining mission, setting out a clear framework for improvement based on four key aims as articulated in the National Improvement Framework (2015). One improvement driver is Assessing Children's Progress. This new approach to assessment has been developed to integrate curriculum, assessment (particularly classroom assessment) and pedagogy. Teacher professional judgement has been central to this, and national initiatives have focused on supporting and strengthening it. In this context, the SNSA was launched in 2017, and is a national assessment tool to support improvement in classroom practice while still providing local and national oversight. This innovative approach to national assessments has started well; however, it has also drawn criticism from those inclined to a more traditional form of national standardised assessments or none at all. Professor Andy Hargreaves (University of Boston) and member of the International Council of Education Advisers to Scotland recently commented 'I think that the solution that is being tried here is different. It involves asking how we use large-scale assessments to inform teachers' professional judgement … Scotland is at the leading edge in that regard. It is good that you are watching the world, but the world is watching you.'

Background and context

The Scottish Government has made education their defining mission. They commissioned and received a report from the OECD in 2015 *Improving schools in Scotland: An OECD perspective*[1]. In response to this report, a number of education reforms were planned including the National Improvement Framework (NIF) (2015). [2]There was broad consensus for the concise framework for improvement based on four key aims:

- improvement in attainment, particularly in literacy and numeracy
- closing the attainment gap between the most and least disadvantaged children and young people
- improvement in children and young people's health and wellbeing
- improvement in employability skills and sustained, positive school-leaver destinations for all young people.

A new approach to national assessment

There are a number of improvement drivers in the NIF, one of which is assessing children's progress.

As part of the development of the NIF, the Scottish Government, in response to OECD recommendations, decided to stop the national sample-based survey, the Scottish Survey of Literacy and Numeracy (SSLN) and adopt in its place a new, census-based approach based on teachers' professional judgement: The Achievement of Curriculum for Excellence Levels Return. Data are collected from schools each June detailing the proportion of children in Primary 1 (P1), Primary 4 (P4), Primary 7 (P7) and Secondary 3 (S3) who have achieved the relevant Curriculum for Excellence (CfE) level. These ACEL data are published each December.

This new approach to assessment has been developed with the focus on the integration of curriculum, assessment (particularly classroom assessment) and pedagogy. Central to this has been an emphasis on the role of teacher professional judgement. National initiatives have therefore focused on supporting and strengthening the centrality of teacher professional judgement.

In this context, the Scottish National Standardised Assessments (SNSA) were commissioned (2016).[3]

They were designed to incorporate OECD (2016, p. 157) advice:

> Standardised assessment tools can be used formatively in all parts of the system if they are referenced to the curriculum, flexible in their use, and provide high quality just-in-time information for teaching and learning, while at the same time having efficient ways to aggregate the results through the system.

The SNSA is a 'low stakes' assessment and aims to provide Scottish teachers with diagnostic information on aspects of reading, writing and numeracy to support the teacher's assessment of children's progress and to plan next steps in learning. This information helps teachers to support individual children as early as possible and avoid attainment gaps widening as children move through school. The SNSA also provides information at a class, school and local authority level, which can be used for improvement purposes.

The Scottish National Standardised Assessments

The SNSA were launched in August 2017. The assessments are delivered on behalf of the Scottish Government by the Australian Council for Education Research International UK (ACER) and their partners SCHOLAR (Heriot Watt University) and Twig World (Glasgow). The SNSA comprise an assessment and reporting system delivered through an online platform, an SNSA public website, a training programme for teachers and school staff (SCHOLAR), and a service desk (Twig World) providing advice by phone and email.

Key features of SNSA

The SNSA program has a range of important and innovative features.

1. It is delivered online

Children and young people undertake the assessments using a digital device: a desktop computer, laptop or tablet. The assessments can be done on any device or browser depending on the availability in the school. The assessments are delivered online, and because all items (questions) are automatically scored, teachers can access their learners' reports as soon as an assessment is completed.

Within this flexibility of delivery, the content of the assessments, within the adaptive design model, remains consistent.

1 http://www.oecd.org/education/school/Improving-Schools-in-Scotland-An-OECD-Perspective.pdf
2 The National Improvement Framework – the agreed national framework for Scottish Education and integral part of Scottish Education Reform https://www.gov.scot/policies/schools/national-improvement-framework/
3 The SG evidence paper submitted to the Scottish Parliament Education Committee (December 2018) and the SNSA National Report (December 2018) are a useful overview. https://www.parliament.scot/S5_Education/Inquiries/20181221Scottish_Government.pdf and https://www.gov.scot/publications/scottish-national-standardised-assessments-national-report-academic-year-2017-2018/. SNSA User Review (produced by SG to inform forward planning and continuous improvement) - https://www.gov.scot/publications/scottish-national-standardised-assessments-user-review-year-1-session-2017/; National Improvement Hub (P1 case studies) - https://education.gov.scot/improvement/self-evaluation/primary-1-snsa-case-studies

2. It is adaptive

The questions presented to children and young people vary according to how well they are performing on the questions they have answered so far. ACER uses an adaptive model using 'testlets' (around 10 items) giving six possible pathways through the assessment. The adaptive design means that the diagnostic value of the assessment is optimised. The adaptive design, when working well, enhances the learner's experience of the assessment and serves optimally in establishing where children and young people are in their learning development.

3. It has a carefully judged number of questions per assessment

Each assessment has from 30 to 36 scored items, with the number of questions increasing from Primary 1 to Secondary 3. On average, in the 2017 to 2018 academic year, children and young people completed each of the assessments within 30 to 40 minutes (less than 30 minutes for Primary 1 children). However, there is no time limit for completing SNSA, and where a teacher judges it necessary, a child or young person may take a break and come back to pick up the assessment where they left off.

Each question in the assessments has been empirically tested to make sure it 'works'. In addition, every question has been reviewed and signed off by a panel of experts from within Education Scotland.

4. Responses are objectively scored

The majority of questions in SNSA are in 'selected response' format, mostly multiple-choice. This provides reliability and standardisation, ease of marking and good curriculum coverage, Reports can be accessed as soon as an assessment is completed, so teachers can use the formative feedback immediately.

Other features of the SNSA program are specific to the Scottish education context.

5. It covers agreed elements of Curriculum for Excellence

The assessments have been constructed to align with the CfE. A design for each assessment covering organisers and learning statements defined in the *Benchmarks: Literacy and English and Benchmarks: Numeracy and Mathematics* (Drafts, August 2016) was agreed with the Scottish Government and Education Scotland before the assessments were built. It should be noted that for the academic year 2018 to 2019, the final version of the *Benchmarks* (published in June 2017) is used as the reference point for the assessments.

6. It has a flexible delivery model

The flexible delivery model is intended to allow children and young people to be assessed at any time in the school year that is judged suitable for the school, class and individual learner. A consequence of the flexible timing is that, when interpreting the results of the assessment at individual, class, school, local authority or national level, the point in the school year in which the assessment was taken needs to be taken into account. Two norming studies were completed to provide Scottish teachers with two comparative national norms – in November or March.

7. It is designed to be accessible to all learners

The system is designed to be compatible with a range of assistive devices, so that learners can use familiar devices from their everyday use in the classroom to support them in completing the assessments, including software and devices such as text readers, screen readers and switches. Detailed guidance is available for teachers in relation to additional support needs (ASN) and English as an additional language (EAL).

Implementation approach

ACER was appointed to develop and deliver the SNSA in October 2016. The assessments went live in August 2017, which was a very challenging timescale. This was achieved through hard work and a successful partnership approach between ACER and the Scottish Government.[4]

Alongside the technical and test development tasks, the SNSA undertook a considerable stakeholder engagement program in order to gain professional feedback and win hearts and minds for the new assessments.

Education Scotland staff, as experienced classroom practitioners, reviewed each of the proposed questions for the SNSA in January 2017, which led to agreed content for the first year of SNSA and the establishment of the quality assurance process. An original 'alpha' design was trialled in five local authorities with over 60 schools taking part (February 2017). The updated 'beta' design was showcased to more than 25 local authority and headteacher groups (June 2017), alongside trials with individual pupils to determine how children would respond to the questions and the SNSA platform.

4 ACER has collated a number of key documents on the design and development process that are available securely on request.

Website and training

An SNSA public website was launched in June 2017 and a SNSA service desk established, both operated by TWIG.[5]

SCHOLAR recruited a new training team, and produced and provided a range of training courses, planned in conjunction with requirements of local authorities for their schools. This was a significant undertaking and demonstrated a commitment to support teachers with the new assessments.

Successes and challenges

There have been considerable successes since implementation two years ago:

- More than 570 000 assessments were completed by children and young people in P1, P4, P7 and S3 in each academic year, which equates to a higher than 90 per cent uptake rate.
- Training has reached, in person, more than 11 000 participants with help and support materials available at all times online.
- The support desk has responded effectively to more than 10 000 enquiries.
- There is growing evidence that the information generated by the assessments and reports is being used to plan effective next steps in learning. This, in turn, gives teachers more confidence in assessing children's progress, with a more consistent understanding of the standards expected of CfE levels in literacy and numeracy.

Towards the end of the first year there were emerging concerns about aspects of the SNSA. These included:

- concerns that children in P1 (age 5) were too young to be formally assessed, causing them undue stress
- a view that standardised assessments negated a more play-based pedagogy in the early years
- concern that the real reason for the SNSA was to provide accountability data for national government
- increased workload pressures on teachers in order to satisfy national government demands.

The SNSA became a political issue and this led to debates and a vote in the Scottish Parliament, and the commissioning of a number of reviews on aspects of the SNSA, particularly with P1 children.

These reviews have now concluded and are available for further study on the Scottish Government website.

Looking forward - areas for thought and further research

This new approach to national assessments has started well; however, it has also drawn criticism from those inclined to a more traditional form of national standardised assessments (high-stakes, summative) or none at all (play not tests).

Establishing and operating a national assessment program that is formative and diagnostic in approach is innovative. Empowering schools and maintaining the focus on teacher professional judgement at a census level as the key measure of children's progress is a laudable ambition but not without risk.

Professor Andy Hargreaves (University of Boston), member of the International Council of Education Advisers to Scotland, recently commented. 'I think that the solution that is being tried here is different. It involves asking how we use large-scale assessments to inform teachers' professional judgement … Scotland is at the leading edge in that regard. It is good that you are watching the world, but the world is watching you.'

The Scottish Government, having made education their defining mission, needs evidence that this approach works and delivers on their political ambitions.

The next stages for Scottish education are to demonstrate that the faith in teacher professionalism and the use of national programs such as SNSA because a formative rather than summative approach can deliver on the dual aims of excellence and equity. Supporting teachers and schools to raise standards (excellence) and close the poverty-based attainment gap (equity) is now the driving focus of government initiatives and research.

The Scottish Government's partnership with ACER is an important and enduring part of this educational reform, where innovative practice and ongoing research can really make a difference.

5 https://standardisedassessment.gov.scot/

The science behind the art of teaching: Evaluation as inspiration

Dr Michele Bruniges AM
Australian Government Department of Education and Training

Dr Michele Bruniges AM is the Secretary of the Australian Department of Education and Training. Michele has held this position since April 2016. Previously, she led the NSW Department of Education and Communities, and the ACT Department of Education. Her qualifications include a PhD in Educational Measurement and a Master of Education.

Dr Bruniges is a Member of the Order of Australia and has received national recognition for her significant contribution to education as a recipient of the 2015 Australian Council for Educational Leaders (ACEL) Gold Medal Award.

Effective from April 2017, Dr Bruniges became the first Australian to be appointed Chair of the OECD's Programme for International Student Assessment (PISA) Governing Board in recognition of her expertise in assessing educational outcomes based on evidence, effective data collection and analysis.

Abstract

Teachers across Australia inspire students to love learning. Our best teachers are constantly evaluating their impact on learning outcomes and adapting their practice – balancing the art and science of teaching. As we move rapidly towards the third decade of the 21st century, there is more pressure than ever for all teachers to deliver both deep discipline knowledge and the skills students need to survive and thrive in the workplace of the future. We need to use technology and data to support teachers to maximise learning outcomes for their students. This has to be done in a way that helps teachers, rather than placing an additional burden on them. Being able to more accurately identify where each student is at in their learning, and delivering the next challenging but achievable step, will maximise student engagement and inspire a love of learning.

Introduction

Teaching is an honourable profession, with communities according it a high status (Commonwealth Parliament of Australia, 2019). Teaching carries the primary responsibility for the learning outcomes of children and young people. It is a profession that must be adaptive and responsive – to the needs of each learning context, each student, the challenge of differentiation, emerging education developments, new curricula, and different measures of success. A profession with intrinsic rewards, it nonetheless requires personal and professional resilience and practitioners who draw strongly from a knowledge and creative base to pursue its unique and distinctive role. Using assessment and evaluation is where the pursuit of quality teaching begins.

There is much written about the challenges that face young people in a world shaped by automation, technological advances and the rise of artificial intelligence, globalisation, uncertainty and major social change. Far less is available on the professional challenges that face the teachers of these young people. Teachers who are vitally important in preparing these people for today's world and tomorrow's, and securing ongoing national prosperity.

As nascent citizens, students today need to acquire a combination of deep discipline knowledge, harness the ability to transfer and apply knowledge and skills to complex problems, and develop adaptive and resilient dispositions (Bialik & Fadel, 2018).

Improving educational outcomes delivers a range of positive impact, from individual benefits of ensuring students are able to succeed in the future workforce, through to the national economic level. Deloitte Access Economics (2016, p. iii) estimates that a 5 per cent increase in the Organisation for Economic Co-operation and Development's (OECD's) Programme for International Student Assessment (PISA) scores could lead to improved labour productivity and result in an increase to Australia's long-term gross domestic product by as much as $12 to $26 billion, once the benefits were fully realised.

In our increasingly complex world, one principle is generally agreed: it is no longer sufficient to 'teach to the middle'. Teachers have to draw on different pedagogical approaches to cater for the full spectrum of ability within a single classroom. Differentiation is widely considered the best way to maximise the learning potential of each individual, yet it is one of the greatest challenges for teachers.

Practicality may often dictate that instruction is pitched toward students achieving at the middle of the group (or the expected curriculum level), thereby not extending high-performing students or supporting low-performing students (Goss & Hunter, 2015). Australia's PISA results reflect this. When compared to high-achieving countries, around 20 per cent of 15-year-old Australians fell short of PISA's minimum proficient standard in mathematics, and only 15 per cent reached the highest levels of mathematical proficiency, compared to 40 per cent of students in the five best performing systems (Goss & Hunter, 2015).

The ambition articulated in *Through Growth to Achievement: Report of the Review to Achieve Educational Excellence in Australian Schools* is to achieve 'one year's growth in learning for every student every year' (Department of Education and Training, 2018, p. x). To deliver on this vision, teachers need professional knowledge of their discipline, effective and up-to-date pedagogical knowledge, knowledge about the way students learn, and knowledge of how to create effective learning environments. An understanding of the 'research–theory–practice nexus and the inquiry and research skills that allow teachers to become lifelong learners and grow in their profession' is also needed (Schleicher, 2018, p. 9).

Research has positively linked teaching performance to the ability to understand and effectively use three types of knowledge in the classroom – content knowledge, pedagogical knowledge and pedagogical content knowledge. While each of these types of knowledge is a critical element in delivering positive student outcomes, it is the depth of pedagogical content knowledge – the intersection of content knowledge and pedagogical knowledge – that elevates teachers to an expert level, allowing them to effectively differentiate teaching strategies in response to individual students (Teacher Education Ministerial Advisory Group, 2014).

As well as high professional expectations, the community calls for teachers to be passionate and compassionate individuals, able to respond effectively to students with a range of needs and backgrounds, able to promote tolerance and social cohesion and ensure that their students feel valued and engaged in their learning (Roy Morgan, 2017).

In a century characterised by striking, fast-paced advances in technology, good teaching is one endeavour that cannot be fully automated. Quality education will always require quality teaching and leadership. The rapport that teachers have with their students is the essence of teaching – it is the humanity, the interpersonal, the compassion, the relationships at the heart of the profession.

Every class or learning setting a teacher encounters will be different. Teaching *must* therefore be adaptive and responsive to the different needs of each setting and each student. The essential question is, how can teachers be encouraged and supported to achieve this goal? There is no single solution, however, there is a single place to start: *the belief that it is possible*.

The 'art' of teaching: teacher judgement and collective efficacy

What teachers do, and how they do it, are key to better educational outcomes.

Building on John Hattie's (2009) meta-analysis on student achievement, a recent report commissioned by the Department of Education and Training found that school and teacher factors contribute as much as 28 per cent of variation in student outcomes. Teaching practice, classroom organisation and environment, and school leadership are the most important drivers within this variation. Specifically, 'variations in teaching practice explain the largest variation in student scores, at 6.1 per cent for PISA maths scores, and 13.1 per cent for TIMSS Year 8 (and 3.9 per cent of TIMSS Year 4) maths scores' (Deloitte Access Economics, 2017, p. 45).

Teachers make multiple decisions daily about their practice: what they will do next, knowing what they know about individual students. Teachers continually use intuitive professional judgement, informed by their experience and knowledge, to gather information on what and how to teach. Recent research has confirmed that while intuitive judgement is an important part of teacher expertise, it is enhanced when complemented by a range of measures including achievement and attitudinal data from formative and summative measures. By incorporating such data collection into their repertoire, teachers are able to make sophisticated decisions that support enhanced student outcomes (Vanlommel, Van Gasse, Vanhoof, & Van Petegem, 2018). Teachers engage, motivate and stimulate students' love of learning by keeping themselves informed of the latest developments in their discipline to inspire and bring subjects to life. This is the art of teaching: combining deep discipline knowledge with rich contextual information about students to inform judgements about teaching that engages and inspires students.

Teachers develop professional judgement throughout their careers, as they progress from beginning to proficient to highly accomplished professionals. They do not develop this judgement in isolation of their peers. While a teacher may often stand solo in front of a class, teaching is a highly collaborative profession.

The concept of collective teacher efficacy – the collective belief of teachers in their ability to have a positive impact on student learning – has a longstanding evidence base (Bandura, 1993 & 1997; Goddard, Hoy, & Woolfolk Hoy, 2000; Hoy, Sweetland, & Smith, 2002). And a strong correlation between collective efficacy and student achievement was recently highlighted by John Hattie.

Michael Fullan (2018) describes *collective efficacy* as encompassing 'a shared belief in [a] conjoint capacity to produce results, a culture of collaboration to implement high-yield strategies, evidence of impact as a primary input, with leadership participation in frequent, specific collaboration.'

Successful illustrations of collective teacher efficacy include the practice of Japanese lesson study, (Doig & Groves, 2011) and Gore and Bowes' Quality Teaching Rounds (Bowe & Gore, 2017). Each of these practices is characterised by a group of educators coming together in professional learning communities to observe, evaluate, discuss and collectively develop each other's professional knowledge and practice.

Collaborative professional development practices empower teachers to pursue more critical and deeper analytical work on their practice (Bowe & Gore, 2017), and allow participants to draw on the collective experience, creativity and insights of their peers, strengthening teaching as a collective endeavour and overcoming professional isolation.

An examination of the OECD Teaching and Learning International Survey (TALIS) and PISA results highlights the value that collaborative professional development can provide as part of regular teaching practice.

The 2013 TALIS results showed that while around 50 per cent of Australian teachers regularly exchange teaching materials and engage in discussions about student learning, richer collaborative practices such as engaging in team teaching (18.1 per cent), joint activities across classes (7.9 per cent) and teacher observation (4.9 per cent) were much less common (OECD, Table 6.15, 2014).

All professional engagement and exchange and coordination activities should be encouraged; however, deeper professional collaboration is more beneficial in enriching the profession and where Australian teachers could gain the greatest benefits (Clement & Vandenberghe, 2000).

Using data in the classroom: The 'science' of teaching

All effective teaching uses evaluation, and uses it consistently and often. Measurement is integral to the process of identifying children potentially at risk and charting change (Bruniges, 1999, p. 23). Teachers reflect on student responses to strategies used in the classroom through observations and classroom assessments and as professionals through communities of practice.

Like any measure, NAPLAN data, our national assessment, does not replace teacher judgement – it informs and augments it. NAPLAN assesses aspects of literacy and numeracy in Australian students at Years 3, 5, 7 and 9. It provides valuable diagnostic information about the strengths of individuals and areas for their further development. As such, it provides a valid and reliable source of evidence for teachers to use in their professional judgements.

Traditional assessment practices focus on comparing a student to the others within their cohort. While this can be effective to differentiate within a group, it has limited value for teachers seeking to understand what a student knows, can do, or understands (Bruniges, 1999, p. 11).

Well-considered and delivered assessment practices support teachers to monitor student progress and inform next steps, determine the effectiveness of chosen teaching strategies – both for learning and engagement – and to measure understanding of a unit of work (Stronge, 2002). By developing more effective and targeted assessments, teachers can assess with greater precision, and get richer information to inform and support their decisions on what and how to teach.

Neuroscience and psychometric education research have contributed important observations of student development. Student learning is not consistently linear, with learners experiencing periods of learning 'growth spurts' and plateaus (Bruniges, 1999). Assumptions about patterns of growth are important components in ensuring that descriptions of expectations are based on what should typically occur at particular ages, or stages, in the schooling continuum (Bruniges, 1999, p. 23). Yet, too great a reliance on the knowledge of the development of 'typical' students can disadvantage many students.

Early work on learning progressions by the Australian Council for Educational Research (ACER), Australian Curriculum, Assessment and Reporting Authority (ACARA) and others has the potential to provide powerful information for the profession. Learning progressions describe the common development pathway along which students typically progress in their learning, regardless of age or year level. They describe the skills, understanding and capabilities students acquire as their proficiency increases in a particular area. This helps teachers to identify the stage of learning reached, any gaps in skills and knowledge, and plan for the next challenging but achievable step to progress learning.

The development of learning progressions will assist teachers to more easily establish the current levels of achievement of their students, as well as any gaps in learning. When linked with on-demand resources and professional learning, they will support teachers to identify and plan the next teaching and learning steps for each student (Cawsey, Hattie, & Masters, 2019). Technology must be harnessed to support teachers. The challenge is in knowing how to develop or access relevant and useful assessments, receiving data in accessible formats, and using the results to complement the rich contextual information held by the teacher – then deciding what to teach next based on the skills and knowledge of the students.

The benefits of the digital age in schools have been described by Andreas Schleicher (2018, p. 17) as:

> In the past, schools were technological islands, with technology often limited to supporting existing practices, and students outpacing schools in their adoption and consumption of technology. We need to use the potential of technologies to liberate learning from past conventions and connect teachers and learners in new and powerful ways, with sources of knowledge, with innovative applications and with one another.

Adaptive teaching and learning: Evaluation as inspiration

Advances in adaptive teaching and learning require a collective effort, starting with professional collaboration between teachers, as embodied in the concept of collective teacher efficacy.

Opening up of the profession with a greater culture of classroom observation, coding of lessons, instructive teacher feedback loops and translation of important contributions of school leaders, researchers, and policymakers into the classroom requires action. Such a collective effort would allow teachers to access the valuable research insights. With support, incorporation of insights into daily practice would ensue.

There is a wealth of high-quality educational research taking place nationally and internationally that can assist in the identification of the most effective ways to achieve better educational outcomes and support teachers to make simple but meaningful changes to their practice with a resultant positive impact on student outcomes.

In the 2013 TALIS, for example, 94 per cent of teachers on average agreed that it was their role to facilitate inquiry in students. A majority of the teacher respondents also believed that students should be allowed to think of solutions themselves before teachers showed them (93 per cent) (Freeman, O'Malley, & Eveleigh, 2014). Research also indicated that while teacher-directed instruction and memorisation learning strategies assisted students in solving rudimentary mathematics problems, student-oriented instruction and elaboration strategies are more successful for more complex tasks (OECD, 2016).

Yet, when PISA 2012 asked students to report on the prevalence of different approaches found in the classroom, the data often varied from what teachers reported to be desirable learning strategies. While teachers in the United Kingdom reported a strongly constructivist view of teaching, England was among the countries where students reported the highest prevalence of memorisation strategies (Schleicher, 2018, p.17). The percentage of Australian students who reported using memorisation strategies was also significantly above the OECD average. This pattern was similar for many other English-speaking countries.

These PISA findings suggest a concerning disconnect between teacher-identified desirable pedagogies and classroom teaching practices. Translating such research could prompt teachers to understand their current practice, look at what the evidence says and provide the impetus to implement the findings in their day-to-day teaching.

The creation of a national education evidence institute will be an important first step in bridging the gap between research and the classroom; to use evaluation to help teachers adapt their practice and inspire their students.

Conclusion

Teachers have a valuable and powerful role. They guide students' development and influence their futures.

Teaching is a highly sophisticated profession with a clear dualism: it is grounded in evidence and pedagogy yet characterised by values of compassion, empathy and deep care for students. These are complementary.

Well-considered assessment will guide and enhance, not detract, from student learning. Educators must embrace the opportunities assessment and evaluation data provides to reflect on practice and to support them in delivering on intentions, goals and expectations for student learning. Assessment and evaluation information and analysis empowers educators to consider the impact of their teaching and to continually adapt and adjust their teaching to the needs of their students.

Policymakers and researchers need to work *with* the teaching profession to support further research and evaluation of what works and how to do it well – in a way that puts teachers in the driving seat and does not add to the demands placed on practitioners.

Quality teaching does not end with assessment and evaluation, it is where it begins.

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Karmel Oration: On with the 21st century! Preparing Australian education for the 2020s and beyond

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Neil's latest book – Should robots replace teachers? AI and the future of education *will be published in September 2019 with Polity Press.*

Abstract

It is rare that the education community gets the chance to think seriously about the future. The 2019 Research Conference theme therefore gives us a welcome opportunity to be future-focused and forward-thinking. This presentation will preface the conference by reflecting on some pressing issues that Australian education is set to face over the next decade. In particular, we will explore a series of substantial challenges that are likely to come to the fore during the 2020s. These include:

- making a persuasive case for retaining traditional models of 'school' and 'teacher' in the face of compelling alternatives
- develop broader notions of 'skills', 'competencies' and 'aptitudes' that help students to flourish in an age of precarious employment, misinformation and an increasingly fragmented society
- engaging with digital technology in ways that strengthen the character and values of public education
- renegotiating relationships between educational institutions and the corporate actors that are shaping education agendas around the world
- engaging with public opinion, and fostering a genuine public understanding of (and support for) education
- re-imagining educational provision and practices that are appropriate for an age of climate change.

While these are all incredibly complex challenges, there is good reason to remain hopeful. In this spirit, the presentation will consider a variety of ways in which the Australian educational community might move forward in a realistic manner – allowing us to play a proactive part in how the 21st century continues to unfold.

Introduction

Throughout this conference we are likely to hear repeated grumblings that it is too late to be worrying about 'preparing students for life in the 21st century'. After all, we are already one-fifth of the way through the 21st century. The first cohorts of students born in the 2000s have already completed Year 12. Time is flying by!

That said, any mention of 'the 21st century' still raises some important points of contention. These are clearly very distinct and different times. It is now claimed that globalisation is dead, that we are living in a post-digital age, and/or on the cusp of 'Industrial Revolution 4.0'. Notwithstanding such hype, our day-to-day lives are now distinctly different than they were 20 years ago, and these differences will continue to unfold. The nature of Australia's economy, politics, culture and society is steadily (and often unpredictably) shifting. As such, Australian education is in the midst of considerable change.

However, many of the problems that have long blighted Australian schooling continue to be all too prevalent. The Karmel Report (1973) highlights deficiencies in resourcing, significant inequalities of educational opportunity and poor-quality teaching, curriculum and school organisation. All of these concerns remain relevant nearly 50 years later, and are likely to remain so 50 years from now. All told, these are worryingly familiar *and* unfamiliar times for everyone in education.

So, this written precursor to my Karmel Oration is offered in an understandably tentative spirit. What follows is a set of initial ideas that may well change between my writing this text (in April) and presenting at the conference (in August). Given the current volatility of the world, it is unwise to be too fixed in what one expects to be talking about four months down the track. The following text therefore gives a sense of what I currently expect to be reflecting upon in August … it will be interesting to see what alters in the interim.

Looking to the 'near future'

One aspect that I am confident my talk *will* retain is the conference's interest in the future of education. More specifically, I want to reflect on what is termed the 'near future' – that is, the situation in 5 to 10 years' time. While we can all have fun speculating on what the schools of 2069 might be like, this might be of little practical benefit to the conference attendees of 2019. It is far more useful to focus on what we are likely to be grappling with a few years from now. This Karmel Oration is therefore an opportune moment to reflect on Australia's education challenges of the 2020s.

As with any look into the future, anything that I say will be inevitably subjective. Nevertheless, there are ways of keeping our discussions on point and of practical benefit. First, there is the need to speculate on the future in plausible (rather than fantastical) terms. Second, there is the need to distinguish between what is probable, what is possible and what is preferable. Third, there is the need to think of 'futures' plural – that is, being open to the idea of different variations and directions that may well unfold over the next few years.

So, with these guidelines in mind, here are six substantial challenges that I expect Australian education to be facing over the next decade …

Challenge 1

Making a persuasive case for retaining traditional models of 'school' and 'teacher' in the face of compelling alternatives

The next 10 years will see growing push back against traditional forms of 'school' and 'teacher'. For example, the idea of the fixed-schedule, bricks-and-mortar school is attracting sustained criticism – derided as an outdated 'factory' model based on impersonal and inefficient 'batch processing' of students. Flexible alternate models are being developed in the form of virtual schools, open schooling and schools-in-the-community. Similarly, advances in student-centred personalised learning systems are prompting calls for teaching to be automated, learner-driven and 'teacher-proof'. While these technologies still require classroom facilitators and technicians, the need for highly trained expert teachers is being seriously questioned.

Put bluntly, the entire premise of 'schooling' and the 'teaching profession' faces an impending challenge to convincingly justify its existence. Australian educators will be under mounting pressure to explain the benefits of these long-dominant forms of educational provision. While we might like to reassure ourselves that these benefits are self-evident, the education community needs to engage much more forcibly in justifying the added value of the classroom teacher and the traditional school, while also being open to suggestions for improvement.

Challenge 2

Develop broader notions of 'skills', 'competencies' and 'aptitudes' that help students to flourish in an age of precarious employment, misinformation and an increasingly fragmented society

The idea of schools preparing young people with skills required for future employment will be stretched to

its limits during the 2020s. There will be little sense in continuing to set schools up to cater for a 'knowledge economy' that will require masses of highly-skilled information workers. Instead, the 2020s promise growing technological unemployment, low-skilled/semi-automated jobs and other forms of precarious labour. This will particularly be the case for Western economies struggling to retain their 20th century dominance.

Rather than developing skills for future jobs, Australian schools might be recast as sites for the development of competencies, aptitudes and dispositions that will help the next generation to collectively 'hustle' their way through life. Alongside the usual 21st-century skills, these might include critical consciousness, social entrepreneurship, citizen activism, environmental citizenship, and sense of global place. Schools need to be places that foster flexible attributes that will leave young people well-equipped to navigate their increasingly non-linear and unpredictable futures.

Challenge 3

Engaging with digital technology in ways that strengthen the character and values of public education

The 2020s will arguably be the first full 'post-digital' decade. Digital technologies will become entwined across all aspects of education to the extent that they largely stop being noticeable. This will be a decade marked by the increased 'datafication' of educational institutions and the adoption of AI-driven systems that make decisions autonomously.

The educational implications of these new technologies are extremely difficult for anyone (even their developers) to fully discern. Nevertheless, it is crucial that educators begin to exert more influence over the digital processes and practices that they are choosing to be implemented in schools – ensuring that the technologies allowed to deliver and direct educational provision operate in the best interests of teachers, students and the public education ethos. Schooling should not descend unwittingly into a mechanised, overly-individualised and de-humanised free-for-all.

Challenge 4

Renegotiating relationships between educational institutions and the corporate actors that are shaping education agendas around the world

The 2020s will see the expansion of the commercial 'ecosystem' that already exerts considerable influence on what takes place within schools. School systems will continue to be subject to major pushes for privatisation of infrastructure. The global education agenda will continue to be influenced by big corporate 'edu-businesses', such as Pearson, alongside wealthy philanthropics, such as the Gates Foundation. These actors will be accompanied by portfolios of 'start-up' companies (often financed by powerful venture capital interests) spruiking educational 'innovations' and 'solutions'.

While there is nothing inherently wrong with these commercial contributions, questions need to be asked about regulation and oversight of corporate activities in Australian education. For example, should major corporations continue to exercise 'soft power' in influencing and shaping education decision-making, while all the time profiting from the decisions being made? How might we better ensure that commercial actors respond primarily to the needs of the school sector rather than working to create demand for their products within schools?

Challenge 5

Engaging with public opinion, and fostering a genuine public understanding of (and support for) education

Public debate on education is a prominent part of Australian politics, yet public knowledge of what takes place in our schools and universities is highly incomplete and polarised. Public opinion on education should be an important element of the national education debate, offering a basis from which to develop democratically driven change and improvement.

However, for this to happen, the education community first needs to work toward establishing a robust 'public understanding of education'. This will require concerted efforts to better publicise the work of teachers and schools – both to parents and local communities. Similarly, universities will have to work hard to justify the need for higher education. The 2020s should be a decade where teaching and learning takes place in the 'open', and we increase public engagement with current education provision and practices.

Challenge 6

Reimagining educational provision and practices that are appropriate for an age of climate change

The 2020s will be the decade where we finally face up to the imperative to establish sustainability and ecological responsibility as central elements of educational provision and practice. This is already

beginning to drive the ways in which educational buildings are designed, built and maintained, yet there are many other aspects of education that lag well behind. These include the environmental connotations of mass daily school-runs and campus commutes, as well as ways in which digital technologies have been excessively consumed and discarded over the past 20 years in the name of education 'innovation'.

Regardless of how daunting such changes might seem, the education community needs to quickly curtail the environmental and ethical impacts of its practices. Put bluntly, the priority for everyone working in education needs to be a rapid collective change of attitude and action. The next generations of students will be dealing with the environmental consequences of their everyday lives in very different ways than before. It is crucial that their places of education are a source of support rather than a hindrance.

Conclusion

These are all uncomfortably big issues for educators to tackle. Indeed, when faced with challenges of this scale there is always a danger of becoming either blithely optimistic or excessively pessimistic. These are undeniably complex challenges to consider, yet there are decent grounds for Australian educators to address these issues in a hopeful (rather than hopeless) manner.

So, where should this hope take us? Clearly there is a need for the education community to engage with other actors that might traditionally be thought of as 'non-educational' but will nevertheless play a leading role in defining what 'schooling' is throughout the 2020s. Educators certainly need to engage properly with their 'publics' – especially parents and local communities. Educators also need to establish relationships with commercial actors that work in the favour of schools rather than shareholders. Australian society needs to become comfortable with the notion that there is more to schooling than ill-defined imperatives of employability and national economic success.

However, responsibility should not be loaded solely onto individual schools, school leaders, teachers and the general public. As the 1973 Karmel Report proved, considerable progress can be made through the coordination of federal and state government intervention. Yet we are living in very different circumstances in comparison to the Whitlam era. The post-industrial, post-digital, climatic challenges I have outlined are unlikely to be tackled effectively through top-down planning in the manner of a 'Schools Commission Act 2.0'. These are not problems that governments can simply 'plan' their way past. Instead, then, we need to think of ways in which policy responses might be enacted in a manner fitting for the 2020s. Governments need to take a lead in mobilising, unifying and coordinating networks of multiple agencies around visions of education futures that we collectively agree are best for Australia.

But do not just take my word for all this! This short text has outlined six probable challenges, and begun to suggest the types of actions that Australian education might now focus on. Yet these are *my* own preferred futures, and it is likely that every conference attendee will have alternate responses and preferences. So, we now need to commit to engaging in sustained collective conversations about how we might all work together to prepare Australian education for the 2020s … let alone the remainder of the 21st century. I hope that this conference provides momentary respite from the immediate challenges of contemporary education, and an opportunity to think ahead in a realistic manner. Education in the 21st century may already be well under way, yet we should all take a proactive role in how it continues to unfold.

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Conference papers:

Sunday 4 August

21st-century skills: Realising the potential of the Australian Curriculum

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Robert Randall has recently completed two terms as Chief Executive Officer of the Australian Curriculum, Assessment and Reporting Authority (ACARA), first taking up that role in November 2012.

He commenced working at ACARA in 2009 and held the roles of Deputy CEO and General Manager, Curriculum. In the lead-up to the establishment of ACARA, Robert was General Manager of the Interim National Curriculum Board.

Robert began his career in Perth as a teacher of mathematics before holding a range of positions within and beyond schools in Western Australia. In 1996, Robert was appointed Director, Curriculum, with the New South Wales Board of Studies, and in 2001 took up the position of Director of Curriculum K–12 with the NSW Department of Education and Training.

Abstract

The Melbourne Declaration on Educational Goals for Young Australians (Melbourne Declaration) (MCEETYA, 2008) proposed that the Australian Curriculum (and state or territory and local curriculum) develop:

- a solid foundation in knowledge, understanding, skills and values on which further learning and adult life can be built
- deep knowledge, understanding, skills and values that will enable advanced learning and an ability to create new ideas and translate them into practical applications
- general capabilities that underpin flexible and analytical thinking, a capacity to work with others and an ability to move across subject disciplines to develop new expertise.

The Australian Curriculum, approved by education ministers for implementation, includes general capabilities that comprise knowledge, skills, behaviours and dispositions that students develop and use in their learning across the curriculum. The Australian Curriculum identifies where the general capabilities are addressed through the learning areas and where there are opportunities to add depth and richness to student learning.

This session will draw on implementation experience and various national and international reports on 21st-century capabilities to take stock of the opportunities and challenges in delivering the Australian Curriculum. Particular attention will be given to the what, why and how of ensuring that all young Australians are supported to learn these fundamentally important capabilities.

Setting national expectations

General capabilities are a key element in the Australian Curriculum and 'encompass knowledge, skills, behaviours and dispositions that, together with curriculum content in each learning area and the cross-curriculum priorities, will assist students to live and work successfully in the twenty-first century' (ACARA, 2019).

The Australian Curriculum, approved by education ministers for implementation in schools across the country, includes seven general capabilities:

- literacy
- numeracy
- information and communication technology capability
- critical and creative thinking
- personal and social capability
- ethical understanding
- intercultural understanding.

Inclusion of the general capabilities was a design feature of the national curriculum from the outset, with strong guidance from the Melbourne Declaration through its goal that 'all young people in Australia should be supported to become successful learners, confident and creative individuals, and active and informed citizens' (MCEETYA, 2008).

Development of the Australian Curriculum and the general capabilities in particular was guided by *The Shape of the Australian Curriculum* (ACARA, 2013a) *Curriculum Design Paper* (ACARA, 2013b) and *Curriculum Development Process* (ACARA, 2012) papers that provided developers and others with clear advice on the design and development of the curriculum, including references used to develop the general capability sequences.

In the first iteration (2009) of *The Shape of the Australian Curriculum* (see ACARA, 2013a), the Interim National Curriculum Board stated that it would 'deal explicitly with general capabilities within the national curriculum to avoid any risk that they will receive inadequate or unsystematic attention because they are supposed to be addressed "across the curriculum"'.

Initially, there were 10 general capabilities (literacy, numeracy, information and communication technology, thinking skills, creativity, self-management, teamwork, intercultural understanding, ethical behaviour and social competence) described at three levels (end of Years 2, 4, 6 and 10). With ongoing attention to the literature about these capabilities and feedback from teachers and other educators, the set of general capabilities was reorganised as seven, described at five levels (outlining expectations for the end of Years 2, 4, 6 and 10).

While there have been some modifications along the way and additional explanatory advice and support material produced, the general capabilities as described on the Australian Curriculum website today have been in place since 2010.

Diligent effort

In the intervening years there has been ongoing engagement with and discussion about the general capabilities by ACARA, by state and territory education authorities, and increasingly in the broader community. For example, in ACARA's 2011 monitoring report (2012a), it was noted that there was 'strong support for the general capabilities, as a set and for each capability'. Respondents affirmed the general capabilities' alignment with the Melbourne Declaration, their place in a 21st-century curriculum, their value as aspirational expectations for students progressing through schooling, and their potential to link with and enrich the learning areas.

Feedback also focused on the organisation and presentation of the general capabilities with requests for attention to greater differentiation between learning areas and capabilities; addressing gaps in the continua; and reviewing consistency, pitch and progression.

In recent years, greater attention has been given to providing support and resources to assist teachers to understand the purpose and intended use of the general capabilities, developing more illustrations of practice and practical challenges of how to 'teach' the general capabilities.

Feedback about the general capabilities has also included concerns about reduced attention to teaching the disciplines, often setting up a false dichotomy about learning areas or general capabilities. ACARA (2019) maintains the view that was introduced in the first *Shape of the Australian Curriculum* paper, that the:

> … general capabilities are addressed through the content of the learning areas. General capabilities are identified where they are developed or applied in the content descriptions. They are also identified where they offer opportunities to add depth and richness to student learning …

While there are no comprehensive data on implementation of general capabilities (and it may be easy to underestimate the efforts being made by school leaders and teachers), in the time since they have been

approved, there has been deliberate activity to support the teaching and assessment of the general capabilities across states and territories in individual schools, school sectors and school systems. Examples include:

- Rooty Hill High School in New South Wales sought to 'create a capabilities-focused curriculum, assessment and transition program'.
- The Association of Independent Schools of South Australia (AISSA) delivers workshops to support schools wishing to embed the personal and social capability within learning areas as a way of increasing student engagement
- In Victoria, the Victorian Curriculum and Assessment Authority (VCAA) has modified the general capabilities to provide content descriptions and achievement standards for four general capabilities: Critical and Creative Thinking, Ethical Understanding Capability, Intercultural Understanding Capability, and Personal and Social Capability. It has the expectation that schools report student achievement against the set of achievement standards set out in the eight learning areas and four capabilities of the Victorian Curriculum F–10, consistent with the whole-school teaching and learning plan. The VCAA has also developed assessment resources to assist teachers assess attainment and progress in relation to critical and creative thinking.

Contributions to the assessment of student learning of general capabilities have also been made by organisations such as ACER, who has addressed the topic in its Research Conferences and through work of ACER's Centre for Assessment Reform and Innovation (CARI). For example, Fraillon (2015) observes that there was 'danger in using a cross-curricular approach to teaching and assessing general capabilities … the general capabilities can become secondary to the subject disciplines in which they are embedded' and Scoular and Heard (2018) note that 'contemporary thinking about general capabilities is substantially different from five years ago, with a greater focus on finding the best ways to teach and assess skills like critical thinking, creativity and collaboration … [however] not much in the way of guidance for teachers or schools.'

And in response to such needs, CARI has commenced the development of an assessment framework to measure and monitor 21st-century skills in the classroom. Universities also have research and teaching programs seeking to investigate and support the teaching and assessment of the general capabilities. It is worth highlighting the ongoing program in Melbourne University's Assessment Research Centre on the assessment of 21st-century skills, preceded and significantly informed the position taken by ACARA.

Raising expectations

While there has been support for the inclusion of the general capabilities, from the outset the attention given to them and expectations about student learning of them has increased significantly in recent years.

For example, in The New Work Reality, the Foundation for Young Australians (FYA) (2018) argues that 'Young people who are able to build transferable enterprise skills, such as problem-solving, communication and teamwork through formal education can accelerate their transition to full-time work by 17 months'. In another of their reports, The New Basics (FYA, 2017), they state that 'The high demand for enterprise skills underscores the importance of general capabilities being retained and elevated in the curriculum'.

Internationally, the OECD (2018) has led the way with its work on OECD 2030, arguing that:

> Future-ready students will need both broad and specialised knowledge. Disciplinary knowledge will continue to be important, as the raw material from which new knowledge is developed, together with the capacity to think across the boundaries of disciplines and "connect the dots"'… 'students will need to apply their knowledge in unknown and evolving circumstances. For this, they will need a broad range of skills, including cognitive and meta-cognitive skills (e.g. critical thinking, creative thinking, learning to learn and self-regulation); social and emotional skills (e.g. empathy, self-efficacy and collaboration); and practical and physical skills (e.g. using new information and communication technology devices).

And Australia is not alone. There are many countries now seeking to enhance their curriculum through attention to 21st-century skills. Lambert (2017) observes that most countries are trying to include in their curricula, in one form or another, problem-solving/critical thinking/creative thinking; communication (multi-literacies); social skills and teamwork; resilience; ICT skills/digital literacy; self- and social-awareness; respectful relationships; innovation and enterprise; intercultural understanding/global mindset; and self-efficacy.

Unquestionably, there has been significant effort and progress over the last nine years. However, is that progress adequate? Students who started in school in 2011, the year after the Australian Curriculum was approved, are now in Year 8. Is it the case that these young Australians are all well on their way to being 'successful learners, confident and creative individuals, and active and informed citizens' as a result of the national commitment to setting and meeting expectations for all young people, or is it that achieving this goal is still subject to chance – and should this be the case?

Torii and O'Connell (2017) argue that 'although progress is being made on embedding the capabilities young people will need into the curriculum, and there are some sites of world-leading practice in Australia, there is more to be done to ensure all young people are adequately equipped for the future.'

Adding to the imperative that more needs to be done, more quickly, Gonski (2018) observed that:

> The world is not going to slow down and wait for Australia to catch up. We live in an increasingly complex and competitive global economy where success in the future will be defined by our ability to support the learning needs of individual children.

There is commitment, there is expectation, there is change to practice, there is advice and support for teaching and assessment, but is there the extent and quality of change that is desired, if not necessary, for Australia to meet the goal that was set for young Australians more than 10 years ago?

Need to do more, systematically, nationally and learning together

An analysis of implementation literature provides some insights about what is not happening and what could occur to realise the goal that has been set in relation to the general capabilities.

Overall, efforts in Australia to realise the potential of the general capabilities seem more like diffusion and dissemination, rather than what Lyon (2017), referring to Greenhaigh et al., defines as implementation, that is, the use of 'deliberate strategies in specific settings to adopt new interventions, integrate them effectively, and change practice patterns'. If we are serious about the teaching and learning of general capabilities (as well as discipline-based knowledge, understanding and skills), and want all students in all schools to be learning these capabilities, there is a distinct need for an implementation plan that goes way beyond setting expectations, which are laid out in the Australian Curriculum, through to systematic identification and engagement of all of the actors in the process.

Such an implementation plan should pay attention to the fidelity of implementation, with an explicit focus on all Australian students having the opportunity to develop and demonstrate achievement of the general capabilities. Scoping work undertaken for Social Ventures Australia's E4L program by Albers and Pattuwage (2017) concludes (unsurprisingly) that there 'are indications in the literature that high quality implementation contributes to improved educational services and thereby to better student outcomes'. More valuably, it draws attention to a staged approach to implementation based on its examination of implementation frameworks while also highlighting the need for the 'development and funding of rigorous study designs aimed at testing different approaches to implementation of evidence-based practice in classrooms, schools and school systems'.

However, it may be that in some places in Australia this is already occurring, albeit within the walls of an organisation(s); and this highlights another need to be addressed – greater collaboration in the development, publication and dissemination of what works best in schools. This continues to be a challenge for Australia, with many citing constitutional responsibilities for education; however, some argue that we can and need to do better. Bentley and Savage (2017) argue for 'an agenda for system reform that systematically seeks to scale and connect different efforts and build shared institutional capabilities'. Hattie (2017) proposes that our system needs to be rebooted to overcome barriers if Australia is to have 'an education implementation model that is shared between schools and not resident in only a few, dependable recognition of excellence, and a celebration of success of our teachers and school leaders'.

There is a need to establish a confident and sustainable approach to enable the system(s) to learn. Scoular and Heard (2018) argue that 'schools may not be in a position to take a risk in adopting one approach over another without evidence of its effectiveness and researchers can't provide evidence of effective approaches until schools opt-in to trials'. While there are researchers who are ready and willing to work with schools, there may be a need for, and potential gain in, rewriting some of the rules and protocols about how this happens in schools and within and between school systems and sectors. In the few years since it commenced operation in 2016, Social Ventures Australia's Evidence for Learning (E4L) initiative has made a significant contribution to meeting such a need, through its engagement with teachers, schools and school systems to promote an evidence-based national conversation and by making the learning and tools available for all. In particular, its advocacy for innovating, proving and then scaling provides the framework for building evidence-informed practice across the country.

The aphorism 'a rising tide lifts all boats' is very apt in discussion about our national desire to improve progress and attainment for all young Australians, wherever they go to school. It is particularly applicable in our federation in relation to the teaching and assessment of general capabilities, given what is still to be learned and delivered – not just by students.

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Digital literacy skill development: Prescriptive learning analytics assessment model

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Abstract

There is a broad awareness of how information communications technology (ICT) digital literacy impacts everyday life. In schools, use of ICT tools has become mandatory. These tools include computers, tablets and mobile phones. These smart devices are used to send emails, browse the internet and make video calls. It is essential for teachers to identify student digital literacy levels through classroom activities and when to implement flexible ePedagogies for students who need help.

This presentation will provide easy-to-follow steps to manage learning analytics to determine digital literacy skill levels. Learning analytics can be used for a range of purposes: to compile assessment reports for individual learners to know how they rate compared with other learners; to highlight students who may need extra support; to assist teachers to plan supporting interventions for individuals and groups of learners; to support professional development teams when considering new courseware design and development; and to support institutional/corporate marketing and recruitment management strategies. However, some people may find it daunting to undertake learning analytics. This presentation will show why this perception is wrong by explaining a prescriptive learning analytics planning model. This session will give participants an understanding of the skills they need to carry out their own learning analytics through careful preparation of their testing instruments and an understanding of the importance of validating their measurement tools.

Introduction

Information communications technology (ICT) tools influence everyday life (Bradley, 2017). Digital connectivity is taken for granted as telecommunication services merge seamlessly with computer networks. In schools, using ICT tools – computers, laptops/netbooks – has become mandatory. Among other things, smart devices are used for email communication with classmates and teachers, for browsing the internet to find material for assignments and homework, and making video calls to participate in social networking. It is essential for teachers to identify students' digital literacy levels through classroom activities and know when to implement flexible ePedagogies for students needing help (Mat-Jizat, 2012).

Digital literacy is the possession of functional computer/screen-based reading and writing abilities (Spires, Paul, & Kerkhoff, 2017). When the school year starts, the digital literacy skills of students and teachers are usually unknown. However, many young people grow up surrounded by ICT, experiencing these tools as playthings (Bolstad, 2004), and because of this they are confident about seeking digital solutions in the classroom. In contrast, teachers who grew up in less ICT-saturated environments may be less comfortable using digital equipment (Dingli & Seychell, 2015).

It could be supposed that improvement in a teacher's digital skills will significantly boost their classroom confidence. To test this supposition, Mat-Jizat (2012) evaluated a task-based digital literacy tool for teacher training, capturing teachers' actual skill capability. The literacy tool was based on five categories of keyboard-based skills:

- preparing teaching and learning materials using word-processing, spreadsheet and database applications, internet searching, evaluating information found on the internet, browser bookmarking, emailing (including carbon copy and blind carbon copy features), taking a photograph, making a video, scanning a document
- using a spreadsheet to calculate students' total marks, ranking performance outcomes, and preparing graphs
- adding a new database record and making a simple database query
- social networking – correctly registering into discussion forums and posting appropriate feedback
- Word document formatting, including setting margins, adding headers and footers, adding page numbering and creating a table of contents.

Mat-Jizat's (2012) work shows that teachers digital skills could be significantly improved using a task-based digital literacy tool, and the use of one led to a substantial increase in their classroom confidence.

The purpose of this paper is to suggest that modelling digital literacy skills development requires a broader view than one concentrated on keyboard skills. According to Spires and Bartlett (2012), digital literacy extends beyond keyboarding to having the ability to make critical evaluations of digital resources. Well-designed ePedagogies adopt flexible instructional strategies for novice/experience skill development pathways (Victorian Government, 2018).

The paper is divided into two sections: a brief discussion of digital literacy skill development, followed by an introduction to a prescriptive learning analytics assessment model.

Digital literacy skill development

Ever since the advent of online (distance) education, well before the turn of the millennium, researchers have been recording how people interact with technology while they learn (Garrison, 2000). Educational researchers soon became concerned about whether the theoretical foundations of online pedagogy were strong enough to keep pace with emerging technological innovations, and stepped up their investigations of the impact of ICT tools on classroom activities (Anderson, 2008). They showed that the relationship between ICT and change in our social and psychological (psychosocial life) was strengthening. This phenomenon was first identified by Bradley with respect to converging multimodal media platforms (Bradley, 2017), and followed by others showing the relationship as a continually (digitally) connected lifestyle (see Figure 1), which has become omnipresent (De Wit, Koekemoer, & Nel, 2016).

With the rapid pace of technological change and our increased reliance upon ICT, it is no surprise that researchers are continually seeking new ways to characterise and study modern digital skills. Spires and Bartlett (2012) describe digital literacy not only in terms of 'traditional' phenomena that relate to singular computing (keyboarding) tasks, such as word processing, spreadsheets and databases, but in terms of gaining an accurate understanding of online resources through critical evaluation. Without such interrogatory digital skills, students may find themselves being led by the technology rather than overseeing their own learning adventures.

Digital literacy skills involve a complex mix of interrelating human–computer interactions (HCI) that represent the combination of ways people use ICT tools. They include: basic digital tasks (typing, searching, recording details, making calculations, printing); navigating digital content; gaining understanding from multiple digital resources; experimenting with new ways to create novel solutions; and conceptualising ways to communicate this new understanding with others. Development of these softer digital communication skills requires best practice ePedagogical strategies.

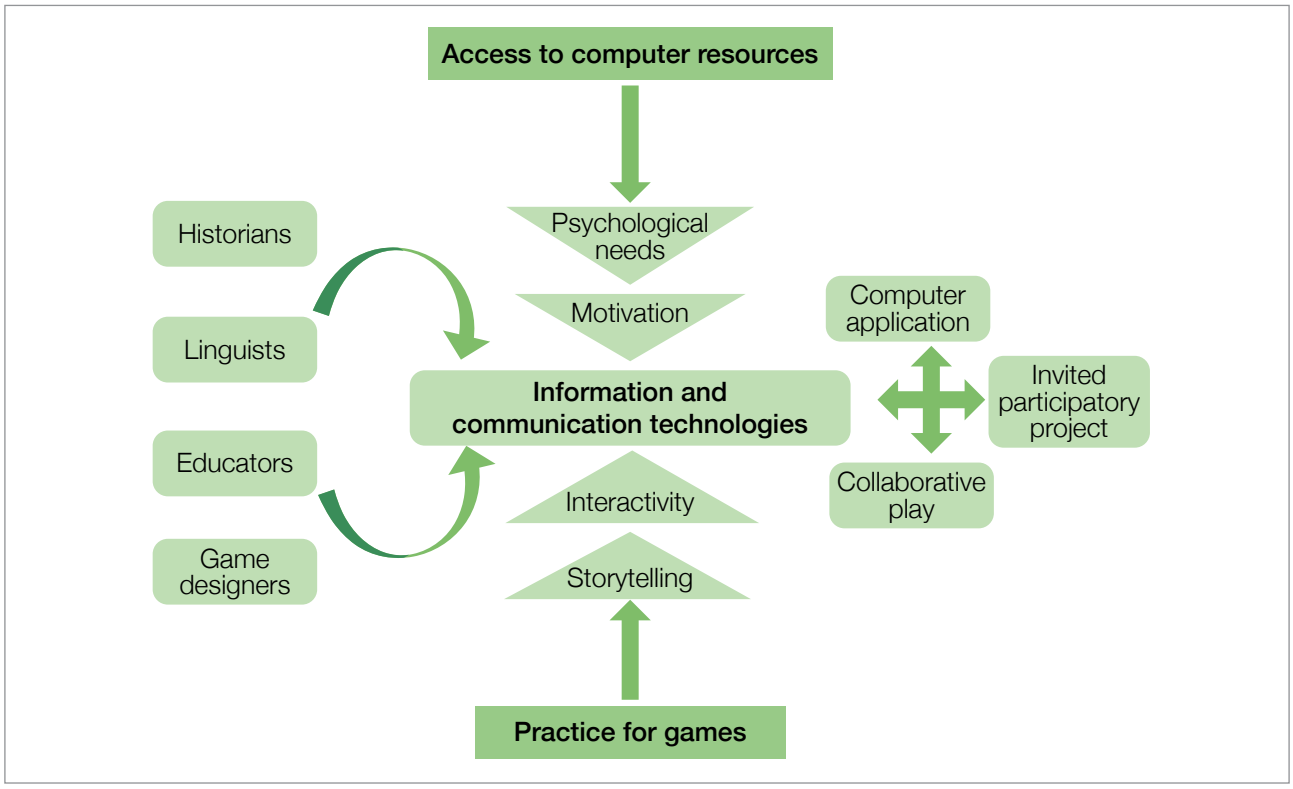

Figure 1 ICT tools signal multimodal media platform popularity (Adapted from Bradley, 2006)

Instructional objectives: Making a pizza

		Declarative		Procedural			
		Band A	Band B	Band C	Band D	Band E	
		Verbal information skill	Intellectual skill	Intellectual skill	Cognitive strategy	Cognitive strategy	
		Concrete concept	Basic rule	Higher-order rule	Identify sub-tasks	Knows the 'how'	
		Knows basic terms	Discriminates	Problem-solves	Recognises unstated assumptions	Recalls simple prerequisite rules and concepts	
		Knows 'that'	Understands concepts and principles	Applies concepts and principles to new situations		Integrates learning from different areas into a plan for solving a problem	
Task no.	**Learning domain**						**Totals**
6	Make sauce					2 questions	2
5	Make dough				3 questions		3
4	Use oven			2 questions			2
3	Measure ingredients			2 questions			2
2	Read recipe	1 question	2 questions				3
1	Decode abbreviations	2 questions					2
	Totals	3 questions	2 questions	4 questions	3 questions	2 questions	14

Figure 2 Test instrument specification matrix (Adapted from Mat-Jizat, 2012; Mager, 1988)

Prescriptive learning analytics assessment model

Learning analytics can be used for a range of purposes: for compiling assessment reports for individual learners to know how they compare with other learners, to highlight students who may need extra support, to assist teachers in planning interventions for individuals and groups of learners, to support professional development teams when considering new courseware design and development, and to support institutional/corporate marketing and recruitment management strategies. However, for some people, undertaking learning analytics may seem daunting. Instead, by following a prescriptive learning analytics planning model, in which time and energies are spent on matching task objectives to required knowledge levels and careful preparation of their assessment instruments, people should be able to carry out their own learning analytics, as outlined in the following steps.

Step 1: Instrument preparation

Design a test specification (skill building) matrix that depicts two separate pedagogical functions to determine skill/knowledge achievement levels. Conduct a thorough task analysis and list the steps needed to achieve the learning objectives for each task (start with the easiest, end with the hardest) (see Figure 2, vertical axis). Determine the types of declarative and procedural knowledge development expected for each task (see Figure 2, horizontal axis). Write out test items according to where they plot on the matrix.

A well-designed skill level test will show test items as a gradual skill building progression. Start with the easy concepts or declarative knowledge (knowing that), moving through mid-range intellectual skills to procedural or cognitive strategies (knowing the how) (Theng, 2012).

Step 2: Set scoring regime

Choose your scoring method (e.g. dichotomous, multiple choice, or partial credit scoring techniques). Write out acceptable answers in preparation for the marking scheme. Allocate scoring for each test item.

Step 3: Validate testing instrument

Use an appropriate software application to check your test items are a fit for the Rasch model (Bond and Fox, 2015, list several such applications). Enter the scored test outcomes into the Rasch measurement application (usually by submitting a test scores input file, often as a spreadsheet or text file). Run the application, examine the result and remove test items considered bad questions from the input file. Rerun your item analysis until all test items are a Rasch model fit (see Figure 3).

Figure 3 represents Rasch estimate data shown here as a data map. The vertical dotted lines represent the fit thresholds; items to the right of the upper threshold (1.25) underfit the Rasch model and are considered bad items that must be removed from the test scores input file, while test items to the left of the lower threshold (.74) overfit the Rasch model, so are redundant items that can also be removed from the input file.

These Rasch measurement applications provide a unidimensional scale. Figure 4 shows equal intervals along each axis that measure people's performance (each X on the left-hand side represents one participant) and test items together (numbered on the right-hand side). ACER software for Rasch measurement is available from https://www.acer.edu.au/conquest (Adams, Wu, & Wilson, 2015; Wu & Adams, 2007).

Step 4: Modify test items

Check the compatibility of the model and the data through the item fit statistics in the Rasch measurement application. Delete and/or modify non-fitting test items as they shift along the scale throughout this process. This iterative process has very powerful benefits, such as revealing what can happen without careful attention to non-fitting test items. Figure 5 depicts a poorly designed instrument that was too easy for the students/trainees.

Step 5: Implement test

Give properly validated test items to participants (students/trainees) in a pre-and-post-test assessment instrument. For instance, when investigating the effectiveness of an instructional strategy/learning program, a pre-test will determine the level of skills/knowledge before people undertake it, while the post-test will measure any change/knowledge acquisition after the instructional intervention.

Step 6: Analyse results

Expressing the magnitude of change in a student's/trainee's proficiency following an instructional program, as the magnitude or size of effect, as defined by Cohen's statistical power analysis (Cohen, 1977), has become popular with researchers (Bakkar, 2016). Some Rasch model applications provide a Quest item analysis output table (Figure 6). This table gives the best of both measurement practices of classical test theory and item response theory in establishing the Rasch model's discrimination value.

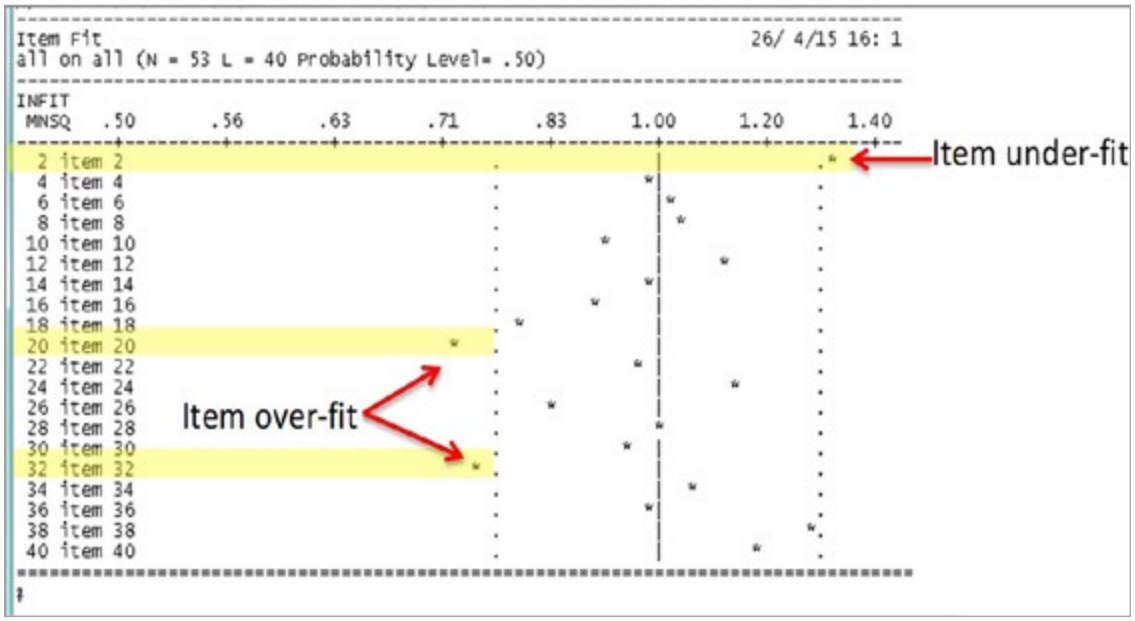

Figure 3 Rasch model – item fit (Adapted from Bakkar, 2016)

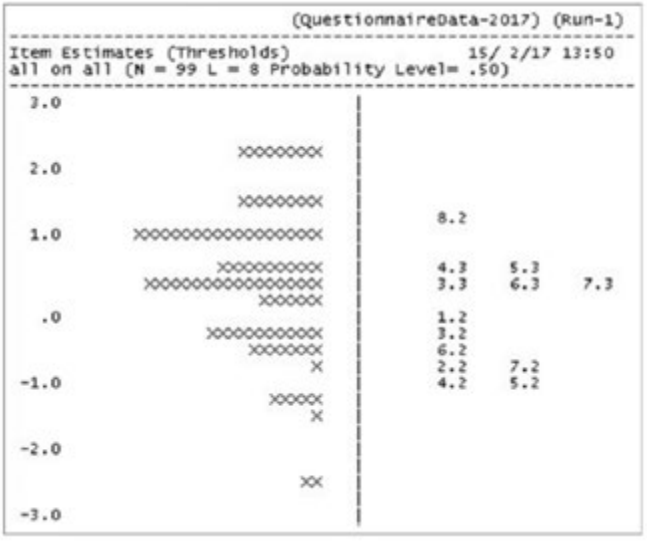

Figure 4 Rasch model – example variable map

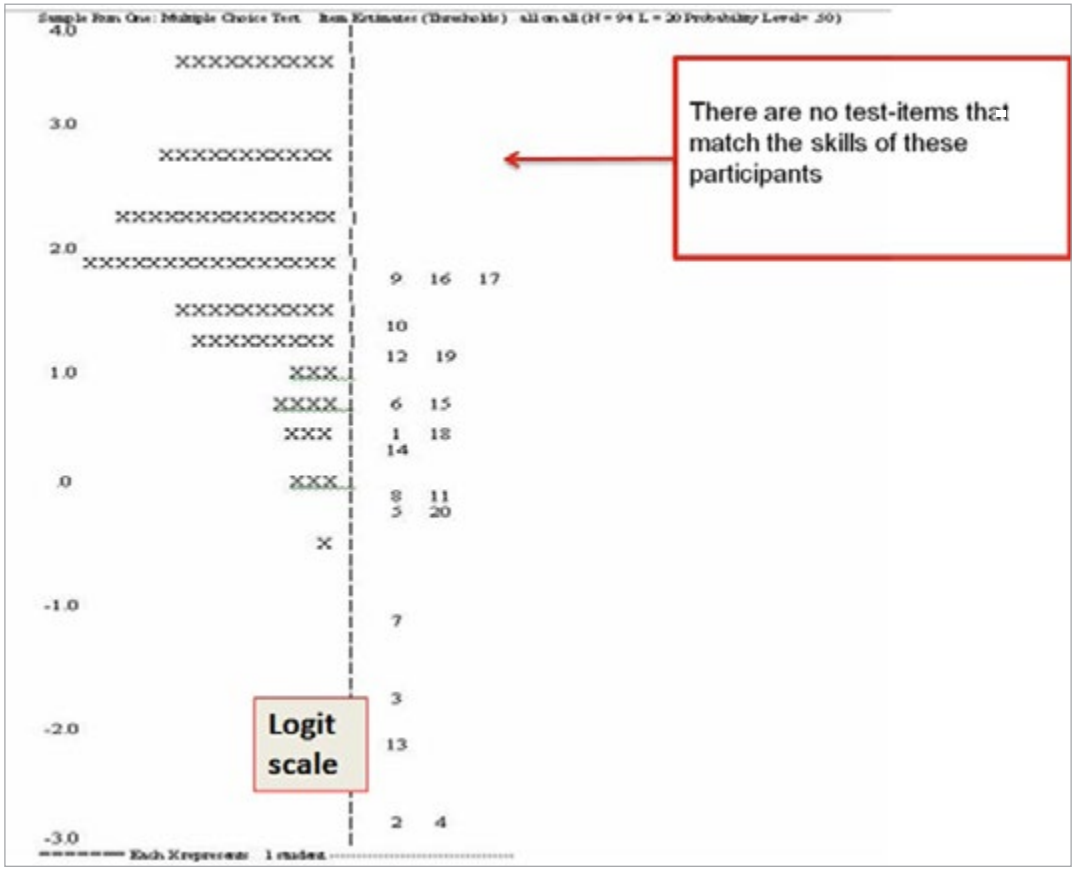

Figure 5 Poorly designed instrument

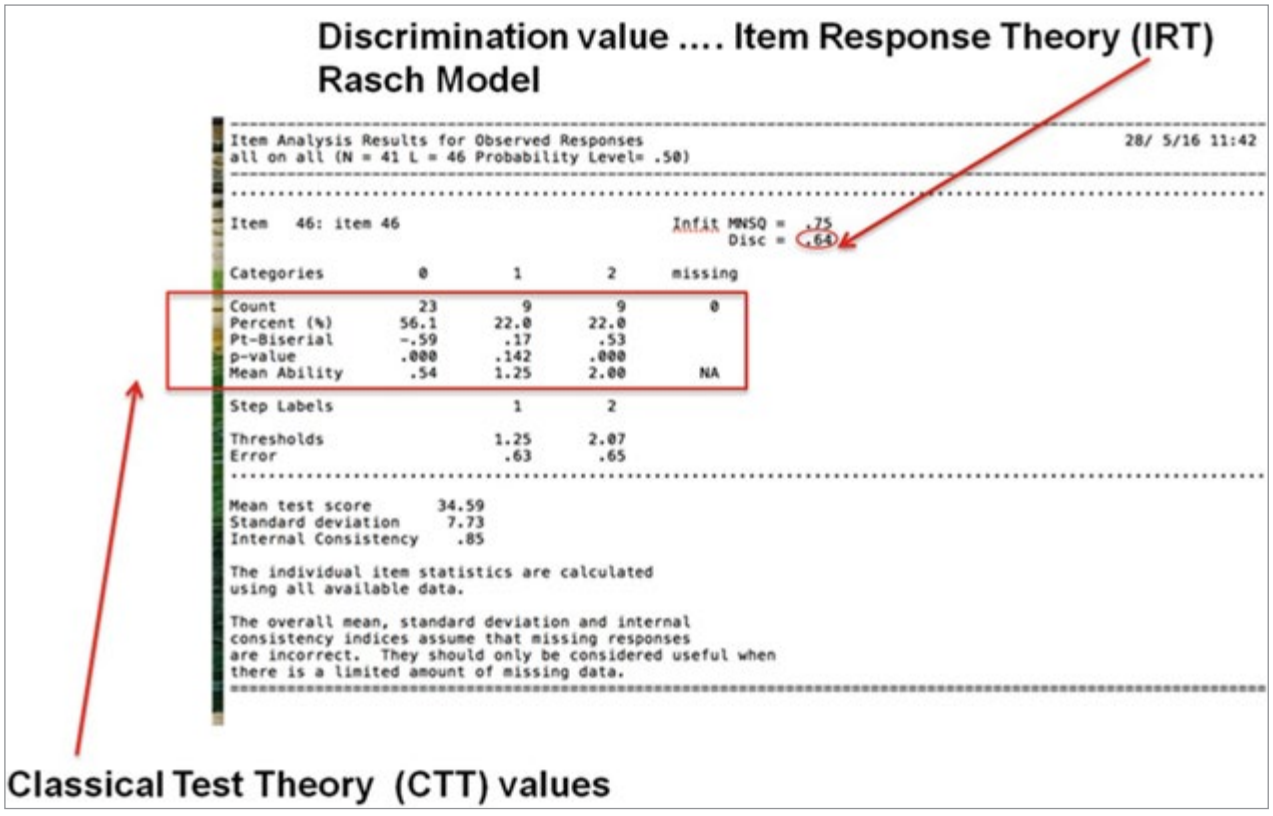

Figure 6 Test item analysis table

Summary

This paper opened with the impact of ICT and digital literacy on our everyday lives and then discussed testing learning performance through a prescriptive learning analytics model. School students are required to navigate their digital learning materials through critical evaluation of various multimodal media platforms. Without carefully crafted ePedagogies, learners will miss opportunities to expand their horizons using 21st-century digital communication skills. Adopting a prescriptive learning analytics assessment model will ensure that teachers/classroom facilitators keep track of digital literacy skill levels by implementing a summative assessment regime that checks accumulated knowledge/skills as classroom activities progress.

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Conference papers:
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Teaching and assessing the general capabilities in a secondary school context

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Loren Clarke is the Curriculum and Data Leader at Eltham High School. She teaches Extended Investigation in Years 10 and 12 and VCE English. Through her role at the school, Loren has developed a program of assessment focused on 21st-century skills, which include critical thinking, collaboration and problem-solving. Over the past eight years, Loren has also been involved in the development of VCE Extended Investigation and the broader application of inquiry-based pedagogy and thinking structures in the secondary years of schooling. She is currently completing a PhD at the University of Melbourne on the potential implications of interdisciplinary and inquiry subjects for teaching and learning in secondary education.

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Abstract

Education researchers, policymakers and private enterprise agree that, in addition to content knowledge, students in the 21st century need to acquire particular skills to equip them for active citizenship in the modern world. This is a real challenge for teachers today: how do they teach and assess the skills needed to live and work in the 21st century? This paper will explore the development of Eltham High School's focus on teaching and assessment of collaboration, problem-solving, and critical thinking over the past seven years. It will explore the development of the assessment program, its connection to the school and state curriculum, and impacts on staff and students.

Introduction

In recent years, a good deal of attention has been given to the development of 21st-century skills as a means of preparing our students for the world into which they will graduate.

What is undeniable is that the rate of change in the world has accelerated exponentially, largely due to technology. The world that the students are navigating, negotiating and attempting to reconcile is fundamentally different to the one we may have experienced in our own education. The way in which knowledge is gained, built and shared, requires our students to think in new and different ways.

Education researchers, policymakers and private enterprise agree that, in addition to content knowledge, students in the 21st century need to acquire particular skills to equip them for a modern world of work; the ability to think critically, to collaborate, communicate, innovate and to solve problems.

Both the Australian Curriculum and the Victorian Curriculum articulate clearly the capabilities that a child needs to develop as they progress through school. How and where these skills are taught remains the decision of the school.

Eltham High School recognises the importance of the development of these skills. Creativity sits proudly among a well-established and adhered-to set of school values that underpin everything we do. For over a decade, the school has sought to shake things up so that we can move disciplines out of their content silos and into a more coherent and connected learning context.

Prior to the introduction of the general capabilities, the structure of the curriculum at Eltham High School was reworked to carve out time and space to teach these skills in an authentic context through the development of the integrated studies curriculum at Year 7. This curriculum is underpinned by an inquiry model (shown in Table 1) that is structured on the basis of work by Kath Murdoch and is grounded in the work undertaken in the surrounding primary schools.

Eltham High School is a school that is very different to a lot of other schools. We look critically at the way that we define ourselves. We want students to be the creators of their own knowledge and we know that as teachers we have to step back from being the font of all knowledge. We know that if we get too caught up in the traditional content of our disciplines, we leave little room for the development of the skills that we know our students need.

The Eltham High School Integrated Studies Program has a focus on big-ideas and real-world learning and has provided increased opportunities to focus on the teaching of generic skills. This interdisciplinary learning space has given time to teach thinking, communication, collaboration, problem solving and innovation, to step out of the race to cover content and build the generic skills that students need.

Scope and sequence curriculum that defines what these capabilities look like, and consequently what growth looks like across a continuum, ensures that the program makes time for the teaching of routines and strategies. As these are employed, they allow students to demonstrate their development.

We recognise that students come to us at high school at a range of points along the various continua – some ready to undertake the types of thinking expected at pre-tertiary levels but with limited experience in effective collaboration, others with rudimentary development in their thinking skills but as expert communicators. Our task is to identify where the students are at on each of these continua and teach them at the level that will allow them to move to the next stage through a dynamic and flexible model that can offer differentiation across many areas.

At Eltham High School, many familiar classroom practices and instructional strategies that focus on building the capabilities are used over and over again in a way that makes them a core practice of the classroom. For example, 'KWL' (What do you know? What do you want to know? What did you learn?), brainstorming, pushing students to give evidence and to reason by asking them 'Why?', classroom arguments or debates, journal writing, questioning techniques

are used to develop thinking skills. Socratic circles are regularly used to support communication and collaborative spaces (both online and paper based) are routinely used to build knowledge across teams.

In *Intellectual character: What it is, why it matters, and how to get it*, Ritchhart (2002) writes of developing explicit and goal-driven routines for thinking in classrooms. 'For these routines to be effective, they usually consist of only a few steps, are easy to learn and teach, can be scaffolded or supported by others, and get used over and over again in the classroom'.

Ritchhart also sees routines as a major enculturating force to communicate expectations for thinking as well as providing students with the tools that they need to engage in that thinking.

Thinking routines help students answer questions they have:

- How are ideas discussed and explored within this class?
- How are ideas, thinking and learning managed and documented here?
- How do we find out new things and come to know in this class?

As teachers, we work to uncover the various thinking, communication and collaboration routines that support students as they go about this kind of intellectual work. When we find gaps, we create new routines and through trial and error, evaluate, refine and improve on these with each new cycle of teaching and learning.

The end result is a bank of teaching and learning resources, protocols and routines that are applied across the course of a student's secondary school experience. Once taught explicitly in Year 7, we see the students go on to engage with these tools as they move through the school.

Assessing the capabilities

Gaining an accurate picture of a child's current capabilities is essential to knowing how to tailor their educational experiences to support their growth. This is the goal of all assessment. This information allows teachers to devise ways to support and foster development in young people, and allow us to be confident that we are indeed providing the strong educational base that they require for their future. Alongside the development of inquiry and 21st-century skills teaching within the school, Eltham High School has articulated a commitment to explicitly assessing and reporting against such skills. The purpose of assessing and reporting on such skills has the same purpose as assessing subject area skills; however, given the relatively new nature of assessment and reporting in this field, measuring students' proficiency on 21st-century skills may require methods that extend beyond traditional approaches. Before commencing any assessment, the skill being measured needs to be identified and the method of collection must be relevant to the skill under investigation. There needs to be a common and articulated understanding of the hierarchical nature of learning the skill. To record and interpret student proficiency on a 21st-century skill, there needs to be a framework that demonstrates different amounts of the skill and tasks or activities need to be identified that demand different amounts of that skill. The activities need to be in accordance with the increasing level of competence so that when they are administered to students, the students' position on that progression can be identified and monitored. In order to achieve this, the school has developed rubrics and assessments tied to developmental continua of practice that can be applied across all curriculum areas.

At the same time, a broader program of standardised testing using validated assessment tools is in place. Both the ATC21S Collaborative Problem Solving and the ACER Critical Thinking tests are embedded within testing from Years 7–10 in order to develop a greater understanding of the continua of skill development within the school and benchmark student achievement against long-term internal standards of achievement (see Table 2). Assessments aligned with developmental rubrics further validate teacher judgements and inform curriculum and program planning at a higher level for teaching and year level teams.

In particular, through undertaking this program of assessment, we have identified that engagement in 21st-century skill teaching and learning leads to positive progress in learning while it has also identified a gap in understanding about how these skills relate to one another. For example, many students are proficient at problem-solving but struggle to work with others collaboratively. Similarly, some students collaborate well but do not perform as well when a task has cognitive demands. Continued engagement with 21st-century teaching and learning is therefore necessary to continue, and maintain, the development of the general capabilities. Longitudinal data that track the development of cohorts' skills from Years 7 to 10 indicates that students' skills develop steadily across Year 7 and continue to develop through multiple exposures and embedded teaching and assessment throughout the following years of secondary schooling.

We are committed to expanding our teachers' understanding of the capabilities, their ability to develop effective interpretations of how they might work to explicitly teach these capabilities, and create situations in our classrooms that prompt the use of them, nurture and reward them.

Eltham High School's inquiry teaching and learning model

Rationale

Inquiry-based approaches to teaching and learning at Eltham High School encourage students to make connections in their learning across a range of disciplines and develop both broader learning dispositions as well as specific research and investigation skills. The focus of inquiry is dually *on* understanding learning processes as well as content. The school recognises that an inquiry-based approach to learning nurtures students' passions and interests and empowers them to make choices in their own learning. It aims to foster curiosity and a life-long love of learning through exposing students to real, open-ended problems that enable deep learning. Through engaging with inquiry-based approaches, students develop an ability to:

- ask good questions
- develop persistence, motivation and self regulation
- be encouraged to take risks and become resilient
- critically consider the value and impact of information
- reflect on their thinking and learning process
- develop an understanding of the research process
- building a real-world context for learning.

As students move through inquiry at Eltham High School they are given increasing levels of responsibility for their own learning and inquiry process. This moves from highly structured and guided approaches at Year 7 to greater student direction at Year 9 and 11. Regardless of the structure, the teacher is a central aspect of guiding student learning using a combination of inquiry pedagogy and direct instruction. This is designed to provide students with the knowledge and skills they need to be successful in their inquiry learning. At all levels, the curriculum knowledge generated within student inquiry is as important as the development of research skills and both work together to deliver learning outcomes on intellectually rigorous topics.

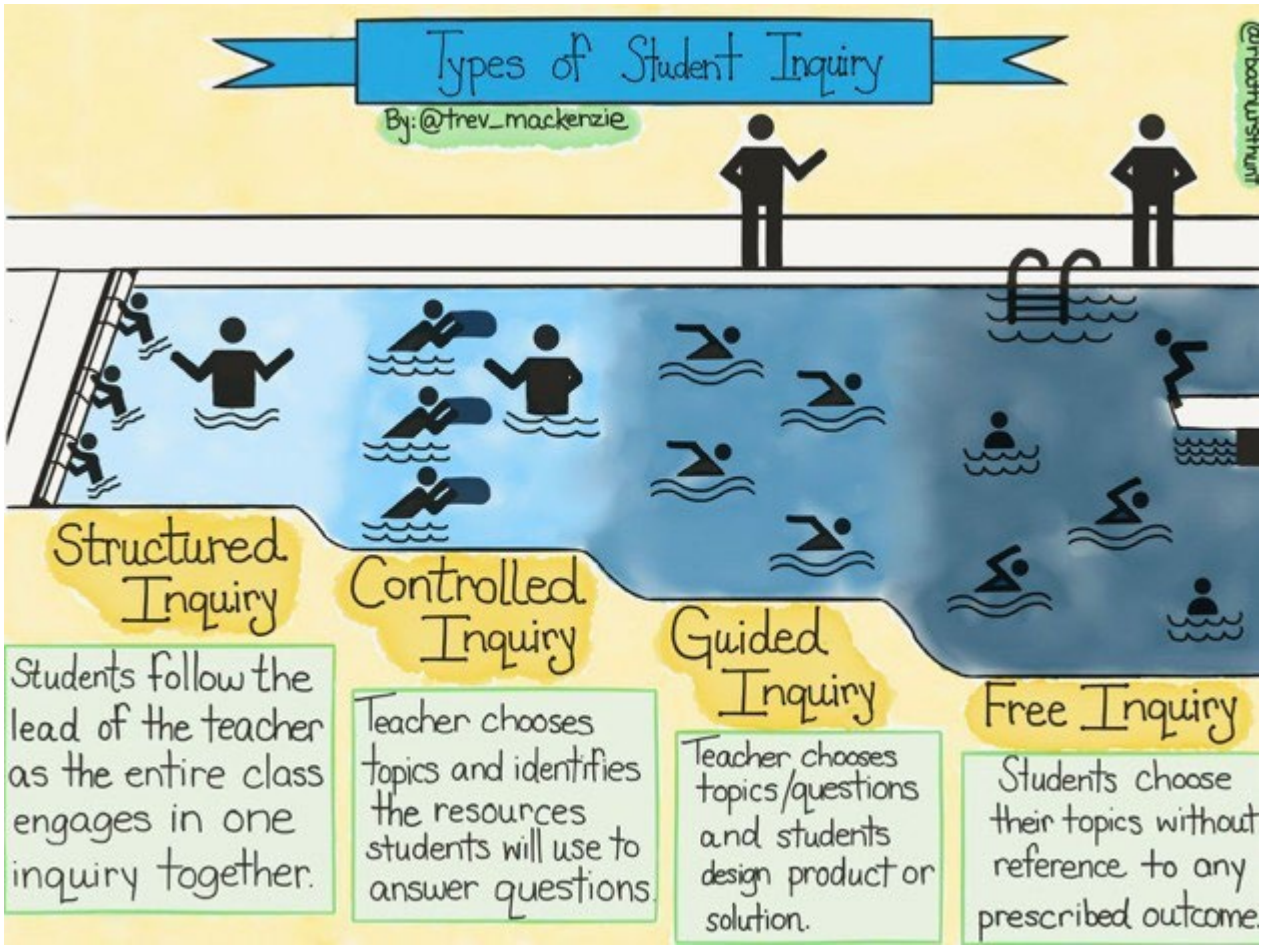

Figure 1 Progression of inquiry teaching and learning

Table 1 School inquiry model

Engaging		
Purpose • To understand what students already know, think and can do • To provide students with opportunities to be engaged with the topic • To help plan future learning and differentiation.	This might look like • Artefact or gallery walks • Watching thought-provoking clips • Mind mapping • Completing reflection tools • Brainstorming • Generating KWL charts • Excursions/Incursions • Guest speakers • Image analysis.	Skill progression
Building key knowledge		
Purpose • To continue building students' curiosity and knowledge. • To establish meaning and significance • To develop students' understanding of essential concepts, skills and knowledge.	This might look like • Direct instruction of core content/skills • Note taking • Short research tasks • Guest speakers • Excursions/Incursions • Jigsaw activities • Think, pair, share • Experiments • Image analysis.	Skill progression
Making connections		
Purpose • To synthese new learning • To connect new learning to existing knowledge; upcoming tasks; significance of topic • To encourage students to begin applying and transferring knowledge • To identify areas of interest/ questions to pursue • To challenge existing beliefs, ideas and values.	This might look like • Introducing assessments • Creating collages • Critical thinking activities regarding information • Using graphic organisers to sort and categorise information • Graphing information and perspectives.	Skill progression
Researching		
Purpose • To develop research skills • To make sense of information • To document development of ideas • To reflect on how knowledge and skill has expanded.	This might look like • Defining the problem at a smaller scale • Note taking and researching from: - books - internet - interviews - visual source analysis, original data collection (surveys, focus groups) • Reflecting on validity and reliability of information • Individual or group project work.	Skill progression
Responding		
Purpose • To assist students to make conclusions and propose solutions • To assess and demonstrate students' progress towards learning goals • To encourage reflection • To support students to consider the impact of audience and relevant presentation modes • To support students to present and justify a case/position.	This might look like • essays • debates • games • concept maps • posters • videos/advertisements/radiosegments • models/dioramas • oral presentations • drama performances.	Skill progression

Table 2 Developmental rubric

	Emerging		Consolidating		Established
Engaging					
Prior knowledge	With support students begin to engage with the inquiry area and can identify what they already understand about a topic and their personal interest.	With support students begin to engage with the inquiry area and can identify what they already understand about a topic and their personal interest.	With support students begin to engage with the inquiry area and can identify what they already understand about a topic and their personal interest. They begin to consider other perspectives.	As students engage with the inquiry area they can independently identify what they already understand about a topic and their personal interest. They consider a number of different perspectives and how this compares to their own.	As students engage with the inquiry area they can independently identify what they already understand about a topic and their personal interest. They consider a range of different perspectives and the factors that have led to their own position.
Building knowledge					
Documenting knowledge	Students are scaffolded to take notes and document their learning within structured templates/ worksheets.	Students are scaffolded to take notes and document their learning within structured templates/ worksheets.	Students are scaffolded to take notes and document their learning within structured templates/ worksheets.	Students are scaffolded to take notes and document their learning in the most appropriate format.	Students can independently take notes and organise their ideas.
Making connections					
Connect ideas	Students can use a range of structured graphic organisers to make links between key ideas and their own understanding.	Students can use a range of structured graphic organisers to make links between key ideas and their own understanding.	Students begin to select relevant graphic organises and ways of representing information to make links between key ideas and their own understanding.	Students independently engage in making links between key ideas and their own understanding. They begin to deal with a wider range of material and are supported to establish connections.	Students independently engage in making links between ideas and their own understanding. They identify links between a wide range of ideas and material.
Thinking critically	Students can use a range of structured critical thinking activities to reflect on: the development of arguments, bias, problem-solving, and developing creative solutions.	Students can use a range of structured critical thinking activities to reflect on: the development of arguments, bias, problem-solving, and developing creative solutions.	Students can use a range of structured critical thinking activities to reflect on: the development of arguments, bias, problem-solving, and developing creative solutions. They can begin to identify connections between these activities and their own independent work.	Students can use a range of structured critical thinking activities to reflect on: the development of arguments, bias, problem-solving, and developing creative solutions. There is increasing evidence that they are able to use these strategies independently in their own reasoning and processing of information.	Students can use both a range of structured critical thinking activities and their own critical thinking capabilities to reflect on: the development of arguments, bias, problem-solving, and developing creative solutions. There is evidence that they can apply these strategies independently throughout the conduct of their research.
Reviewing knowledge	Students use checklists provided by teachers to ensure they have reviewed relevant knowledge and developed their understanding. With support they use this to identify areas for further consolidation. They use information provided by teachers to support identified gaps.	Students use checklists provided by teachers to ensure they have reviewed relevant knowledge and developed their understanding. With support they use this to identify areas for further consolidation. They use information provided by teachers to support identified gaps.	Students begin to independently reflect on the development of their knowledge. With support they can identify areas for further consolidation and are provided with information to support these gaps.	Students independently reflect on the development of their knowledge and identify areas for further consolidation. With support they can locate information to support these gaps.	Students independently reflect on the development of their knowledge and identify areas for further consolidation. They can independently locate information to support these gaps.

	Emerging		Consolidating		Established
Researching					
Question development	Students are able to conduct independent research within a set topic/question scaffolded by the teacher. In some cases they narrow this to a specific issue/solution of their choice.	Students are able to conduct independent research within a set topic/question scaffolded by the teacher. They have greater choice in narrowing this to a specific issue/ solution of their choice.	Students are able to independently develop a research question within a set field of study. This is guided by/negotiated with their teacher.	Students are able to independently develop a research question within an area of interest. This is guided by/ negotiated with their teacher.	Students are able to independently develop a research question within an area of interest. This is guided by/ negotiated with their teacher.
Resources (validity, provision of resources, terminology)	Students are supported through their research through the provision of key resources. They are able to identify further resources with support. Students are guided to begin assessing the reliability of information and the usefulness of this information to answer their question.	Students are supported through their research through the provision of key resources. They are able to identify further resources with support. Students are guided to begin assessing the reliability of information and the usefulness of this information to answer their question.	With support students are able to identify relevant sources. With support they can assess the validity and reliability, and usefulness of this information to answer their question.	Students are able to independently identify relevant sources of information. They begin to access academic research to further support this. With support they can assess the validity and reliability, and usefulness of this information to answer their question.	Students are able to independently identify relevant sources of academic research. They can independently judge the validity, reliability, and usefulness of this information to answer their question.
Attribution of ideas: Referencing	Students can document their research using bibliography scaffolds. They understand that the attribution of information is an important part of the research process.	Students can document their research using bibliography scaffolds. They understand that the attribution of information is an important part of the research process.	Students can document their research using bibliography scaffolds. They understand that the attribution of information is an important part of the research process.	Students understand the components of a bibliography and begin to reference accurately in their work. With support they can engage in academic referencing consistently with an established referencing system.	Students can independently generate bibliographies and use academic referencing that is consistent with an established referencing system.
Note taking	Students can use structured note taking templates to document their information and engage in learning tasks.	Students can use structured note taking templates to document their information and engage in learning tasks.	Students can use structured note taking templates to document their information and engage in learning tasks.	Students can independently take notes as they collect information and engage in learning tasks. They begin to consider the most appropriate format for their notes.	Students can independently take notes as they collect information and engage in learning tasks. They use a range of note taking structures and consider the most appropriate format for their notes.

	Emerging		Consolidating		Established
Responding					
Understanding audience	With support students can identify specific audiences for their presentation and consider the needs of these people when formatting and structuring their information.	With support students can identify specific audiences for their presentation and consider the needs of these people when formatting and structuring their information.	Students begin to independently identify different audiences and consider how their presentation can be most effectively conveyed for these groups. They consider aspects such as format and tone to meet the needs of these audiences.	Students begin to independently identify different audiences and consider how their presentation can be most effectively conveyed for these groups. They consider aspects such as format, language, and tone to meet the needs of these audiences.	Students can independently consider the demands of the audience and the impact of this on their presentation. They consider aspects such as language, format, tone, and visual representation of information to meet the needs of specific audiences.
Terminology	Students begin to use key terms identified in class within their work.	Students begin to use key terms identified in class within their work. There is increasing accuracy in their use of terminology.	Students use an expanding range of key terms identified in class within their learning. There is increasing accuracy in their use of terminology.	Students use a wide range of key terms in their work. They are able to identify some of this terminology independently.	Students engage with the key terminology across their inquiry area. They identify key terms and begin to use synonyms to adjust this across their work.
Responding to research area	Students present a response to the research question/ issue/problem. They demonstrate they have taken into account the materials presented to them and have made some general connections between ideas.	Students present a response to the research question/ issue/problem. They demonstrate they have taken into account the materials presented to them and have made some general connections between ideas.	Students present an increasingly detailed response to the research question/ issue/problem. They demonstrate they have taken into account the materials presented to them and have begun to collect additional information to expand this. They are able to make some general connections between ideas and their research question.	Students present a detailed response to their research question. They demonstrate that they have taken into account a range of information and have begun to make connections between ideas in coming to their conclusions. They have connected all information to their central research question/issue/ problem.	Students present a coherent and detailed response to their research question. They demonstrate that they have taken into account a range of information and have synthesised this in coming to their conclusions. They are able to critically engage with ideas and connect all information to their central research question/issue/ problem.
Selection of medium	Students select from a number of provided formats to present their information. They begin to demonstrate an understanding of the required format and conventions of this presentation medium.	Students select from a number of provided formats to present their information. They begin to demonstrate an understanding of the required format and conventions of this presentation medium.	Students select from a number of provided formats to present their information. They begin to consider the most appropriate format for their work. They demonstrate an increasing understanding of the required format and conventions of this presentation medium.	Students independently select from a range of presentation mediums. They consider the most appropriate format for their work and demonstrate an understanding of the required format and conventions of this presentation medium.	Students independently select from a range of presentation mediums. They consider the most appropriate format for their own and can justify their selection. They demonstrate an understanding of the required format and conventions of the medium.

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Not just for the kids: Adult skills in the 21st century

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Abstract

This paper presents a perspective on what we as educators, policymakers and citizens can learn from the development, implementation and the resulting research and insights arising from international adult skills surveys.

Background

As part of Australia's National Assessment Program (NAP), samples of Australian school-aged children participate in a number of international assessments:

- the Trends in International Mathematics and Science Study (TIMSS) is conducted in four-year cycles for Year 4 and Year 8 students and assesses mathematics and science
- the Progress in International Reading Literacy Study (PIRLS) is conducted in five-year cycles for Year 4 and Year 8 students and assesses reading
- the Programme for International Student Assessment (PISA) is conducted in three-year cycles for 15-year-olds and assesses reading literacy, mathematical literacy and scientific literacy. Other domains are offered from time to time such as problem-solving and financial literacy.

What is less well-known and acknowledged is that Australia also participates in international assessments of adult skills, and has done so since 1996. These surveys have evolved from the International Adult Literacy Survey (IALS) conducted in 1996, to the Adult Literacy and Life Skills Survey (ALLS) in 2006 through to the Programme for International Assessment of Adult Competencies (PIAAC), which was conducted in Australia in 2011–2012. Planning is currently underway for the second cycle of PIAAC, which will be conducted in 2022. PIAAC, like PISA, is conducted under the auspices of the OECD.

PIAAC is an international survey of adult skills that covers reading literacy, numeracy and problem-solving of 16-to-65-year-old adults. The Australian Bureau of Statistics (ABS) conducts these household surveys in Australia. PIAAC survey instruments are administered to a random representative sample across Australia excluding remote Indigenous adults and incarcerated adults. Australia oversamples to include a younger cohort (15-year-olds) and an older cohort (66-74 years) than the minimum international requirements. The oversampling also enables state and territory performance to be compared. PIACC 2012 was completed using pen and paper or computer.

One unique feature of these adult surveys is that participants answer a significant number of background questions (approximately 300) which, together with the assessment of respondents' cognitive skills, provide the potential for rich analysis. These background questions consist of a wide range of socio-demographic questions, and questions about skills' use and practices, which can be correlated with the cognitive skills assessed.

The skills use and practice questions attempt to find information about how people use their literacy and numeracy skills, both in everyday life and at work.

This paper focuses on the development and evolution of the reading and numeracy aspects of PIAAC; however, readers should also look at the findings and research in relation to problem-solving.

Evolution of the reading and numeracy assessments

As with all international assessments, PIAAC is underpinned by the development of comprehensive frameworks that define the skills to be assessed and describe and set out the constructs for developing the actual content of the tests.

Definitions and constructs

Definitions of these adult literacy and numeracy assessments and their constructs have changed as they moved into the 21st century, and are being revised and updated for PIAAC 2022. Table 1 sets out the definitions used in these adult literacy and numeracy assessments since 1996.

What changed and why?

A close reading of the changes in definitions over the 30 years in question brings to light the evolution in conceptualising skills as we've moved into the 21st century.

Reading

In reading, what is apparent, first, is the unification in the 2006 ALLS definition of the prose and document literacy division of 1996 into a single construct – 'literacy'. In the first international adult literacy survey, a polemical point was made, in the separate definitions of prose and document literacy, that reading comprises more than the comprehension of passages of connected text

Table 1 Definitions of literacy/reading and numeracy in adults skills surveys, 1996 to 2022

Survey (year)	Literacy/Reading	Numeracy
IALS – 1996	*Document literacy:* The knowledge and skills required to locate and use information contained in various formats, including job applications, payroll forms, transportation schedules, maps, tables, and graphics. *Prose literacy:*The knowledge and skills needed to understand and use information from texts including editorials, news stories, poems, and fiction.	*Quantitative Literacy:* The knowledge and skills required to apply arithmetic operations, either alone or sequentially, to numbers embedded in printed materials such as balancing a cheque book, figuring out a tip, completing an order form, or determining the amount of interest on a loan. Note: Quantitative literacy was assessed in IALS as one of three dimensions of literacy.
ALLS – 2006	*Literacy* is using printed and written information to function in society, to achieve one's goals, and to develop one's knowledge and potential. *Document literacy:* the knowledge and skills required to locate and use information contained in various formats, including job applications, payroll forms, transportation schedules, maps, tables and graphics. *Prose literacy:* the knowledge and skills needed to understand and use information from text, including editorials, news stories, poems and fiction.	*Numeracy* is the knowledge and skills required to effectively manage and respond to the mathematical demands of diverse situations.
PIAAC 2012 (cycle 1)	*Literacy* is the ability to understand, evaluate, use and engage with written texts to participate in society, to achieve one's goals, and to develop one's knowledge and potential.	*Numeracy* is the ability to access, use, interpret, and communicate mathematical information and ideas, in order to engage in and manage the mathematical demands of a range of situations in adult life.
PIAAC 2022 (cycle 2)	*Literacy* is accessing, understanding, evaluating and reflecting on written texts in order to achieve one's goals, to develop one's knowledge and potential and to participate in society.	*Numeracy* is accessing, using and reasoning critically with mathematical content, information and ideas represented in multiple ways in order to engage in and manage the mathematical demands of a range of situations in adult life.

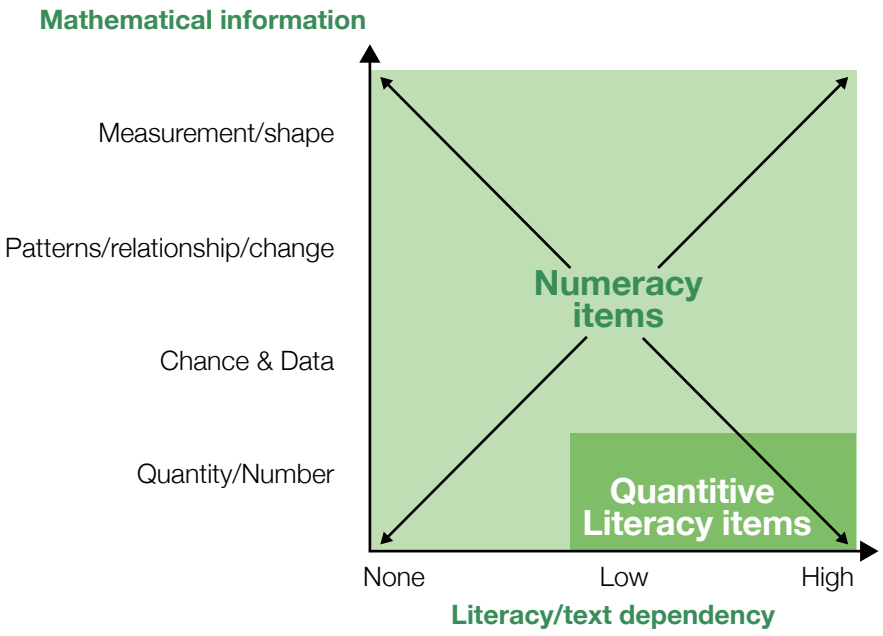

Figure 1 Numeracy versus quantitative literacy

('prose literacy', which is the traditional, school-based idea of 'reading'). It includes the ability to deal with texts such as forms, graphs, tables, maps and diagrams – the kind of reading that makes up the bulk of many adults' engagement with texts. By 2006, this expanded notion of reading was generally accepted so the division into two types of reading literacy was not needed.

A second marked feature of the 2006 ALLS definition is the new, confident statement about the purpose of literacy in the contemporary world: that literacy is needed 'to function in society, to achieve one's goals, and to develop one's knowledge and potential'. The purposes are economic, social and personal, penetrating every aspect of adult life.

A third change is introduced in the PIAAC definition of 2022: 'evaluate' now accompanies 'understand' and 'use' from the previous definitions. We see here the articulation of a growing awareness that critical literacy is a key element of 21st-century life – a capacity that goes beyond the merely functional uses of literacy that are represented by 'understand' and 'use'.

Finally (so far), in the new definition of literacy for PIAAC 2022, 'access' is included, picked up from the numeracy definition of PIAAC 2012. Access is a term that takes a 21st-century meaning that relates to the ability to search for and extract information from digital and online sources. This skill in its full sense requires not just a mechanical or technical competence, but draws also on advanced cognitive competence in analysing, selecting and critiquing from what is typically, in the online context, a plethora of possibilities.

Numeracy

In developing the argument to replace the previous quantitative literacy (QL) component of IALS with numeracy in ALLS, the numeracy expert group needed to show why numeracy was a broader and significantly different measure. While there is a clear connection and relationship between numeracy and the IALS QL measure, there are significant differences. Numeracy covers a much wider breadth of mathematical skills and purposes and is also not as heavily dependent on literacy skills where tasks are embedded in text (as they were in IALS 1996). Figure 1 illustrates the differences and highlights the wider coverage of content and item types in numeracy in ALLS compared with quantitative literacy in IALS.

As with literacy, the framework and assessment developed from the first delivery of numeracy in ALLS through to PIAAC 2022, has evolved to recognise the growing awareness that critical numeracy, like critical literacy, is a key element of 21st century life that goes beyond a merely functional perspective on numeracy. The definition and construct for numeracy in PIAAC cycle 2 has attempted to reflect the impact of the changing demands of 21st-century society and of workplaces (e.g. see Binkley et al., 2012; Foundation for Young Australians, 2017; Griffin, McGaw, & Care, 2012; Hoyles, Noss, Kent, & Bakker, 2010; Partnership for 21st Century Skills, 2016; Pellegrino & Hilton, , 2012). 21st-century skill requirements are more demanding, and require more critical, reflective reasoning skills and the ability to interpret and understand a broader range of texts and materials, and that, increasingly, the new skills interact with the digital world and technology. As a result the revised numeracy definition has some new emphases: *reasoning critically* with mathematical content, information and ideas *represented in multiple ways*.

Australian performance in PIAAC 2012

Five levels of proficiency are described in PIAAC, although Level 1 has been split into Below Level 1 and Level 1, given the high numbers of adults performing at Level 1.

Table 2 shows the proficiency descriptions for the top and the lower two levels of PIAAC, and the percentage of Australians achieving each level.

Figure 2 shows the distribution of Australia's performance across the different levels defined for PIAAC 2012 for both literacy (reading) and numeracy.

In September 2017, the OECD released a targeted country report on Australia's performance in PIAAC, *Building Skills for All in Australia: Policy Insights from the Survey of Adult Skills* (OECD, 2017). This closer examination of Australia's performance revealed the following key challenges:

- numeracy represents a particular challenge in Australia
- signs of poor numeracy performance can be traced back to initial schooling
- women have weaker numeracy skills than men
- there is a relatively large gap between the most proficient and least proficient adults in literacy and in numeracy
- many well-educated adults have low literacy and/or numeracy skills
- young women in Australia are much more likely to not be in employment, education or training (NEET) than young men. (OECD, 2017, p. 9)

The report concluded:

> Taken together, although Australia's average results are not poor, the challenges presented by adults with low basic skills may lead to Australia being left behind in terms of innovation and economic growth by countries that have been more successfully investing in the skills of all their people. (OECD, 2017, p. 9)

Table 2 Proficiency levels of PIAAC Cycle 1, with percentage of Australians per level

Level	Percentage of Australians at this level	The types of tasks completed successfully at each level of proficiency	
		Reading	**Numeracy**
Below Level 1	Reading: 3.7% Numeracy: 6.5%	The tasks at this level require the respondent to read brief texts on familiar topics to locate a single piece of specific information. There is seldom any competing information in the text and the requested information is identical in form to information in the question or directive. The respondent may be required to locate information in short continuous texts. However, in this case, the information can be located as if the text were non-continuous in format. Only basic vocabulary knowledge is required, and the reader is not required to understand the structure of sentences or paragraphs or make use of other text features. Tasks at this level do not make use of any features specific to digital texts.	Tasks at this level require the respondents to carry out simple processes such as counting, sorting, performing basic arithmetic operations with whole numbers or money, or recognising common spatial representations in concrete, familiar contexts where the mathematical content is explicit with little or no text or distractors.
1	Reading: 10.4% Numeracy: 15.3%	Most of the tasks at this level require the respondent to read relatively short digital or print continuous, non-continuous, or mixed texts to locate a single piece of information that is identical to or synonymous with the information given in the question or directive. Some tasks, such as those involving non-continuous texts, may require the respondent to enter personal information onto a document. Little, if any, competing information is present. Some tasks may require simple cycling through more than one piece of information. Knowledge and skill in recognising basic vocabulary determining the meaning of sentences, and reading paragraphs of text is expected.	Tasks at this level require the respondent to carry out basic mathematical processes in common, concrete contexts where the mathematical content is explicit with little text and minimal distractors. Tasks usually require one-step or simple processes involving counting, sorting, performing basic arithmetic operations, understanding simple per centages such as 50%, and locating and identifying elements of simple or common graphical or spatial representations.
2	Reading: 30.1%; Numeracy: 32.5%		
3	Reading: 37.9%; Numeracy: 31.3%		
4	Reading: 14.5%; Numeracy: 10.9%		
5	Reading: 1.2% Numeracy: 1.4%	At this level, tasks may require the respondent to search for and integrate information across multiple, dense texts; construct syntheses of similar and contrasting ideas or points of view; or evaluate evidence-based arguments. Application and evaluation of logical and conceptual models of ideas may be required to accomplish tasks. Evaluating reliability of evidentiary sources and selecting key information is frequently a requirement. Tasks often require respondents to be aware of subtle, rhetorical cues and to make high-level inferences or use specialised background knowledge.	Tasks at this level require the respondent to understand complex representations and abstract and formal mathematical and statistical ideas, possibly embedded in complex texts. Respondents may have to integrate multiple types of mathematical information where considerable translation or interpretation is required; draw inferences; develop or work with mathematical arguments or models; and justify, evaluate and critically reflect upon solutions or choices.

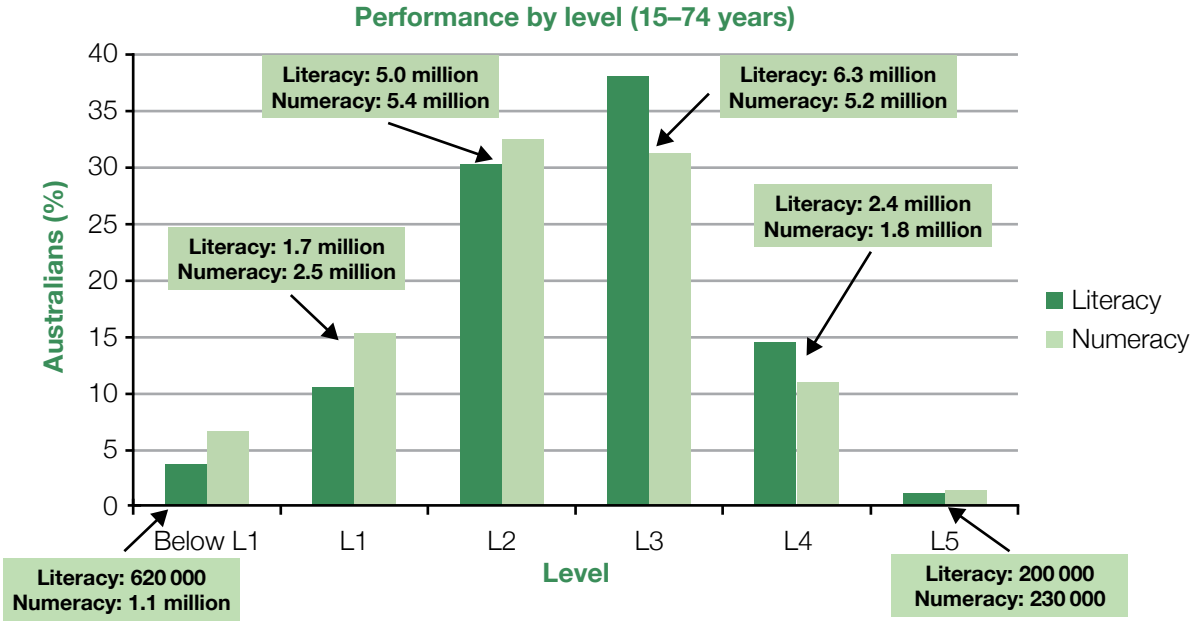

Figure 2 Proportions of persons in Numeracy in PIAAC 2012. Total Australian population aged 15–74 years

Research outcomes

Based on three cycles of international assessments of adult literacy and numeracy skills (IALS, ALLS and PIAAC), research indicates, among a number of other findings, that people with higher literacy and numeracy skills are significantly more likely to be employed, to participate in their community, to experience better health, and to engage in further training. They also earn more on average (see OECD, 2013; OECD, 2016). As well, the research demonstrates that each extra year of education improves literacy and numeracy skills.

An example of the analytic potential of PIAAC is shown in the graph in Figure 3.

The data demonstrate that adults with high proficiencies in literacy and in numeracy are much more likely, compared to those with lower skills, to report good health, to be employed, to have higher earnings, and to have positive social dispositions and take part in community life. The odds ratios shows the likelihood of positive social and economic outcomes among highly proficient adults (those scoring at Level 4/5) compared with less proficient adults (those scoring at Level 1 or below) were considerably higher for numeracy in the areas of health, employment and high salary, compared to literacy. These data show that numeracy can play a more important role than literacy in both human and social capital terms.

The value of PIAAC and some key messages for Australia

Participation in international surveys of learning and skills can provide very practical information to inform policy and practice

Information relevant to teaching and learning stems from the theoretical frameworks, constructs and descriptions of the adult skills assessments and from the research based on the rich data set of empirical information about adult literacy and numeracy performance and their background data. It is essential to go behind and beyond the initial and media-focused messages from such assessments about the results to look at the definitions and frameworks themselves, and what the related research tells us about teaching and learning. This is equally, if not more important, than the results themselves. Building on the empirical and theoretical research emanating from such international assessments and their frameworks strengthens the links between testing, research and practice.

We will briefly outline two uses of such international adult skills surveys. The first example is a pragmatic outcome related to the development of a literacy and numeracy assessment for graduating teachers. The second illustrates what the results tell us about Australia's foundation skills as we move further into the 21st century.

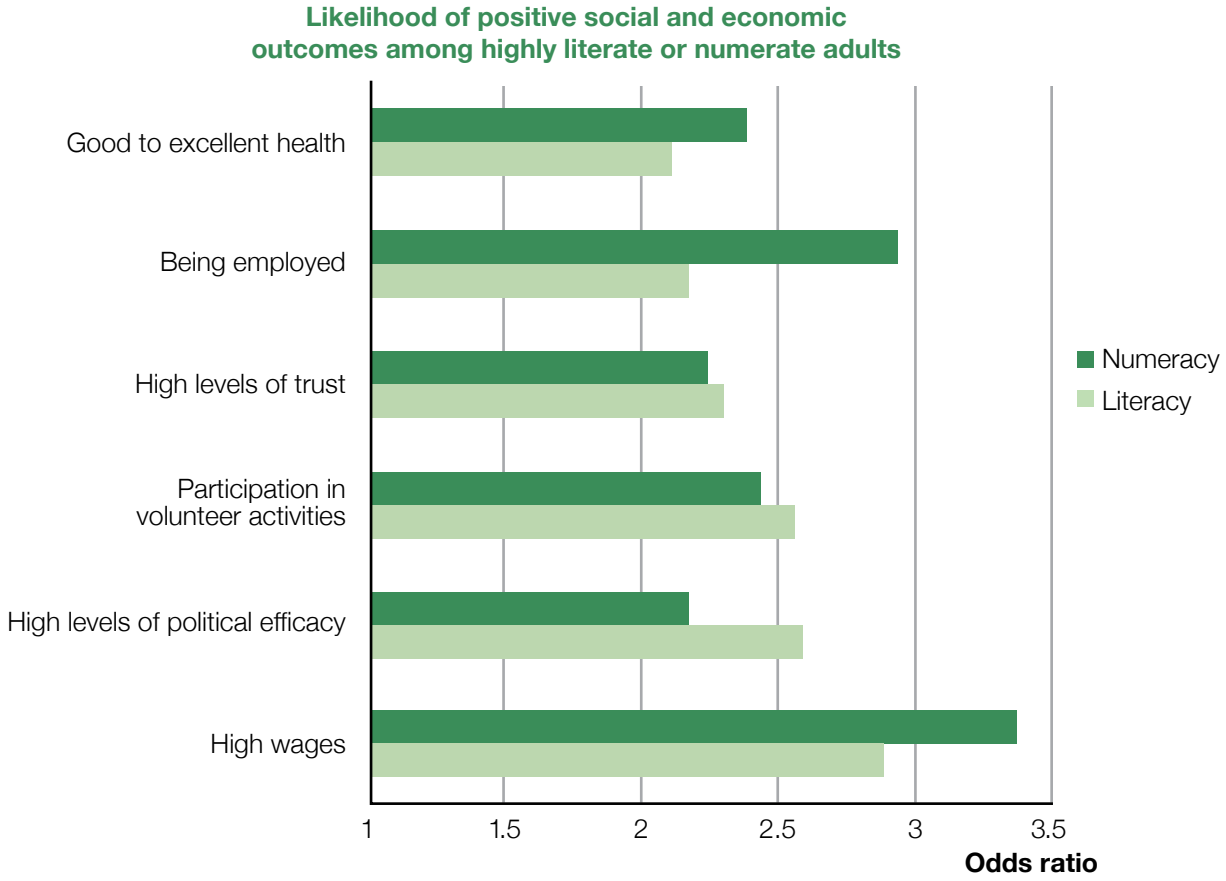

Figure 3 Likelihood of positive social and economic outcomes among highly literate or numerate adults (OECD, 2013b)

Literacy and numeracy standards for graduating teachers

PIAAC 2012 data were able to contribute in to the development of the the assessment of literacy and numeracy standards for students graduating from initial teacher education (ITE) programs – henceforth referred to as 'the test' – which was introduced nationally in Australia in 2016.[1]

In 2011, all Australian education ministers agreed to a national approach to the accreditation of ITE programs, including the expectation that all students who graduated from ITE courses would need to be in the top 30 per cent of the population for personal literacy and numeracy. With this goal, it was agreed that a national assessment of literacy and numeracy would be instituted. A framework for the test and the development of assessment material began in 2013. As part of this development, national panels of experts were assembled to set standards for minimum achievement in personal literacy and numeracy. These standards – set in the first instance in relation to the panel members' experience of what could reasonably be expected in the way of literacy and numeracy of students at the end of an ITE program – were 'indicative', and helped to frame the design of the assessment and the difficulty of the test material. Once assessment questions had been developed, and piloting undertaken, the indicative standards were revisited, reviewed and modified, to result in provisional standards, which were set and applied to the first round of pilot testing in 2015 and then again reviewed and confirmed by a larger trial test and a second round of standard setting, which was applied from mid-2016, when the test was officially launched. Notwithstanding these successive rounds of trial testing and standard setting, it was yet to be determined whether the test had identified the top 30 per cent of the population in literacy and numeracy. The difficulty here was that no national data collection or metric exists that robustly measures the literacy and numeracy competence of the Australian population – that is, apart from the international adult literacy surveys.

Accordingly, in order to check on how closely the applied standards of personal literacy and numeracy adopted for the first year of the test approximated to the top 30 per cent of the population, a methodology was

1 The authors gratefully acknowledge the work of our ACER Senior Research Fellow Ray Peck, who prepared a description of the process of standard setting in the Literacy and Numeracy Test for Initial Teacher Education students, including the use of PIAAC data to validate the standards.

applied to equate the test with Australia's performance in PIAAC 2012 – using data that were now available from the ABS and OECD. Sets of items that had been administered to the representative sample of Australian adults in PIAAC, in 2011–12, were included (as unscored items) in the test administered to ITE students in 2017. Once sufficient numbers of responses had been obtained from the test administration, psychometric analysis was undertaken to locate the performance of the top 30 per cent of all adult Australians in PIAAC and place these results on the literacy and numeracy scales for the ITE test.

The analysis found that the essentially judgemental approach that had been implemented in setting the standards on the test was very close to the statistical equating. For numeracy, the panel of experts had set the standard only three points lower than that indicated by the statistical equating: 107 instead of 110 scale points. For literacy, the panel of experts had set the standard just one point lower than the statistically derived standard: 106 instead of 107 scale points This was a remarkable result, and a tribute to the expertise of the literacy and numeracy panellists. The numeracy standard on the test was subsequently raised marginally, to match the PIAAC-based standard and thus conform with the standard of matching the top 30 per cent of the adult population. The literacy standard was maintained unadjusted, given its almost exact match to the judgemental standard.

Regardless of the actual outcome and consequences of this exercise, this case study indicates the value of Australia's participation in PIAAC and its forerunners: that participation made possible the empirical confirmation of a national education policy that would otherwise have remained notional.

Australia's foundation skills – are we prepared for the 21st century?

Australia's ALLS and PIAAC results, no matter how you read them, demonstrate unequivocally that a significant number of Australian aged from 15 to 74 years do not have access to sufficient foundation skills in reading and numeracy to be able to cope equitably with life and work in the 21st century (OECD, 2017). This is consistent with Australia's most recent performance on PISA (2015) and its measure of the abilities of 15-year-olds. The capacity to make considered decisions requires good foundational literacy and numeracy skills – whether they be instantaneous decisions at a workplace or when out shopping, or following written instructions about a medical or health matter, or making decisions about financial matters, or understanding the implications of gambling. The results of these surveys show that millions of Australian teenagers and adults do not have such foundational skills and they are, potentially, disempowered, especially as we move further into the 21st century and its demands for higher level and more flexible skills.

Conclusion

It will be crucial to see how Australian adults perform in PIAAC 2022, and to reflect on these results from both a policy level in relation to adult education, but also in relation to how school education is preparing young people for the world as adults.

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Using learning analytics to measure 21st-century skills

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Dragan Gašević is Professor of Learning Analytics in the Faculty of Education and Adjunct Professor in the Faculty of Information Technology at Monash University. Before this post, he was Professor and Chair in Learning Analytics and Informatics in the Moray House School of Education and the School of Informatics and Co-Director of Centre for Research in Digital Education at the University of Edinburgh. He was the Canada Research Chair in Semantic and Learning Technologies and Professor in the School of Computing and Information Systems at Athabasca University between Jan 2007 and Jan 2015. Dragan served as the immediate past President of the Society for Learning Analytics Research and holds several honorary appointments in Australia, Canada, Hong Kong, the United Kingdom and the United States. A computer scientist by training and skills, Dragan considers himself a learning analyst who develops computational methods that can shape next-generation learning and software technologies and advance our understanding of information seeking, sense-making, and self-regulated and social learning. Recently, he has founded ProSolo Technologies Incorporated that develops a software solution for tracking, evaluating, and recognising competencies gained through self-directed learning and social interactions. Dragan has authored numerous research papers and books and is a frequent keynote speaker.

Abstract

The unprecedented opportunities to collect data about learning and contexts in which learning occurs has attracted great attention in education. The use of data analytics and machine learning methods have offered much potential to address many relevant questions in education. This talk will focus on the use of learning analytics to measure 21st-century skills in education and outline the types of data commonly used. It will also discuss approaches that are used for analysis and modelling of relevant learning processes and outline the ways in which learning analytics can be used to track learning progression and how the validity of the findings with data analytics is assured. Numerous empirical studies will be drawn upon to look at self-regulated learning, learning strategies, and problem solving in individual and group activities.

Introduction

The ability to collaborate, solve problems, seek information, critically and creatively think, and effectively self-regulate learning are just some of the examples of the skills now known as 21st-century skills (Griffin, McGaw, & Care, 2012). Their importance has been highlighted in policy and research frameworks and many employers have clear expectations about these skills, which are necessary for different jobs. To possess these skills also allows equitable participation in modern society and access to different public services. In response to these demands, education institutions on all levels have a range of programs that support the development of these skills.

With the growing attention of policymakers and employers, sophisticated approaches to the measurement of 21st-century skills have also been proposed (Wilson & Scalise, 2015). However, there has been much less advancement in measurement approaches that track the progress of 21st skill development 'in the wild'; that is, in authentic learning and working environments. For example, measurement of (complex and collaborative) problem-solving has been done by the Organisation for Economic and Co-operation and Development (OECD) through the Programme for International Student Assessment (PISA). However, PISA is undertaken in highly controlled conditions in which a) only predefined messages could be used for communication among human collaborators (Rosen & Foltz, 2014) and b) actual collaboration is assessed through joint work between humans and computer agents to control for possible issues associated with human–human collaboration (e.g. uncooperative or incompatible collaborator) (Rosen, 2014). Moreover, very little work has been completed in learning environments where pedagogical models can range from very structured approaches to collaborative learning to those where collaboration emerges due to the problems identified by individuals who seek help from their peers in their classes or from a broader social network.

Learning analytics offers promising approaches that can be leveraged to address measurement of 21st skills in authentic settings (Buckingham Shum & Deakin Crick, 2016). Learning analytics harnesses the potential of big data – collected as the digital footprint of learners' use of technology – to develop measurement techniques, by working at the intersection between machine learning, measurement science, and the learning sciences. Recent research has offered promising improvements in the measurement validity of learning analytics to provide reliable means for developmental assessment of 21st-century skills. This paper will outline a case study that demonstrate the use of learning analytics for developmental assessment of collaborative problem-solving as a 21st-century skill.

Case study: Measurement of collaborative problem solving

Collaborative problem-solving (CPS) offers several advantages over individual problem-solving approaches. In essence, working collaboratively on complex problems is now a fundamental part of contemporary life, work, and society (Griffin et al., 2012; National Research Council (US), 2011). For example, collaborative solutions are often more creative as they are built upon expertise, information, and knowledge from multiple (complementary) perspectives (Graesser et al., 2018). Yet, successful collaboration does not always happen and requires certain conditions to be met to enable for productive group work. CPS can be ineffective due to the influence of an uncooperative teammate or a counterproductive group composition (Yong, Sauer, & Mannix, 2014). At the same time, effective leadership can help overcome many challenges a group may face and ensure that all members can productively contribute to CPS outcomes (Graesser et al., 2018).

To support their development and assessment, several models of CPS skills have been proposed (Hesse, Care, Buder, Sassenberg, & Griffin, 2015; OECD, 2013). The CPS literature mainly defines CPS skills as a collection of two domains – cognitive and social (Griffin et al., 2012). The cognitive domain is typically related to the existing literature on problem-solving and self-regulated learning (Griffin et al., 2012) and includes skills for task regulation and knowledge building. The social domain is focused on the skills necessary for productive collaboration (OECD, 2013). For example, Hasse et al. (2015) posit that social skills of CPS include participation, perspective taking, and social regulation. CPS is also defined in the well-known model of communities of inquiry that identifies social and cognitive presence of learners (Garrison & Arbaugh, 2007). Rather than thinking of CPS as a collection of isolated social and cognitive skills, the literature on computer-supported collaborative learning suggests that being an effective collaborator means performing well in a role (Dillenbourg, Järvelä, & Fischer, 2009). A role is an ensemble of cognitive and social skills that assume interactions with the right people at the right times and in the right ways.

Learning analytics offers promising approaches that can enable the measurement of CPS in 'in the wild'. Measurement is performed into two phases: i) identification of traces of cognitive and social dimensions of CPS; and ii) measurement of CPS skill development by combining the identified traces over time. First, traces of both dimensions of CPS can be identified through automated analysis of transcripts of conversations learners may have. These conversations can be both online (social media, chats, or discussion boards) and face-to-face (transcribed recording or automatically recognized speech). Transcripts of such conversations can automatically be analysed with

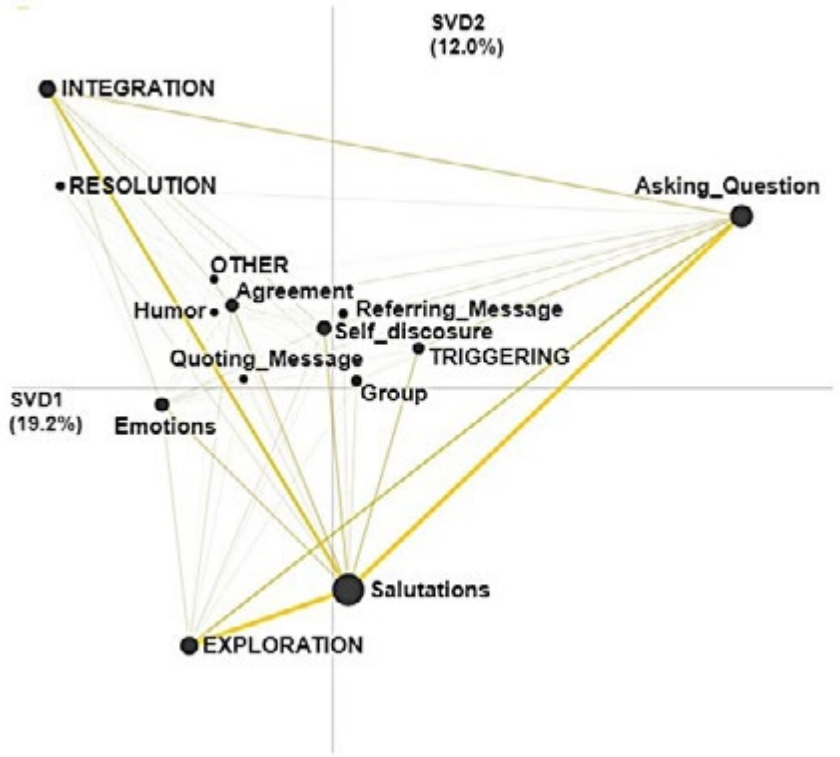

Figure 1 Epistemic network analysis of the association between cognitive and social presence in communities of inquiry: the epistemic network between phases of cognitive presence (capital letters) and indicators of social presence

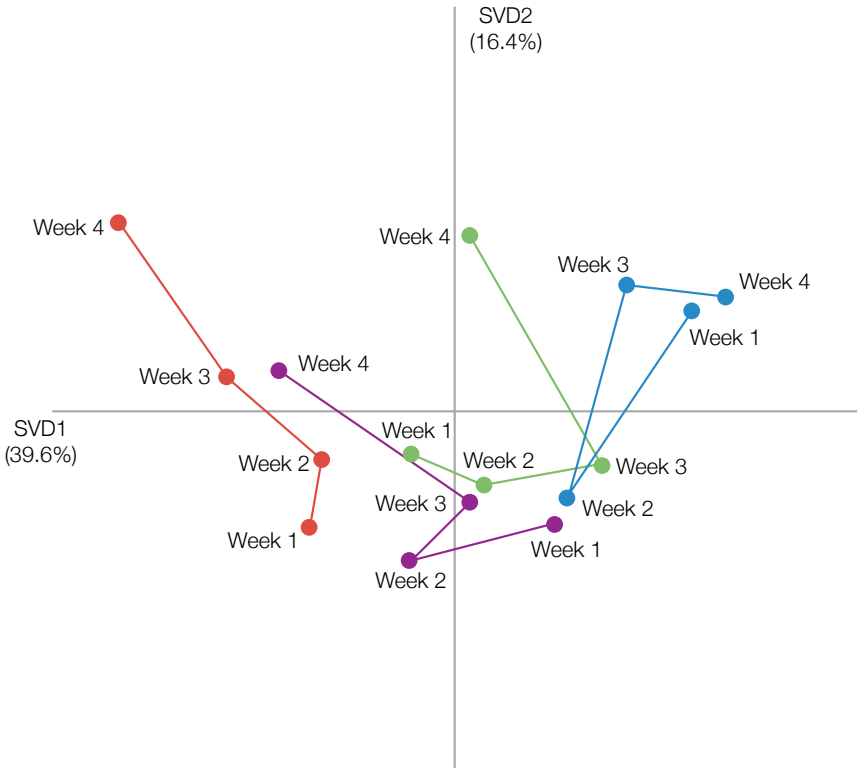

Figure 2 Epistemic network analysis of the association between cognitive and social presence in communities of inquiry: trajectory analysis of the students in the four conditions across four weeks of discussions – expert-control (red), expert-treatment (purple), practicing researcher-control (blue), and practicing researcher-treatment (green)

artificial intelligence-driven techniques to detect traces of cognitive and social dimensions of collaboration. For example, Kovanović et al. (2016) developed an automated classifier for automatic coding of discussion messages, with the coding scheme used to identify occurrences of different phases of cognitive presence in online discussions. The evaluation of Kovanović et al. (2016) demonstrated high levels of accuracy for messages in the English language. The high level of accuracy was further corroborated by Neto et al. (2018) for messages written in Portuguese.

Second, measurement of CPS skill development (i.e., progression) requires techniques that can ensemble the identified traces of cognitive and social dimensions and analyse the progress over time. Epistemic network analysis (ENA) can be applied to these tasks (Shaffer, Collier, & Ruis, 2016). ENA is based on the theory of epistemic frames (Shaffer, 2006), which posits that expertise in complex domains is not as a set of isolated processes, skills, and knowledge, but as a network of connections among knowledge, skills, values, and decision-making processes. Specifically, epistemic networks in ENA are built by looking at the co-occurrence of the codes in collaborative discourse.

To measure CPS and analyse track progression in CPS skill development, ENA was applied to combine phases of cognitive presence (i.e. triggering events, exploration, integration, resolution) and indicators of social presence (13 indicators categorised in general three categories – interactive, affective, and group cohesion) as proposed in the model of communities of inquiry (Rolim, Ferreira, Lins, & Gašević, 2019). The epistemic network in Figure 1 shows that the lower levels of cognitive presence (triggering event) were more connected with the indicators of the interactive category of social presence (e.g. asking questions or continuing a thread), while higher levels of cognitive presence (integration and resolution) were linked with the indicators of the affective category of social presence (e.g. use of humour or self-disclosure). The ENA also enabled unveiling of the difference in the links between social and cognitive presences of the students who were in different intervention groups (i.e. discussion scaffolded with external standards about the quality expectations versus only the expectation about the quantity of messages) and different roles assigned (experts and practicing researchers). The trajectory analysis diagram in Figure 2 indicates that the students who were only required to submit a set number of messages in the role of researcher did not make much progress in their cognitive inquiry across four weeks of discussions; that is, they did not move towards the left to reach integration and resolution phases of cognitive presence. For the other three groups, evidence of the progress was noted.

Conclusions

The case study introduced in this paper highlights some promising aspects of the use of learning analytics for measurement of 21st-century skills. Several points however need to be raised (Gašević, 2018). First, learning analytics at the stage of development offers promising measurement approaches that can be used for assessment for learning, rather than assessment of learning. Second, measurement approaches utilised in learning analytics need to be scrutinised against similar validity standards as commonly done in measurement science (Messick, 1995). Third, certain conditions needs to be built to assure the quality of data used by learning analytics, which directly impact the quality of the results produced in learning analytics. If learning tasks are inadequately designed and/or conditions in which data collection happens do not create conditions for learners to demonstrate skills measured, the value of learning analytics will be limited. Finally, future work is needed to establish validity, reliability and use frameworks for learning analytics when applied for measurement of 21st-century skills.

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Assessing and understanding social and emotional skills: The OECD Study on Social and Emotional Skills

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Dr Sue Thomson is the Deputy CEO (Research) at ACER. A classroom mathematics teacher prior to joining ACER in 1998, Sue is an experienced researcher who specialises in quantitative analysis methods. She has led analysis and reporting on large-scale and longitudinal data sets such as the Longitudinal Surveys of Australian Youth, Project Good Start, and the Australian components of Schools around the World, Programme in International Student Assessment, Trends in International Mathematics and Science Study, and Progress in International Reading Literacy Study. Sue has published widely on the findings from these large-scale international studies, including translational pieces on the outcomes of education and equity issues in the provision of education in Australia. She was a co-investigator on the Australian Child Wellbeing Project, a project funded by the Australian Research Council (ARC), and a Chief Investigator for the Science of Learning Research Centre, a Special Research Initiative of the ARC. Most recently, Sue has also been managing the OECD's Study on Social and Emotional Skills, a new study which was implemented in 2018 in 10 cities and countries internationally.

Abstract

In an increasingly fast-changing and diverse world, the importance of developing social and emotional skills is becoming more evident. The large body of accumulated evidence shows that these skills have strong relationships with life outcomes and they have been referred to as a key component of 21st century skills. The Organisation for Economic Co-operation and development (OECD) Study on Social and Emotional Skills is a new international assessment of these skills in students at primary and secondary schools. This study also gathers information on students' families, schools and community learning contexts, aiming to provide information about the conditions or practices that foster or hinder the development of these critical skills.

This paper will examine the development of the study – based on the 'Big Five' model of personality characteristics – and describe developments so far.

Introduction

A growing number of countries and economies participate in large-scale assessments such as PISA, TIMSS and PIRLS.[1] The performance of students in mathematics, science and reading on these tests has an influence on education policy with the countries involved – and sometimes it's just the published rankings in the form of league tables that have the influence. However, there is a body of evidence to show that achievement tests such as these do not adequately capture the underlying traits that they are intended to measure. Even the OECD, the designers of PISA, argue that 'children need a balanced set of cognitive, social and emotional skills to adapt to today's demanding, changing and unpredictable world' (2015). During an interview at the World Economic Forum in January 2019, the Prime Minister of New Zealand, Jacinda Ardern, spoke about the need for governments to address societal wellbeing as well as the economic wellbeing of countries (Parker, 2019). There seems to be an increasing recognition by policymakers that social and emotional skills are important, providing an opportunity for the OECD to commission work that would provide policymakers with valid, reliable, and comparable information on social and emotional skills.

What are social and emotional skills?

The focus of policymakers on social and emotional skills reflects arguments presented by academic researchers such as James Heckman for many years. Heckman and Kautz (2012) argue that:

> soft skills – personality trait, goals, motivations … are valued in the labor market, in school, and in many other domains … Soft skills predict success in life … they produce that success, and programs that enhance soft skills have an important place in an effective portfolio of public policies.

So while research has shown that education is an important predictor for success in life – leading to higher levels of tertiary education completion, better job outcomes, and higher salaries, it has also shown the importance of social and emotional skills such as the ability to pursue long-term goals, work with others and manage emotions. The development of cognitive, social and emotional skills interacts and, in this interaction, are mutually influenced. For example, children who have strongly developed skills in self-control or perseverance are more likely to finish reading a book, or finish their homework, which in turn contributes to further enhanced cognitive skills. As more education systems identify social and emotional skills as being of primary importance in the development of 21st century skills, there is a need to develop a set of metrics that can be used to enhance policies to improve the development and wellbeing of children and young people.

The OECD (as well as the International Association for the Evaluation of Educational Achievement for TIMSS and PIRLS) have made efforts to incorporate measures of social and emotional wellbeing in their studies, most notably in PISA. Measures of self-belief, motivation, expectations, and perseverance have been included in all of the major large-scale international assessments since their inception, and students' scores on these indices are used to help explain differences in achievement between students and between countries. However the OECD's view is that cognitive skills do not just involve applying knowledge, but also include the ability to reflect and engage in more complex thinking patterns. The very definitions of literacy in PISA as 'the capacity of students to analyse, reason and communicate effectively as they pose, solve and interpret problems in a variety of subject matter areas' (OECD, 2006) illustrate the multidimensionality of cognitive skills. However, these are precisely the skills that Heckman and Kautz (2012), among others, argued are poorly captured by achievement tests.

The OECD Study on Social and Emotional Skills

In order to capture information about social and emotional skills, the OECD launched the Study on Social and Emotional Skills (SSES). The purposes of the Study are to:

- provide participating cities and countries with information on the social and emotional skills of their students
- provide insights on how to support students to develop social and emotional skills
- demonstrate that valid, reliable, and comparable information on social and emotional skills can be produced across diverse populations and settings.

Social and emotional skills, unlike cognitive skills, or height and weight, cannot be directly measured. Personality psychologists primarily measure these skills through self-reported surveys, and research over many years has resulted in a taxonomy of personality factors called the Big Five inventory. This inventory underpins the OECD's Study. Figure 1 summarises the five domains that were decided to be included in the study, and lists the 19 specific social and emotional skills that were to be included in the Field Test, plus a category for 'Compound skills' – a combination of two or more of the individual skills.

The study is aimed at two populations of students: 10-year-olds and 15-year-olds. Students report on their social and emotional skills in both their home and school environment. In addition to this direct assessment, parents of the selected students will provide a report

1 Programme for International Student Assessment; Trends in Mathematics and Science Study; Progress in International Reading Literacy Study

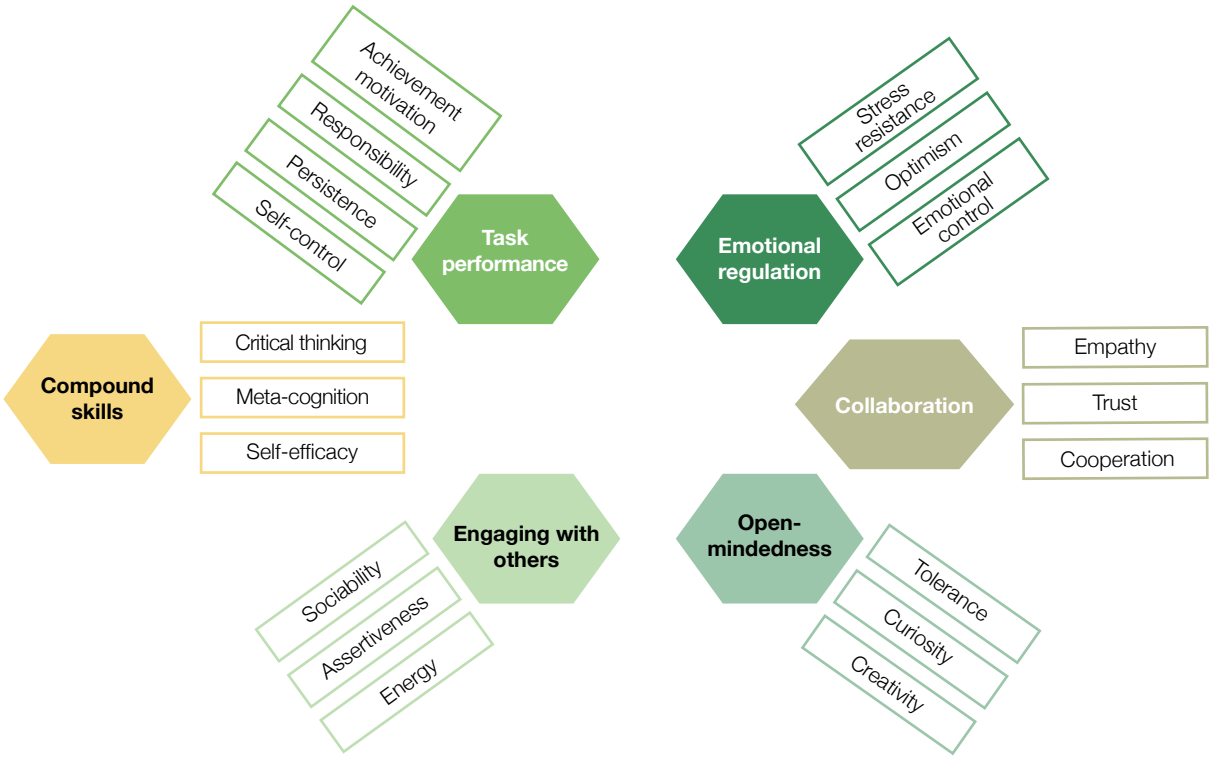

Figure 1 Skills to be included in the field trial for the OECD Study on Social and Emotional Skills

on their child's social and emotional skills in the home environment, while a teacher who knows the student well will provide information about their social and emotional skills within the school environment. This combined direct and indirect assessment of a student's social and emotional skills is an important triangulation. Asking both student age cohorts, teachers and parents to respond to the same items allows the domains to be compared in school and home contexts, as well as providing an insight into how social and emotional skills develop across childhood and adolescence.

As with many other large-scale studies, a range of contextual information is also sought. This includes family, school and community learning contexts and the background characteristics of students, teachers and parents.

The SSES field trial

The field trial was carried out between October and November 2018 across the 11 participating sites. Usually, an organiser of an international assessment only allows countries to participate; however, the OECD believes that there is an increasing role for cities to take responsibility for the education of its citizens; a number of cities now have relative autonomy over their education system. Figure 2 shows the participating cities – note the wide spread over different countries, languages and systems.

Some sites (Houston, Ottowa and Helsinki) collected data from students in two languages. Across all sites, approximately 7000 students at each age level participated in the field test.

What sort of questions were asked?

In the first part of the assessment, students were asked to respond on a five-point Likert scale (strongly disagree through to strongly agree), the extent to which they agreed or disagreed that each of the behaviours representing the 19 social and emotional skills accurately described themselves.

For example, the social and emotional skill of *cooperation* was measured using the following items:

- I argue a lot.
- I like to help others.
- I get along well with others.
- I work well with other people.
- I start arguments with others.
- I treat others with respect.
- I am always willing to help my classmates.
- I am ready to help anybody.
- I am polite, courteous to others.
- I am unwilling to help others.

Figure 2 Cities who participated in the SSES Field Trial

Another of the skills, *empathy*, was measured with these items:

- I do not care what happens to other people.
- I am helpful and unselfish with others.
- It is important to me that my friends are okay.
- I can sense how others feel.
- I know how to comfort others.
- I predict the needs of others.
- I understand what others want.
- I am warm toward others.
- I rarely ask others how they are feeling.
- I am compassionate, have a soft heart.

In addition to this direct assessment of the student's social and emotional skills, teachers and parents were asked to respond in the same way to the same questions (for example *this student* does not care what happens to other people, *my child* is helpful and unselfish with others) to provide indirect assessments of the student's social and emotional skills.

In the second part of the assessment, students were presented with items in a contextual questionnaire. Scales were then derived on factors such as:

- wellbeing, attitudes and aspirations (e.g. WHO-5 Wellbeing index)
- family and peer relations (e.g. perceived treatment by mother/father, peer affiliation and social acceptance)
- school life (e.g. sense of belonging at school, bullying at school, cyberbullying).

Altogether, 17 different scales were field-trialled. This paper focuses on just two of these: *perceived treatment by mother* and *bullying*.

Perceived treatment by mother

For the *perceived treatment by mother* scale, students were asked to 'Describe how true each of the following statements is', and asked to respond on a four-point Likert scale ranging from *almost never* or *never true* through to *almost always* or *always true*.

- My mother understands me.
- My mother listens to me.
- My mother accepts me as I am.
- My mother is proud of me.
- My mother helps me with my problems.
- My mother cares about me.
- My mother pays attention to me.
- My mother is easy to talk to.
- My mother respects my feelings.
- My mother encourages me to be confident.
- My mother is interested in my school activities.

Bullying

For the *bullying* scale, students were asked how often they had had each of the following experiences over the previous 12 months, with responses ranging from *never* or *almost never*, through to *once a week or more*:

- Other students left me out of things on purpose.
- Other students made fun of me.
- I was threatened by other students.

- Other students took away or destroyed things that belonged to me.
- I got hit or pushed around by other students.
- Other students spread nasty rumours about me.

What do we hope to find out from the main study?

The data gathered for the field trial are not as robust as those data that will be collected in the main study. In the field trial, sampling is not done as rigorously as in the main study, and so data are not necessarily representative of the population. The main purpose of a field trial is to test procedures and instruments. There were many more items in the field trial than will be necessary for the main study, and all of the instruments have been cut down for the main study in order to minimise fatigue.

For the main study, a random sample of schools will be drawn from each of the target populations, and from those schools, a random sample of 3000 students for each of the two age cohorts will be drawn in each participating city or country.

Given these caveats, each of the scales presented in the previous section of this paper shows different relationships with the set of social and emotional skills under examination.

Perceived treatment by mother illustrates the differing relationships between skills and beliefs (Figure 3). The largest correlation was with optimism *(I believe good things will happen to me, I tend to feel depressed and blue*), and this was the same for both age cohorts. Other moderate correlations were with self-efficacy, self-control and cooperation, although notably more for the younger cohort. Interestingly, perceived positive treatment by the student's mother has a negligible relationship with *assertiveness* and *critical thinking*, in particular, and, interestingly, small correlations for the older cohort for *empathy* and *trust*.

As would be expected, positive responses by students on the bullying scale were associated with negative scores on skills, although none of the correlations was particularly large (Figure 4). The largest correlation for the younger cohort was for responsibility (I sometimes behave irresponsibly, I am less dependable than others), for the older cohort, optimism.

Given the number of variables available for analysis, the two presented here are just the very tip of the iceberg. However, the primary emphasis of the field test is to ensure that processes work and that instruments work. Many more items were field tested than will be used in the main study, and rigorous analysis over the past six months has identified items that don't work, scales that are not psychometrically sound, and tightened the assessment by removing superfluous items.

Conclusion

The assessments for the main study have now been finalised and processes for moving forward have been put into motion. Sites are in the process of preparing their sampling frames to submit to ACER to draw the sample of schools, and testing will happen in October–November this year. The final reporting on this project will provide a huge amount of evidence to establish a baseline for social and emotional wellbeing for the participating sites and will certainly add a great deal to the literature.

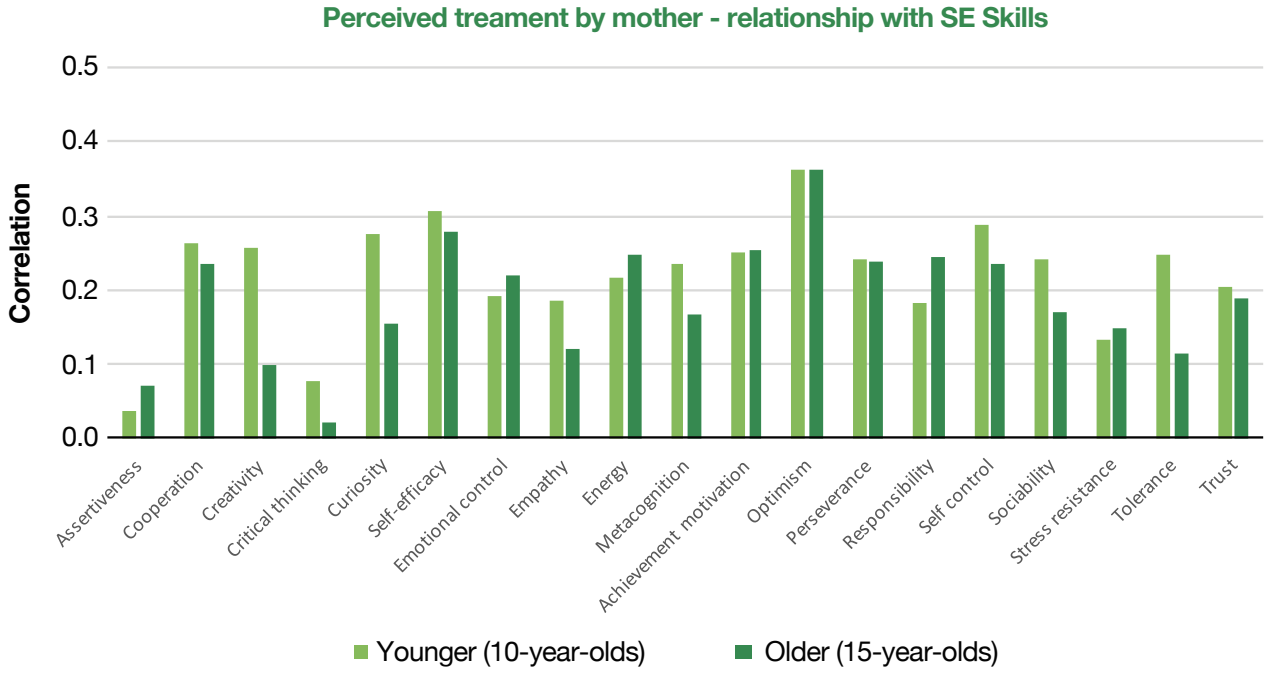

Figure 3 Relationship between perceived treatment by mother scale and social and emotional skills

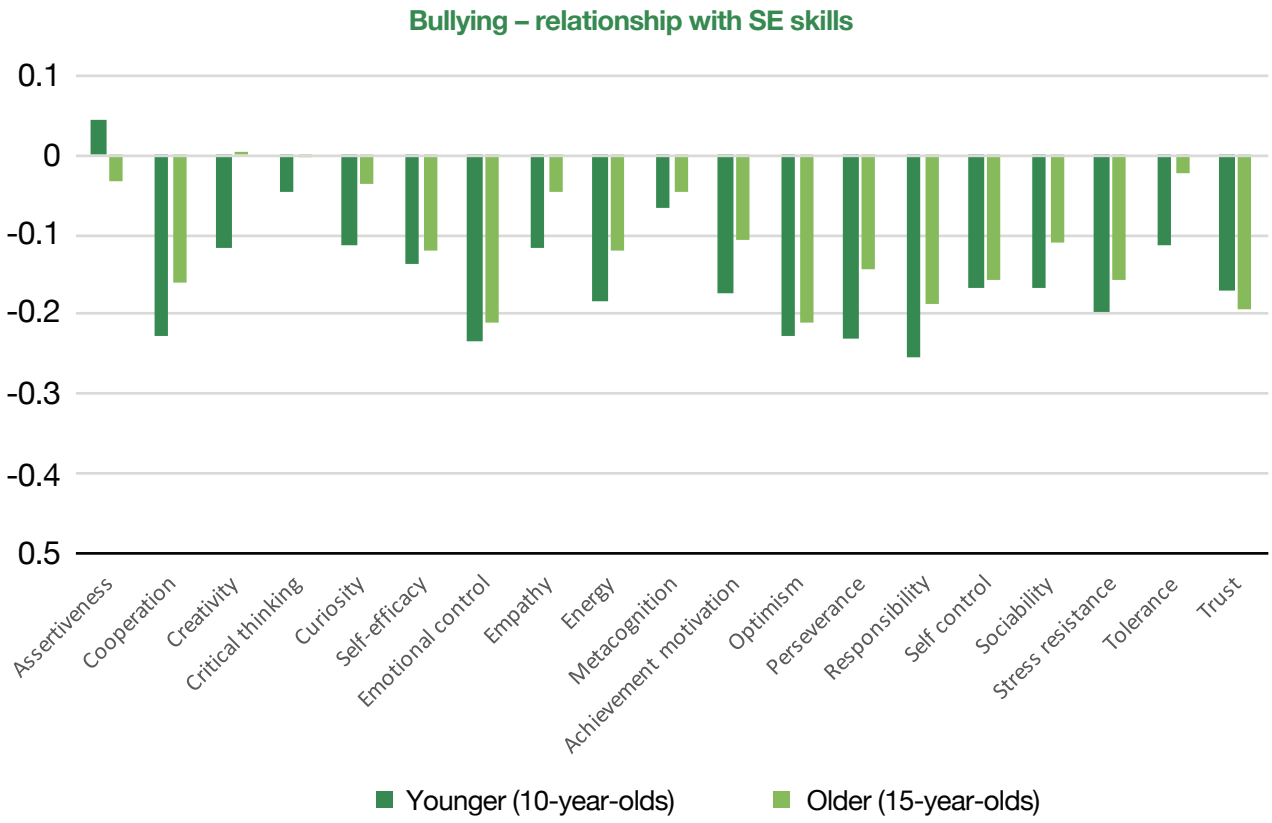

Figure 4 Relationship between bullying scale and social and emotional skills

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Wii-Ma-Li (light the fire): The impact of the Connected Communities Strategy on Hillvue Public School

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Chris Shaw is currently Director Educational Leadership, Western Plains Network, NSW Department of Education and a board member on the University of New South Wales Gonski Institute. Chris has 38 years' experience in education, and has been the principal of six schools with enrolments that ranged from 32 to 750 students. From 2013 to Term 1 2018, Chris was the Executive Principal of Hillvue Public School. Hillvue has an enrolment of approximately 300 students, 80 per cent of whom identify as Aboriginal or Torres Strait Islander. Located in Tamworth, Hillvue is one of 15 Connected Communities Schools in New South Wales. In Semester 2, 2018 Chris stepped out of his role as Director to relieve as Executive Principal of Walgett Community College, also a Connected Communities School. He has received a number of accolades, including the ACEL William Walker Award for Excellence in Educational Leadership in 2015 and a New South Wales Nanga Mai Award for outstanding commitment to increasing knowledge and understanding of Aboriginal histories, culture and experiences of Aboriginal peoples in 2018.

Abstract

The Connected Communities Strategy is about developing an inclusive culture in a school and providing an environment that maximises student learning with an emphasis on high expectations, engagement and achievement. Globally, there have been significant changes to the ways that children learn and teachers teach. Our school environment and the world in which our students grow and function continues to change in so many ways! We are responsive to the influences that impact on the Hillvue Public School community as we deliver a quality and engaging education now and into the future. It is up to us to light the fire of education in our students and communities, a fire that ignites a passion for learning and valuing education and the opportunities it provides. Our journey has involved the development and implementation of many initiatives that go hand-in-hand to support improved outcomes for our students and families. At Hillvue, our focus is on innovation, opportunity and success. We believe that all students can learn and all students will learn. We have significantly improved literacy and numeracy outcomes, increased both student and parent engagement and developed a strong culture of professional learning and reflective practice.

Background

I entered on duty as the Executive Principal of Hillvue Public School in January 2013. I am very proud of our achievements over the five-year period and I continue to watch closely the school's progress and achievements. We should never consider education a luxury; it is a necessity, especially for children in poor and minority communities, so that they can someday enjoy a high quality of life. It may be their only chance at a better life (Muhammad, 2009).

This journey involved the development and implementation of many initiatives, some are briefly outlined in this reflection. Everything we have done was underpinned by respect, trust and the building of honest and open relationships. It is important for me to acknowledge the work of Hattie (2011), Dinham (2016), Mahammad (2009) and Connors (2000). Their research and reflections formed the basis for many discussions, as we read, reviewed and workshopped throughout the change process.

Hillvue Public School has an enrolment of approximately 300 students, 80 per cent of whom identify as Aboriginal or Torres Strait Islander. The school, located in Tamworth, is one of 15 Connected Communities schools in New South Wales. *The Connected Communities Strategy* (NSW Department of Education and Communities, 2011) positions schools as community hubs. It broadens the influence of the community and school leadership to play a role in the delivery of key services and in supporting children and young people from birth through school into further training, study and employment.

The transition to becoming a Connected Communities school

A significant challenge for me as the Executive Principal was working with staff who felt as though they were victims in the Connected Communities Strategy. The announcement to move to a Connected Community was made through media channels, which is how most staff found out about the initiative. The incumbent principal was moved to an alternate position and many of the staff felt undervalued, some were angry and others were completely disillusioned about the way the strategy had been communicated. They felt as though everyone thought they were being portrayed as teachers who had failed the students at Hillvue Public School. I had to gain their trust, improve morale and rebuild a cohesive staff.

Our journey commenced by asking three simple questions: What are the best things about Hillvue Public School? What areas do we need to address? What would you change immediately?

The responses were compiled and discussed at length. All items were addressed in some form, and regular feedback was provided to staff. It was also clear that everyone was heading in a different direction and we needed to develop a clear vison for the school. What did Hillvue stand for? A set of focus areas was then developed to address the responses and support the Connected Communities key deliverables. The focus areas were a vision statement, school culture and the physical environment; professional learning; community engagement and strong partnerships; and student and staff welfare, attendance and communication.

A shared vision for high-impact learning and teaching and a cohesive organisational culture resulted in significant growth in all areas. Student success in learning was the only option. The high expectations held by our team and our sense of collective efficacy were fundamental to our ultimate goal of achieving improved outcomes for our students and families, and key to our success. The overwhelming belief in self and the power as a team to impact change through a shared belief in our ability to overcome challenges and plan a pathway for success.

My vision and focus are based on providing an environment that maximises student learning with an emphasis on high expectations, engagement and achievement. The Connected Communities Strategy is about developing an inclusive culture in the school.

Globally, there have been significant changes to the ways in which children learn and how teachers teach. Our school environment and the world in which our students grow and function continues to change in so many ways! We are responsive to the influences that impact on the Hillvue Public School community as we deliver a quality and engaging education now and into the future. It is up to us to light the fire of education in our students and communities, a fire that ignites a passion for learning and valuing education and the opportunities it provides.

Our journey has involved the development and implementation of many initiatives that go hand-in-hand to support improved outcomes for our students and families. At Hillvue our focus is on innovation, opportunity and success.

Our belief that all students can learn and all students will learn because of what we do is fundamental to our ultimate goal of achieving improved outcomes for our students and families. We close the window and look at the reflection in the glass. What are we doing? What can we change? What can we control? What can we offer? We don't open the window, look outside and blame parents, community and governments. We identify barriers and challenges and we address them. We get on with the business of doing. This culture is being instilled in our students and community.

Figure 1 Hillvue's vision statement

Development of a vision statement

The process of developing a vision statement took a semester and involved student, staff and community consultation. The end results are clearly displayed at the front of the school on a wall, covering an area of approximately 6 metres by 4 metres (see Figure 1). It includes these statements:

> Hillvue Public School is my second family.
>
> Hillvue Public School shows me our culture is important.
>
> Hillvue Public School encourages me to be the best person I can be.
>
> Hillvue Public School allows me to have choices.
>
> Hillvue Public School shows me university is possible.
>
> Hillvue Public School is a place where my teachers believe in me.

The vision statement is used as a teaching and learning tool for students and the community.

A positive school culture

A significant amount of time was spent understanding and developing a positive school culture. A culture that is supportive of all students. A culture that is professional and safe, where everyone feels appreciated, listened to, valued and respected.

> One of the most important and powerful elements of an effective and successful school is its positive culture. In a school with a well-defined and shared focus on student learning, staff and students are more likely to work towards the specific goals and visions of the school (Muhammad, 2009).

Differentiated learning/open-plan environments

Differentiated learning/open-plan environments were created by opening up classrooms and breaking down silos to address the needs of students through open-ended activities and scaffolding strategies, while maintaining high expectations. All grades are taught together in these open-plan areas. The fostering of collaboration and group skills in students and teachers is a priority.

Targeted professional learning

All teachers on staff are released from class for an hour each week to participate in grade professional learning led by our instructional leaders. The instructional leaders work closely with staff to reflect on practice, analyse data to inform teaching and next steps in learning, collaboratively plan, differentiate teaching, select and design interventions to support students, and team teach. This is sacred time and is never interrupted. If the instructional leaders are away, the session is led by one of the other teachers.

Assessment data

We now have joint ownership of assessment data. Students, teachers and parents are familiar with the children's progress and targets throughout the year, not just at report intervals. Highly targeted use of data enables all those involved in teaching, planning, supporting, leading and managing to respond to issues quickly and efficiently. Regular celebrations of student achievement are held in each grade across the school.

A focus on key transition points

In 2015, we moved a teacher from Year 2 to Year 3. We now do this with every grade each year. The transitioning teacher brings cumulative knowledge in relation to background, welfare and learning to the classroom. This has significantly reduced disruption to student learning and supports continuity of learning.

Language matters – teaching Gamilaraay language to students K–6

You cannot teach language without teaching culture. We have staff trained in both Certificate I and Certificate II Gamilaraay language through TAFE Western. Gamilaraay language is taught in every classroom every week at Hillvue Public School. Our language teacher works with classroom teachers to embed the teaching of language across the school. Language is now part of the school culture and is present in teaching and learning, on word walls in classrooms and each classroom block is named in English and Gamilaraay.

Stronger partnerships

Partnerships with University of Newcastle Rural Health Faculty, the University of New England and TAFE New England, and TAFE Western support aspirational programs and knowledge for students and community about future learning options and opportunities.

Our partner schools program that operates with Tamworth High School and feeder schools is now being mirrored by Peel High School. Monthly meetings are held to plan, review and discuss a variety of initiatives and strategic directions, which include:

- professional learning for high school staff (led by primary teachers)
- curriculum design and monitoring and tracking student progress
- mirroring our flexible differentiated learning environments in Stage 4.

TAFE classes for parents

TAFE classes commenced at school to engage parents and community in lifelong learning. Parents were asked what they would like to learn and a program was developed at school in coordination with TAFE New England to support the areas identified by parents. Each session started with a wellbeing session, where parents went for a walk and did some exercise.

The focus in the classroom was literacy and numeracy. This initial introduction has led to a number of parents enrolling full time in classes at the TAFE campus. Two parents are now employed as a result of their commitment to learning and the confidence they gained from attending classes and developing skills.

Stephanie Alexander Kitchen Garden Program and community engagement

Pleasurable food education teaches students positive food habits through fun, hands-on learning. The Kitchen Garden Program Foundation gives students all the skills, experiences and role modelling they need to learn to love their vegetables and make healthier choices about what to cook and eat, for life. A kitchen specialist and a trained horticulturalist are employed to implement the Stephanie Alexander Program. Students grow and harvest from the vegetable garden each week and then prepare and cook meals in the kitchen. Each session is completed by sitting and sharing the meal that has been prepared. Parent sessions, grandparent's high tea and cafes run by students for parents also take place in the kitchen throughout the year.

Wii-Ma-Li early years extended transition program

This program is based on the Early Years Learning Framework (Australian Government, 2009) and aims to build strong relationships between the school and the home, ensuring a positive experience as each child starts school at Hillvue. Children attend a transition session each week in Terms 2, 3 and 4. The development of school readiness programs, social skills and building strong partnerships with families to support attendance are priorities. Students' eyesight, hearing, speech and teeth are screened. Parents are provided with take-home resource packs to assist their children at home with school-readiness activities. We also hold workshops to support parents and members of the community in obtaining Working with Children Checks (WWCC) and birth certificates.

Eat Well 2 Learn Well (breakfast club)

Eat Well 2 Learn Well continues to operate at the school each morning and is available for all students free of charge. A warm, healthy breakfast is a great way to start the school day. Between 40 and 60 students have breakfast at school each morning. Eat Well 2 Learn Well is supported by the University of Newcastle Department of Rural Health, members of the local Anglican Church and Rotary Club.

Conclusion

We faced many challenges and we are proud of the overall impact of the change process implemented at Hillvue Public School.

As I highlighted at the beginning of this narrative, our journey has involved the development and implementation of many initiatives. All of which fit together like a jigsaw puzzle to build a culture that is underpinned by respect, trust, and honest and open professional relationships. The staff were hardworking, dedicated and caring professionals who wanted the best for the students in their care, but that was not enough.

We had to build a culture of high expectations, explicit teaching and effective feedback, use of data to inform practice, wellbeing and collaboration. Many of our students were failing and staff were working in silos. Different results were being achieved across grades and in many cases poor results were being attributed to student cohorts and not lack of differentiation and the one-size-fits-all mentality of using whole-grade text books. The shift in culture from 'this is how we do it at Hillvue' and having welfare as the priority, to placing academic rigour, professional learning and reflective practice as priorities was pivotal to our success. Believe in students, support and challenge students and they will achieve.

Welfare is important and we must have strong support mechanisms in place to support our students and families but we are teachers and our priority must be to deliver high quality, relevant and engaging teaching and learning.

In the past, Hillvue was the school that many parents investigated ways to avoid enrolling their children. Hillvue Public School is now the school of choice for local families. A school that parents, students, staff and community are proud of. A school they feel part of and in which they feel they have a voice. Parents are more willing to come into the school and actively engage in their child's learning. There is also increased pride in the school by the entire school community.
A happy and collegial staff and a positive atmosphere in the playground with numerous activities to engage students has led to less stressful playground duties for staff (a comment from a teacher: 'I don't even need to be on duty anymore, students have so much to do, it's great.'). We have seen reduced suspensions, reduced negative classroom notifications and significantly increased classroom engagement and literacy and numeracy results.

I know we often hear the saying that 'there is no "I" in team', and this was certainly the case as we transformed the culture of Hillvue Public School. It was a team effort and for me personally it was like leaving my family when I stepped out of the role as Executive Principal and into my current role as Director Educational Leadership.

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Assessment in the interpersonal domain: Experiences from empathy assessment in medical education

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Neville Chiavaroli is a Principal Research Fellow in the Tertiary Education Program at the Australian Council for Educational Research, where his current research focuses on assessment and selection theory and practice in tertiary contexts. Prior to joining ACER in 2019, Neville was Head of Assessment in the Doctor of Medicine degree at the Melbourne Medical School, but his pedagogical work and research interests also encompass the development and assessment of empathy, professional identity formation and the medical humanities. He coordinated and taught the assessment subjects in the University of Melbourne's Graduate Certificate and Diploma courses for health professional educators for several years. Neville is an ongoing assessment consultant to many medical and health professional colleges and schools, and regularly conducts assessment workshops both nationally and internationally. Originally trained as a physiotherapist before completing a Master of Education and moving into educational research, Neville is currently pursuing a doctorate on learning and assessing in the affective domain in professional education.

Abstract

Frameworks for the teaching and assessment of 21st-century skills commonly recognise the importance of learning and skill development in the interpersonal domain. They also usually acknowledge the challenge of reliably and validly assessing students in this domain. In the field of medical education and in selecting students for medical courses, the concept of empathy has become central to representing the particular interpersonal understandings and skills expected of students and practising doctors. Attempts to assess these attributes during medical training are just as challenging as in school contexts. This presentation draws on several years' experience of working with medical educators to consider how empathy has been conceptualised, taught and assessed by educators. This analysis explores three common assessment approaches: self-report, performance examinations, and longitudinal observation and judgement in the clinical context. Each approach addresses important aspects of empathy and interpersonal skills. Each also has its limitations, although the self-report approach has emerged as the more widely known and used in medical education. Much still remains to be understood about making meaningful and valid use of observational judgements in the assessment of empathy, and, by extension, the interpersonal domain. In the meantime, useful guidance for teachers assessing interpersonal skills in the classroom may be found in alternative learning frameworks currently used in professional education that precede the 21st-century skills movement.

The interpersonal domain as a 21st-century skill

> In 1970 the top three skills required by the Fortune 500 were the three Rs: reading, writing, and arithmetic. In 1999 the top three skills in demand were teamwork, problem-solving, and interpersonal skills. We need schools that are developing these skills.
>
> *Linda Darling-Hammond, Professor of Education, Stanford Graduate School of Education*

The 21st-century-skills movement attempts to identify and promote the key skills that will support young people to successfully apply their learning to the world beyond their schooling. Alongside well-known skills such as critical thinking, problem-solving and personal motivation, frameworks for the teaching and assessment of 21st-century skills commonly recognise the importance of the interpersonal domain. The importance of such skills in life and in work seems undeniable, although their inclusion as a key skill for school curricula has been labelled as 'contentious' (Lamb, Maire, & Doecke, 2017). This paper will consider the approaches and implications for assessing this domain, based on the author's experience of working in medical education, where the promotion and monitoring of empathy is a key objective of medical courses.

The first thing to note is the diversity of terms used for skills in the interpersonal domain. A glance at the key 21st-century skills frameworks demonstrates the following terms being used by different educational reports: affectivity, collaboration, cooperation, (complex) communication, emotional learning, empathy, interpersonal domain/skills, relating to others, teamwork, as well as several variations on 'social' such as social awareness, social capability, social management, and so on. In medical education, these ideas are also referenced by concepts such as empathy, emotional intelligence, people skills, rapport, or 'soft skills'. This proliferation of terms can be confusing and frustrating, but they probably also point to the importance of the domain.

While a single, universally accepted definition of this construct or 'skillset' seems hard to come by, a succinct description offered by one educational body seems adequate and useful: 'skill in processing and interpreting both verbal and non-verbal information from others in order to respond appropriately' (NRC, 2011). The key terms in this definition are 'interpreting' and 'appropriately'. Good interpersonal skills involve insight, understanding, and the kind of situational awareness that helps one determine what might be an 'appropriate' response. There can be no set rules for determining this, much to the frustration of many – teachers and students alike. In other words, skill in the interpersonal domain involves some element of cognitive ability, a point explicitly made by Howard Gardner's (1983) coining of the term 'interpersonal intelligence'. Further, while it can be tempting to believe that people either have or do not have good interpersonal skills, 21st-century skill frameworks do not see it this way. As Lamb et al. (2017) succinctly note, two key principles underlie the conception of skills in frameworks: as 'developing expertise', and as 'contextual'. Both principles apply to the way the interpersonal domain is conceptualised and, necessarily, assessed (Spitzberg, 2003).

When it comes to the assessment of interpersonal skills, most 21st-century frameworks readily acknowledge the challenge this domain presents. Besides the elusive terminology, the frameworks also note the difficulty of precise assessment for such a 'complex' domain, the strong influence of context (including cultural), and the evolving nature of interpersonal skills in an increasingly sophisticated technological world (NRC, 2011). To some extent, these challenges apply to all the 21st-century skills, but particularly those 'complex skillsets', such as collaboration, which draws on multiple domains, including the cognitive and the social (Care & Kim, 2018).

However, it is worth remembering that educators have been wrestling with teaching and assessing in the domain long before the 21st-century-skills movement, and that useful guidance may be found in learning frameworks and taxonomies that have long been used in school contexts, and occasionally in professional contexts, too. The most obvious is Bloom's Taxonomy of the Cognitive Domain (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956; Anderson & Krathwohl, 2001), which outlines the different levels at which educational objectives can be focused and assessed with suitably adapted formats. Most teachers will be familiar with this framework, and it can be readily applied to the cognitive dimension of interpersonal skills. Less well-known is Krathwohl's Taxonomy of the Affective Domain, which provides a similar structuring for 'objectives which emphasize a feeling tone, an emotion, or a degree of acceptance or rejection' (Krathwohl, Bloom and Masia, 1964). A more recent taxonomy of interpersonal skills is that of Klein, DeRouin, & Salas (2006), which divides this domain into two broad areas, with associated subskills, as shown in Table 1.

Table 1 Taxonomy of interpersonal skills (Source: Klein et al., 2006)

Communication skills	Relationship-building skills
Active listening	Cooperation and coordination
Oral communication	Trust
Written communication	Intercultural sensitivity
Assertive communication	Service orientation
Non-verbal communication	Self-preservation
	Social influence
	Conflict resolution and negotiation

The example of empathy in medicine

> The biggest deficit that we have in our society and in the world right now is an empathy deficit. We are in great need of people being able to stand in somebody else's shoes and see the world through their eyes.
>
> *Barack Obama, 44th President of the United States*

A related approach may be seen in the area of medical education, where the assessment of empathy represents a strong valuing of the interpersonal domain. In many ways, empathy is an ideal example with which to examine teaching and assessing in the interpersonal domain more closely. It is commonly acknowledged as involving multiple dimensions, for example, a *cognitive* dimension, which enables a person to *understand* the feelings or viewpoint of another, and an *affective* one, which allows a person to *feel* and *respond* to what the other may be feeling (Jeffrey, 2016); thus empathy would be classed as a 'complex skillset' (Care & Kim, 2018) in 21st-century frameworks. Similar to the status of interpersonal skills in these frameworks, empathy resonates strongly with stakeholders in medical education. For many, the concept of empathy has come to represent the particular interpersonal understandings and skills expected of students and practising doctors. In some cases, its deficiency is identified as a fundamental source of medicine's failures, as in the Stafford Hospital scandal of 2008 (Francis, 2013); or, indeed, society's failures, as the above quote by Barack Obama suggests. Assessing empathy in students, validly and authentically, is therefore vital.

Assessment approaches

Broadly speaking, there are three approaches to assessing empathy in medicine – self-report, direct observation (usually under examination conditions), and clinical supervisor judgement (usually longitudinal observation). The observation methods are sometimes referred to as 'third person assessments' (complementing the 'first person' perspective of the self-report measures) (Hemmerdinger, Stoddart, & Lilford, 2007); this highlights another possible approach to its assessment, termed 'second person', that is, the person who is on the receiving side of the interaction. In medicine, this 'other person' is usually the patient or their family, who, perhaps surprisingly, is only occasionally consulted as a source of judgement regarding students' (or clinicians') level of empathy. These potential approaches combine with three key considerations about assessing skills to determine how empathy is assessed in the clinical education context: ways to conceptualise a skill set, its contextual nature and the importance of authenticity of assessment.

Conceptualising empathy

There is a fundamental distinction between empathy as a form of understanding and as a form of feeling; in medicine, there is also an important third aspect – that of empathy-related *action*. This third dimension is often referred to as behavioural or communicative empathy. In other words, in medicine empathy entails thinking, feeling and behaving (Jeffrey, 2016). Sometimes a fourth dimension is defined: the ethical or moral dimension, specific to the role that empathy plays in compassionate care (Jeffrey, 2016). Clearly, empathy constitutes exactly the kind of 'complex skill set' discussed in 21st-century frameworks (Care & Kim, 2018).

Different emphases (or omissions) in relation to these three domains will affect the way empathy is assessed, or rather, the validity of any conclusion drawn from those assessments (Downing, 2003). This is an important issue in medical education. A recent review of empathy assessment in medical education (Sulzer, Feinstein, & Wendland, 2016) identified significant variation in the way different assessment methods defined or characterised empathy, along the three lines indicated above. Table 2 shows the relative emphases of studies that used available empathy measures for assessment purposes.

While the emphasis reflected in Table 2 is consistent with the place of empathy in medical education – most commonly understanding the patient's perspective, with acknowledgement that this understanding should lead to appropriate action by the doctor – Sulzer et al. (2016) noted that the selection of assessment instrument did not always match the dimension of empathy they were interested in. Clearly, there needs to be alignment between the underlying conceptualisation, as reflected in the objectives, and assessment methods for valid inferences to be drawn about student empathy development.

Table 2 Characterisations of empathy in available measures (Source: Based on Sulzer et al., 2016)

Empathy characterised as …	Studies (no.)
Thinking and acting	31
Thinking only	17
Thinking and feeling	14
Thinking, acting and feeling	12
Acting only	9
Acting and feeling	3
Feeling only	3

Contextual basis

Empathy, like the interpersonal skills domain, is generally acknowledged to be a contextual skill (Jeffrey, 2016), so that the nature and quality of empathy displayed by students depends on the given circumstances. Quality, in the interpersonal domain, is best summed up as 'effectiveness' and 'appropriateness' (Spitzberg, 2003); and the same author helpfully delineates the common contextual factors as culture, time (arguably 'timing' would be the better term), relationship, situation and function. Medical students learning the art and skill of empathy are often caught out by such contextual nuances; where the common phrase 'that must be really hard for you' might in some circumstances convey authentic empathy to a patient narrating her experience of illness, its over-use or hasty use, however well-intentioned, at the wrong time, or with the wrong patient, can have exactly the opposite effect (Coulehan et al., 2001). These factors impact on how empathy will be assessed, and judged, especially in the often summative and high-stakes context of medical school. Rubrics can be designed to support and guide assessor judgement on any particular assessment (Jonsson and Svingby, 2007), but they risk over-prescribing acceptable performance of such a complex skill.

Medical education's answer to this dilemma has been twofold: first, to assess empathy (along with other clinical skills) partly under standardised conditions with a highly-structured assessment format using trained, simulated patients, known universally throughout medicine as the OSCE (Objective Structured Clinical Assessment). Second, to draw on the key principle of sampling (Norman, 2002); that is, to assess empathy often, with different patients, in different clinical contexts, and by different assessors, thereby minimising the context-specific effects of the individual assessments. As one assessment expert puts it, referring to the measurement error inevitably contained in highly specific, contextual and necessarily unstandardised individual assessments, 'many fallible judgements, summed together, create value' (Hodges, 2013). While the notion of broad sampling would seem readily transferable to classroom contexts, the creation of a discipline-wide method of assessment of interpersonal skills would, I imagine, be prohibitive. Fortunately, it is neither desirable nor necessary.

Degree of authenticity

The significant advantage of the sampling approach is that it meets the third fundamental element of empathy assessment in medicine, namely authenticity. This notion is fundamental to the assessment of all 21st-century skills (Care & Kim, 2018), and in a practically-oriented profession such as medicine, is a key consideration in the evaluation of such skills, including empathy. In medicine, the strongest and most influential articulation of the goal of authenticity in assessment is represented by the taxonomy known as Miller's Pyramid (Miller, 1990)

This framework for assessment depicts visually the different 'levels' of clinical knowledge and skills desirable in medicine: *knowing*, *knowing how*, *showing how*, and *doing* – usually accompanied by common assessment methods targeting that level (see an example in Figure 1). In many ways this relatively simple framework is a variant of Bloom's Taxonomy, and no doubt other similar heuristics for teaching and assessment exist in classrooms both in Australia and around the world. But its impact in medical education has been profound, and has been credited with moving the practice of assessment from a poorly considered dependence on multiple choice questions and essays, to a more thoughtful alignment of assessment purpose, desired skill set and appropriate format. In other words, improving the authenticity, and potential validity, of assessments in medical education.

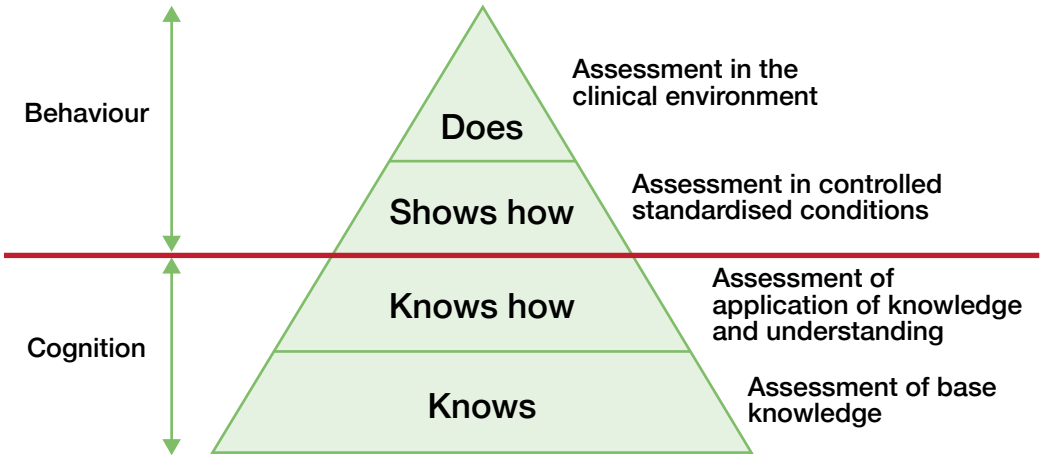

Figure 1 Miller's Pyramid of clinical assessment (Source: Adapted from Miller, 1990)

Applying this model to the assessment of empathy helps us make sense of the various conceptualisations, assessment approaches and tools available for assessing empathy and other interpersonal constructs. The cognitive dimension of empathy, understanding how others may feel or why they behave in a certain way in a given situation, can be represented by the levels of *knowing* and *knowing how*. The *knows* level aligns with an interest in students' base knowledge of human behaviour, assessed, for example through a written test, or self-report questionnaire relating to the value of certain principles for clinical practice.

The *knows how* level enables a higher level of contextual understanding and insight about people's thoughts and feelings. It can be assessed in written or oral formats, but clearly requires a specific context in which that understanding needs to be displayed. Commonly available commercial tests of empathy and related constructs such as the Mayer–Salovey–Caruso Emotional Intelligence Test™ and Ickes' empathic accuracy test target the *knows how* level are, but similar items, either selected or constructed response, can also be developed for classroom or clinical placement use.

At the top two levels of Miller's Pyramid, empathy is assessed as an action or behaviour, though founded upon the 'lower level' knowledge and understanding. *Showing how* requires the demonstration of relevant empathy but in a relatively controlled and standardised setting, usually represented in medicine by the OSCE assessment format. However some self-report instruments and 'situational judgement tests' (e.g. Lievens, 2013) that invite respondents to indicate how they might respond in a given situation could also be described at assessing at this level. However, as discussed above, empathy cannot be limited to constrained and prescribed situations. For the assessment of empathy in more authentic contexts, students are assessed in their everyday interactions with real patients, during actual clinical interviews or procedures, normally assessed by their supervisor or other clinical staff, using previously validated rating forms. Such assessments are commonly 'opportunistic', although may be planned in advance. The distinguishing feature of assessment at this level of 'doing' is the authentic context, the unstructured environment, and once again, the opportunity for multiple samples of the behaviour of interest.

Notably, the affective dimension of empathy is not clearly represented in Miller's Pyramid. This is consistent with the assessment approach in medicine which tends to avoid direct exploration of the affective or emotional aspect of medical training. Many medical educators claim this is a 'blind spot' in medicine's approach to empathy (e.g. Halpern, 2001). As mentioned previously, Krathwohl's Taxonomy of the Affective Domain provides a model for which the development of affective empathy could be charted and assessed. Self-report instruments would constitute the 'base level' of the domain, involving awareness and receptivity to others' emotions.

An important lesson from the above schema of empathy assessment is that educators need to resist the temptation to simply reach for the most common or convenient assessment format available. Various 'empathy assessments' conceptualise empathy differently, and target different dimensions and levels. A mismatch in these factors will undermine validity and risk drawing inappropriate conclusions about students' empathy. Many in medical education argue this may well be behind the contentious claim that medical students appear to 'lose' empathy through their course – a judgement usually based on the administration of self-report instruments rather than actual performance and judgement in authentic situations (Colliver, 2010).

Like most disciplines, there can be a gap between theoretical assessment approaches and actual practice. While medical courses may not always meet the goals of the curriculum designers, their attempts to enact authentic, aligned and valid assessment of empathy can provide a useful example for school classrooms faced with the challenge of assessing the interpersonal skills of students. Despite the obvious contextual differences, the assessment of empathy in medical schools provides an important example of how an interpersonal skill is highly valued, and how existing frameworks can assist teachers to assess them.

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Digital literacy: Myths and realities

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Abstract

Digital literacy, under a wide variety of names, is routinely classified as a 21st-century skill and is frequently reported as an area of high priority in school education systems internationally. In comparison with students in other countries, Australian students have high levels of access to digital technologies both at and outside of school. With this access comes the expectations that students will be highly-proficient users of digital technologies and that schools will use digital technologies in transformative ways to support student learning. This session will examine how concepts of digital literacy have developed over time, what data from large-scale assessments of student digital literacy tell us about students' learning in this area (both in Australia and across countries) including how it has changed over time. We will also reflect on the differences between the rhetoric and the realities of digital literacy and what these mean for the future direction of this critical area of learning.

An incomplete history of computing instruction in schools

Introduction

Computing instruction became pervasive in schools during the 1980s with the advent of affordable personal computers. In these early days, the focus of computer instruction was on programming and software and computer use (Haigh, 1985). During the 1980s and 1990s, while computing and computer literacy were still a focus of computer education, the use of computers in libraries led to the need for students to develop skills in searching for and using information. This gave rise to information literacy, which extended beyond searching for information to include critical thinking and evaluation skills relating to the research skills that include: establishing research questions; searching for and finding information; and, evaluating the credibility, relevance, and usefulness of found information. The rapid development of the internet as an information resource during the 1990s gave further importance to the value of the critical aspects of information literacy. Early conceptualisations of digital literacy, such as information and communication technologies (ICT) literacy emphasised information literacy skills and deliberately de-emphasised computing skills. During that time, computers were regarded as tools for information seeking and production and the technical skills associated with using computers were of little importance. In 2003, a feasibility study commissioned by the Organisation for Economic Co-operation and Development (OECD) supported the inclusion of ICT literacy in the Programme for International Student Assessment (PISA). For the study, ICT literacy was defined as:

> … the interest, attitude, and ability of individuals to appropriately use digital technology and communication tools to access, manage, integrate, and evaluate information, construct new knowledge, and communicate with others in order to participate effectively in society (Lennon, Kirsch, Von Davier, Wagner, & Yamamoto, 2003).

In the 21st century, the role of understanding aspects of computing in the use of computers has been reflected in curricular and assessment constructs associated with digital literacy. Initially this was through a greater emphasis on understanding computing as an aspect of digital literacies, but more recently this has been evident in the establishment of programs relating to digital technologies that include coding and computational thinking. Figure 1 shows the relationship between three main areas of emphasis in digital competence that have evolved over recent decades: computer science, ICT/digital literacies, and computational thinking/digital technologies.

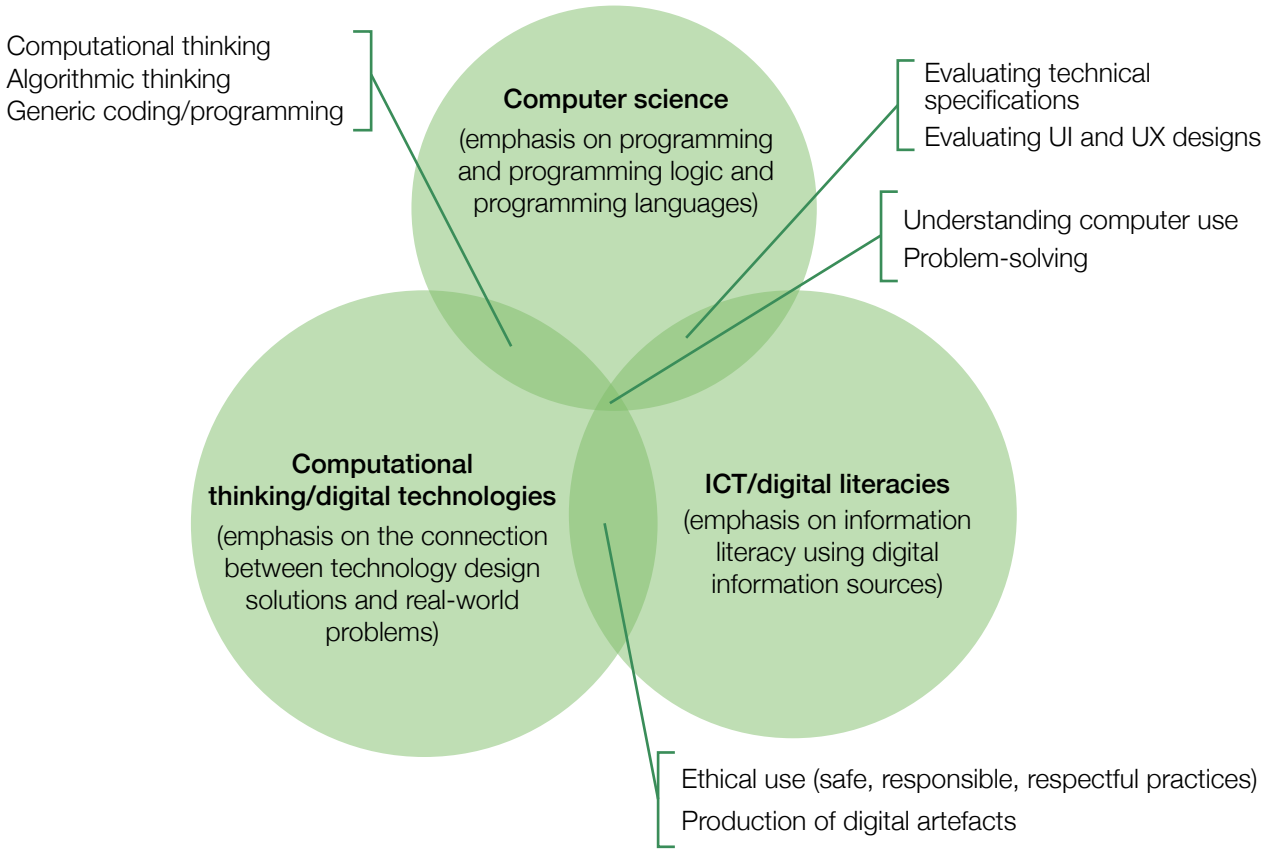

Figure 1 Relationships between the three main areas of emphasis in digital competence

Examples of work measuring and reporting on ICT/digital literacies

Two examples of work measuring and reporting on digital competence that are relevant to the Australian context are the Australian National Assessment Program, ICT Literacy (NAP – ICTL) and the International Computer and Information Literacy Study (ICILS). NAP – ICTL is part of the Australian National Assessment Program (NAP), managed by the Australian Curriculum Assessment and Reporting Authority (ACARA), and established as an 'initiative of ministers of education in Australia to monitor outcomes of schooling specified in the 1999 Adelaide Declaration on National Goals for Schooling in the 21st Century' (ACARA, 2018, p. 1). NAP – ICTL has collected and reported on achievement data in ICT Literacy from nationally representative samples of Australian Year 6 and Year 10 students every three years from 2005.

ICILS is a cross-national, large-scale assessment of computer and information literacy (CIL) commissioned by the International Association for the Evaluation of Educational Achievement (IEA). The first cycle of ICILS was conducted in 2013 across 21 countries, including Australia, to collect achievement data from Year 8 students in representative samples of schools in each participating country as well as data from teachers, school leaders and system-representatives about the teaching and learning of CIL. A second cycle of ICILS was conducted in 14 countries in 2018. In addition to the core data collection established for ICILS 2013, ICILS 2018 included an optional test of computational thinking for students. Australia did not participate in ICILS 2018. The ICILS 2018 international report will be released on 5 November 2019.

Data from NAP – ICTL and from ICILS 2013 can shed light on some of the myths and realities associated with the learning and teaching of aspects of digital competence in Australia and across a range of other countries. In the following section, we will explore some of these myths and realities.

Myth 1: The rise of the digital natives

The idea that young people who are growing up with access to digital technologies develop 'sophisticated knowledge of and skills with information technologies' as well as learning styles that differ from those of previous generations (Bennett, Maton, & Kervin, 2008, p. 777) is naturally seductive to those of us who did not grow up with this same access. This notion of a self-developed capacity to use digital technology is at the heart of the concept of the 'digital native' (Prensky, 2001). Adults frequently comment on the ease and apparent expertise with which young people use digital technologies. However, there remain questions about the sophistication and value of some of these skills.

Both ICILS and NAP – ICTL measure and report the achievement of student digital literacy skills on empirically-based achievement scales that include descriptions of the knowledge, skills and understanding expressed by students at different 'levels'. Table 1 includes the descriptions of the lowest level of achievement measured in each of ICILS (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2014, p. 74) and NAP – ICTL (ACARA, 2018, p. 24).

The NAP – ICTL program reports on student achievement from Years 6 and 10 and consequently the lowest level in the scale represents achievements that are somewhat easier than those in Level 1 of ICILS, which focuses on Year 8 students. However, neither of the levels shown in Table 1 represents sophisticated use of digital technologies. Examples of achievements at Level 1 of NAP – ICTL are, 'basic file and computer management functions such as dragging and dropping files' or applying generic commands such as 'save as' or 'paste'. Examples of achievements at Level 1 of ICILS include 'insert an image into a document' or 'use software to crop an image'.

In NAP – ICTL 2017, 13 per cent of Year 6 and 3 per cent of Year 10 students nationally were at Level 1 or below on the NAP – ICTL scale (ACARA, 2018). In ICILS 2013, across all countries, 40 per cent of Year 8 students were at Level 1 or below and in Australia, which was one of the more highly achieving countries in ICILS, 23 per cent of Year 8 students were at Level 1 or below on the ICILS scale (Fraillon et al., 2014).

Table 1 Lowest level of achievement measured in each of ICILS

NAP – ICTL Level 1 descriptor	ICILS Level 1 descriptor
Students working at Level 1 perform basic tasks using computers and software. They implement the most commonly used file management and software commands when instructed. They recognise the most commonly used ICT terminology and functions	Students working at Level 1 demonstrate a functional working knowledge of computers as tools and a basic understanding of the consequences of computers being accessed by multiple users. They apply conventional software commands to perform basic communication tasks and add simple content to information products. They demonstrate familiarity with the basic layout conventions of electronic documents.

So, regardless of the observation that young people embrace technology, there remain large proportions of young people who continue to have very low levels of practical functional digital knowledge skills and understandings. As Koutropoulos (2011, p. 351) suggested when looking at the research into young people's digital skills:

> … we see that there is no one, monolithic group that we can point to and say that those are digital natives. As a matter of fact, the individuals who would fit the stereotype of the digital native appear to be in the minority of the population.

Myth 2: Boys use technology better than girls do

Data from each of NAP – ICTL and ICILS both contradict the general belief that boys will perform better than girls when using digital technologies. What the data tell us clearly thus far is that the opposite is true. Across all cycles of NAP – ICTL since 2005, the performance of Year 6 female students was significantly higher than that of male students and this was the same for Year 10 students across all cycles except for the first assessment in 2005 (in which the difference in performance between female and male students was not statistically significant) (ACARA, 2018). Similarly, in ICILS 2013, female students outperformed male students in all but two countries (where again the difference in performance between female and male students was not statistically significant) (Fraillon et al., 2014). At the end of 2018, the release of ICILS 2018 data on computational thinking will include analysis of gender differences in achievement in an area that is hypothesised to be one of relative strength for male students.

Myth 3: Digital technologies have transformed classrooms and pedagogy

There is no question that digital technologies offer teaching opportunities that previously had not been readily feasible. The internet provides opportunities to immediately access to up-to-date information from around the globe. The ongoing evolution of (for example) communications, planning, simulation and online learning applications are resources that provide opportunities for a new world of teaching and learning. However, while examples of highly innovative uses of digital technologies in schools are (rightly) promoted and lauded, the data suggest that these practices are the exceptions rather than the norm.

In NAP – ICTL 2017, students were asked about the frequency with which they used digital tools for school-related purposes. The most commonly used tools reported by Year 6 and Year 10 students were word-processing software, presentation software and computer-based information resources (such as websites or wikis). Each of these tools was reported to be used at least once a month and by more than 60 per cent of Year 6 students and by more than 70 per cent of Year 10 students. In contrast, simulations and modelling software, computer-aided drawing (CAD) software, data logging or monitoring tools and concept mapping software were reported to be used far less frequently by students. Typically, these were reported to be used at least once a month by between 15 per cent and 30 per cent of students at both year levels (ACARA, 2018).

In ICILS, both students and teachers were asked about their use of ICT in their learning and teaching. The most frequent uses reported by students were: preparing reports or essays, preparing presentations, working with students from their own school, and completing worksheets or exercises. The most frequent uses of ICT in class reported by teachers were: presenting information through direct instruction in class, reinforcing learning through repetition of examples, providing feedback to students, assessing students learning through tests (Fraillon et al., 2014).

The least frequent uses of ICT for school-related purposes by students were: organising their time or work, writing about their learning, and working with students from other schools. The least frequently reported uses of ICT by teachers were: supporting inquiry learning, collaborating with parents or guardians in supporting students' learning, enabling students to collaborate with other students (within or outside school) and mediating communication between students and experts or external mentors (Fraillon et al., 2014).

In ICILS 2013, we drew the conclusion that 'computers were most commonly being used to access digital textbooks and workbooks rather than provide dynamic, interactive pedagogical tools' (Fraillon et al., 2014, p. 257). At the end of this year we will see whether data from ICILS 2018 suggest a shift to more innovative use of ICT in teaching; however, data from NAP – ICTL 2017 suggest that this is less likely than we might hope for.

Myth 4: Student digital literacy will continue to increase

With the ongoing development of digital technologies, increasing availability and increasing emphasis on the value of developing digital literacy (such as through the establishment of the Australian Curriculum: ICT Capability and more recently the Australian Curriculum: Digital Technologies) it is reasonable to hypothesise that young people's digital literacy would continue to increase. Evidence from NAP – ICTL does not support this.

In Australia, since 2005 there has been very little change in the ICT – Literacy of Year 6 and Year 10 students (Figure 2). At Year 6, on average across Australia, NAP – ICTL scores varied from 400 scale points in 2005 to a high of 435 scale points in 2011 and subsequently returned to 410 scale points in 2017. The 2017 average was not statistically significantly different from that of 2005. At Year 10, on average across Australia, scores ranged from 551 scale points in 2005 to a high of 560 scale points in 2008 and 2011 and have since decreased to 523 scale points in 2017. The 2017 Year 10 average scale score was statistically significantly lower than that of all previous cycles of NAP – ICTL except for 2014.

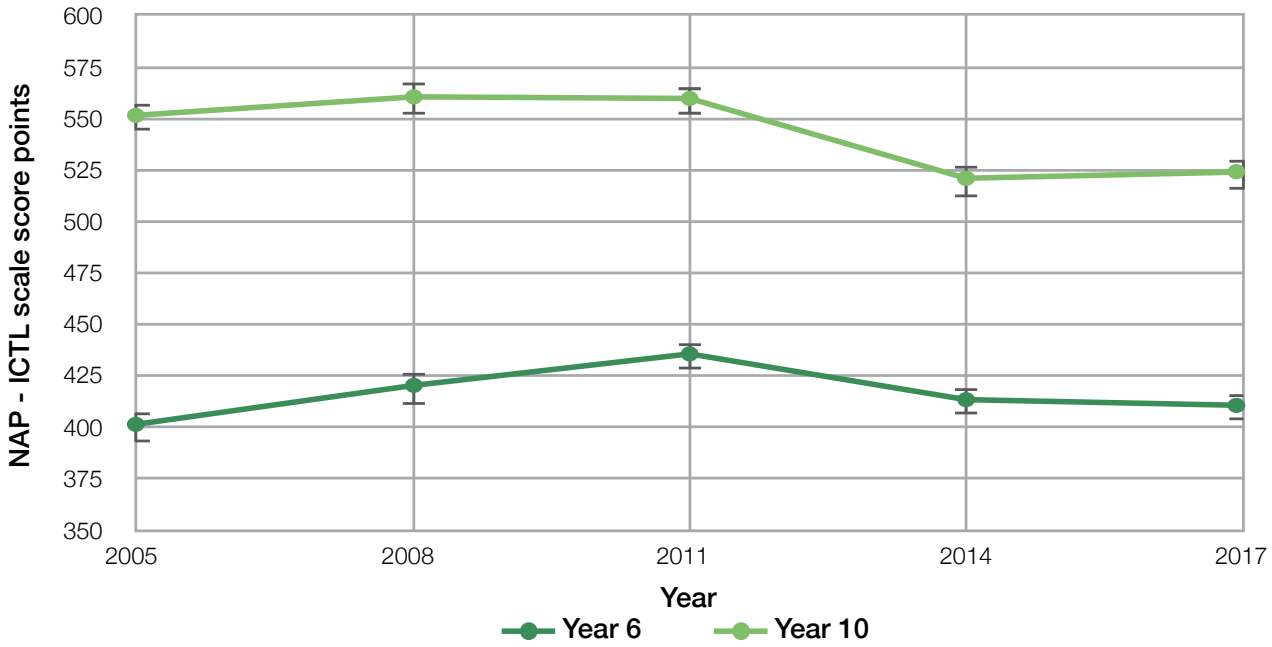

Figure 2 NAP – ICTL Year 6 and Year 10 average national scale scores (2005 to 2017)

Concluding comments – pause for thought?

We live in a time of unprecedented and increasing access to digital technologies and proliferate use of digital technologies by young people in Australia, which often brings with it the assumption that, because the technologies look complex, the act of using them must be sophisticated. This comes with the corollary that young people are innately developing highly sophisticated digital skills.

The research evidence challenges these assumptions by shining a light on the proportions of young people who can only demonstrate the most basic skills and by showing that, somewhat counter-intuitively there has been no increase in students' measured ICT literacy in Australia between 2005 and 2017. Students' access to ICT and digital devices has increased over the same period. Their attitudes towards the importance of working with digital devices have remained positive and their confidence in using digital devices has remained very high (ACARA, 2018). Why has the ICT literacy of Australian students not increased since 2005, in a time of such rapid technological development and positive attitudes towards technologies among students?

While the answers to these questions are beyond the scope of this paper, the simple response is that digital literacies need to be taught. In Australia, the advent of the Australian Curriculum: ICT Capability and, more recently, the Australian Curriculum: Digital Technologies provide educators with curriculum resources that previously were unavailable. The provision of strong curriculum and learning resources for teachers is clearly a step in the right direction. This too should come with professional support for teachers to implement ICT in their teaching. In ICILS, we found that across countries the strongest predictors of teachers' likelihood to emphasise CIL in their teaching were those who were confident using ICT, had positive views about the use of ICT and reported that they were in schools where there was a collaborative approach among the staff to the use of ICT (Fraillon et al., 2014).

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Key skills for the 21st century: An evidence-based review

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Abstract

It is vital that education systems deliver quality outcomes for all young people and prepare them well for their future in the economy and society. To do so, many systems have traditionally had a strong focus on developing academic skills, particularly in literacy and numeracy. In recent years, education systems have developed greater expectations that schools will also equip young people with a broader set of skills for the 21st century (e.g. creativity, critical thinking, problem-solving). This paper addresses these developments and the challenges they present. Building on an evidence-based review, this paper asks what are the key skills required for the 21st century? How do various jurisdictions articulate their aspirations concerning these broader skills within their curricular and policy frameworks? What evidence is there about the best way to incorporate key skills for the 21st century into curriculum and teaching and learning? How can a more diverse set of skills be measured and assessed?

Introduction

Many countries articulate ambitions to improve the way students develop 'a comprehensive set of cognitive, social and emotional capabilities to better face the socio-economic challenges of the 21st century' within education policies and reform objectives (OECD, 2015, p.130). This paper discusses four key questions for education systems responding to the challenge of developing key skills for the 21st century. These questions concern 1) the nature of these skills, 2) their integration into education systems' curricular and policy frameworks, 3) evidence on best practice for teaching and learning, and 4) measurement and assessment.

1 What are the key skills required for the 21st century?

Efforts to empower all students to develop a comprehensive range of competencies have a long tradition in Australia and overseas. Over 45 years ago, the Karmel report expected all students to learn

> … to be able to relate to others, to enjoy the arts both as a participant and as a patron, to acquire physical grace and to exercise developed mental powers in all aspects of living … as means to a more generous and fulfilling life (1973, p. 24).

Debates about the conceptualisation of these competencies have taken place and are still evident in the literature. In our review of key skills for the 21st century, and leaving aside technological skills that have received separate attention, we identified nine skills figuring prominently in this space (Lamb, Maire & Doecke, 2017). Critical thinking, creativity and problem-solving are skills that are directly applicable to performing tasks or creating products. To support the use of these competencies, students also depend on 'second-order' dispositions and skills that relate to how students learn and participate. These include metacognition, motivation, conscientiousness and grit.

Underpinning any meaningful engagement is students' sense of self-efficacy; that is, their belief that their application and efforts can make a difference. Finally, students' collaborative skills are considered to be increasingly important in solving complex problems or finding solutions to issues relevant to their communities.

These nine dispositions and skills have received attention primarily for their relationship with student achievement in school. Various frameworks have attempted to map the ways in which these attributes are interrelated, based on theoretical premises (Pellegrino & Hilton, 2012) as well as on empirical grounds (Lamb, Jackson, & Rumberger, 2015). Yet, it remains unclear how these skills are interrelated in shaping student learning, for theoretical (Coleman & Cureton, 1954) as much as measurement reasons (Farrington et al., 2012).

Beyond definition and classification controversies, however, research on 21st-century skills suggests that these attributes can be developed by individuals, albeit to a varying extent in different contexts. Accordingly, their development in schools is most likely to be nurtured by deliberate approaches to teaching and learning, where students are given rich and varied opportunities to improve them.

2 How do jurisdictions articulate their aspirations concerning these broader skills within their curricular and policy frameworks?

Increasingly countries remodel their curriculum frameworks in order to place these skills front and centre (Schleicher, 2018). Australia is well-recognised for the inclusion of general capabilities such as critical and creative thinking within the Australian Curriculum. Certain states in the United States, some Canadian provinces, New Zealand, Finland and Singapore are also leading in their developments in this area (ACARA, 2019). However, a common trend is that very little is

formalised beyond the curriculum, especially in terms of teaching and learning practices to develop a broader set of skills (Care & Luo, 2016).

One jurisdiction that has orientated itself towards social–emotional skills is the state of California, where eight of its largest school districts have formed a coalition, called the CORE Districts. A major focus of this coalition is the development of the four social–emotional skills of growth mindsets, self-efficacy, self-management and social awareness. The CORE Districts promote their importance through additional resources provided to schools. They place value on collecting a rigorous measure of students' skill development within their School Quality Improvement System (Krachman et al., 2016).

The CORE Districts conduct a student survey to gather self-reported measures of all four social–emotional skills. Evaluations of the CORE Districts' work in this area find that assessment of social–emotional skills demonstrates strong correlation in the 'expected direction with other academic and behavioural outcomes', with acceptable levels of internal reliability (Gehlbach & Hough, 2018; Krachman, Arnold, & Larocca, 2016; Transforming Education, 2016; West, 2016).

3 What evidence is there about the best way to incorporate key skills for the 21st century into curriculum and teaching and learning?

Part of the reason for the lack of detailed models for teaching 21st-century skills is the scarcity of evidence on best practice. As Binkley et al. (2012) note, our understanding of the acquisition of the different dispositions and skills in school remains thin, especially for the skills often labelled as 'non-cognitive' (i.e. intrapersonal and interpersonal skills). The difficulty in identifying how students build these skills makes it difficult to determine how best to teach them.

Nevertheless, a number of promising teaching methods have been considered. Chu and colleagues (2017) have recently focused on inquiry-based learning. This approach to learning encourages students to take responsibility for their own learning, linking with the 'second-order' skills listed (i.e. metacognition, motivation, conscientiousness and grit). In turn, this calls for appropriate support from teaching and non-teaching (e.g. library) staff and resources. The authors particularly highlight the central role technology-rich environments can play in inquiry-based learning.

Creative problem-solving was one of the key areas of the Programme for International Student Assessment (PISA) 2012 (OECD, 2014). Results from this large-scale international assessment highlight the importance of solving problems in meaningful contexts, the use of metacognitive (i.e. self-regulated learning) strategies and the value of subjects such as visual arts in helping students develop problem-solving skills. For PISA 2015, the OECD assessed collaborative problem-solving (OECD, 2017). International results suggest that social activities, safe and supportive school environments and physical education can play an important role in helping students collaborate. Exposure to student diversity in classroom learning can also foster the development of collaboration. Saavedra and Opfer (2012) similarly emphasise the importance of relevance, disciplinary-based learning and the use of thinking skills for the development of 21st-century skills.

As these examples suggest, existing evidence on teaching for 21st-century skill development points to strategies and methods that are characteristic of good schools and teaching more generally. Further research focused on 21st-century skills' teaching and learning could help determine whether these are valid across all skills and assist in making informed judgements about the relative merits of different approaches.

4 How can a more diverse set of skills be measured and assessed?

Measuring any skill is a complex task. In particular, the theory and measurement of social–emotional skills is still very much 'in its infancy' (Whitehurst, 2016). Researchers are in general agreement that skills and educational constructs cannot be measured well without first having a clear understanding of what they are (Ananiadou & Claro, 2009; Soland, Hamilton, & Stecher, 2013). However, 21st-century skills are constructs that lack 'inherent measurement properties independent of human definition' (Care & Vista, 2017). Whitehurst (2016) states that 'within the domain of soft skills there is nothing remotely close' to the level of specificity as that outlined with a literacy standard. The lack of high-quality and robust measures is due to various factors, including the fact that these constructs overlap one another and transcend discipline areas in a way that traditional subject areas do not.

There are three methods of assessment and evaluation currently used to capture and measure key skills for the 21st century within education contexts. They are:

1. student self-rating
2. direct assessment
3. teacher judgement and reporting.

Self-rating is achieved through the use of a student survey constructed and administered in a standardised format, using multiple-choice items or open-ended

prompts (Lai & Viering, 2012). Direct assessment involves the administration of a test or task to demonstrate a student's mastery of a competency or skill. The 21st-century skills commonly measured via direct assessment include collaborative problem-solving and critical and creative thinking (e.g. OECD's PISA). Teacher judgement is the final method of assessing skill development. Assessing and evaluating students in either a formative or summative way is crucial to the role of teachers and is often articulated as a key criteria within the teacher professional standards (e.g. such as those specified by Australian Institute for Teaching and School Leadership).

Although each method of assessment has strengths, it is also important to keep in perspective their limitations (West et al., 2014). There is a constant need for reflexivity when it comes to measurement, as any approach should be continually evaluated to ensure it supports the targeted educational objectives. Currently, schools and teachers employ a mix of methods of assessment concerning more traditional academic skills. Many researchers have similarly argued that a mixed and complementary assessment approach is necessary for a broader set of skills (Duckworth & Yeager, 2015). Different methods of assessment tap into different aspects of a construct and provide a fuller perspective of student achievement. Employing different methods of assessment ensures that they can be complementary to one another and also helps in circumventing their methodological limitations (Kautz, Heckman, Diris, Weel, & Borghans, 2014).

Conclusion

In the first decades of the 21st century, a broad range of attributes, dispositions and skills are receiving considerable attention in educational research and policy. While most countries have developed a strong focus on 21st-century skills in their school education systems, this emphasis is more marked for high-level policy than through effective approaches for teaching and learning. Evidence on valid and reliable assessment is also limited. This calls for further investment in research on key skills for the 21st-century, focusing particularly on teaching, learning and assessment.

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Assessing computational thinking

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Abstract

This paper provides some context for the role of computation thinking (CT) in the Australian Curriculum, an abridged literature review of CT as a problem-solving framework from the ICILS 2018 assessment framework and some examples of how CT has been used to solve real-world problems. Finally, this paper presents ways to teach and assess CT.

Assessing computational thinking

Computational thinking and the Australian Curriculum

The National Assessment Program (NAP) began as an initiative of ministers of education in Australia to monitor outcomes of schooling specified in the 1999 Adelaide Declaration on National Goals for Schooling in the 21st Century (Adelaide Declaration). The NAP was established to measure student achievement and to report this against key performance measures in relation to the national goals, using nationally comparable data in each of literacy, numeracy, science, and information and communication technologies (ICT). In 2008, the Adelaide Declaration was superseded by the Melbourne Declaration on the Educational Goals for Young Australians (Melbourne Declaration).

In 2010, the Australian Curriculum and Assessment Reporting Authority (ACARA) released the Australian Curriculum, which organised the curriculum into learning areas. General capabilities were introduced to the Australian Curriculum in 2012, including the ICT capability, and in 2014 the technologies F–10 learning area was added. This draws together the subjects of design technologies and digital technologies. In the Australian Curriculum, subject content includes descriptions of what students are expected to learn. These include knowledge, understanding and skills, described at a year level or band of years. The content descriptions are accompanied by content elaborations that give teachers ideas about how they might teach the content. Within the digital technologies subject content, the curriculum refers to CT and is defined as:

> A problem-solving method that involves various techniques and strategies that can be implemented by digital systems. Techniques and strategies may include organising data logically, breaking down problems into parts, defining abstract concepts and designing and using algorithms, patterns and models (ACARA, 2014).

From Foundation to Year 2, students develop skills in CT to understand digital systems to organise, manipulate and present data and begin to conceptualise algorithms as a sequence of steps for carrying out instructions. One example given in the content descriptions is identifying the significant steps of making a sandwich. At the most basic level a student might simply provide the instruction, 'make a sandwich'. However, as students develop skills in CT they are able to differentiate between a process and a set of instructions required to complete a process by identifying significant steps such as 'put the bread flat on the table', 'open the jar', 'put the knife in the jar' etc. Sample portfolios accompany the content descriptions that showcase student work that is satisfactory, above satisfactory or below satisfactory. One such example at Foundation to Year 2 is a video demonstration of students who have developed a sequence of steps to program a Bee-Bot® (a small physical robot) to navigate an 8 × 10 grid. Another example at Years 5 and 6 is a video interview with a student who describes a computer network. The student describes the steps involved in sharing information between computers, including the need for a specialised computer (a server or DNS) that distributes unique addresses to other computers (clients) in a network. The student also contextualises this abstract digital system by describing the way it helps her collaborate with her classmates by using a shared folder to share files.

Computational thinking as conceptualised by the ICILS 2018

One aspect of learning to use computer technologies focuses on learning the foundational principles of computing. This aspect was evident in the early stages of the introduction of computers into classrooms in terms of arguments that saw the links between 'programming' and problem-solving as important for educational development (Papert, 1980). In the 1980s, the Logo language used commands to move a cursor or robot (a turtle) on a screen and line graphics. Many educational approaches closely linked to constructionism and oriented to cognitive development were based on Logo (Maddux & Johnson, 1997; McDougall, Murnane, & Wills, 2014; Tatnall & Davey, 2014).

Since those early developments, visual programming languages (where programs are created by manipulating program elements, or blocks, graphically) for children have emerged in addition to text-based programming languages. Scratch is an example of a visual programming language in which students use simple blocks of code to develop projects (Ortiz-Colon & Marato Romo, 2016). Scratch has a potential role in helping cognitive and meta-cognitive development, as well as providing opportunities for introducing the principles of computing in a practical and productive way.

Shute, Sun & Asbell-Clarke (2017, p. 142) argued that CT is required to solve problems algorithmically (with or without the assistance of computers) by applying solutions that are reusable in different contexts. They elaborated that CT is 'a way of thinking and acting, which can be exhibited through the use of particular skills, which then can become the basis for performance-based assessments of CT skills.' They suggested that CT involves six elements: decomposition, abstraction, algorithm design, debugging, iteration and generalisation. The ICILS 2018 assessment framework defines CT as 'an individual's ability to recognize aspects of real-world problems

which are appropriate for computational formulation and to evaluate and develop algorithmic solutions to those problems so that the solutions could be operationalized with a computer' (Fraillon et al., 2019).

Solving real-world problems with computational thinking

Numerous real-world problems have been solved with computational thinking. In 1936, Alan Turing invented the automatic machine (more commonly known as the Turing machine), a mathematical model of computation. Global communications via the internet were enabled by the development of the TCP/IP protocol by the Defense Advanced Research Projects Agency (DARPA) in the late 1960s (Cerf & Edward, 1983).

The Byzantine generals' problem (Lamport, Shostak, & Pease, 1982) was solved by combing Merkle Trees and cryptography to create blockchain technology (an immutable and distributed ledger), further enabling censorship resistant applications and decentralised cryptocurrencies such as Bitcoin (Nakamoto, 2008). Computer vision has surpassed human performance (He, Zhang, Ren, & Sun, 2015) to enable autonomous vehicles assisted by cameras and is the result of deep learning algorithms that utilise the perceptron (Minsky & Papert, 1969), stochastic gradient descent (Bottou, 2004) and backpropogation (Hecht-Nielsen, 1992).

Examples of CT curriculum and assessment

CT does not necessarily involve developing or implementing a formal computer code (Barr, Harrison, & Conery, 2011). Wing (2006, p. 33) argued that the concept of CT is applicable to all individuals rather than just computer scientists. Goode and Chapman (2013) developed the curriculum resource *Exploring Computer Science* (ECS) to help elaborate the meaning of CT. This curriculum package includes resources, lesson plans, and professional development for teachers. Its focus is on 'conceptual ideas of computing', but it includes consideration of 'computational practices of algorithm development, problem-solving and programming' (Goode & Chapman, 2013, p. 5) in contexts of real-life problems (using the Scratch programming tools).

ECS is linked to the Principled Assessment of Computational Thinking (PACT; see https://pact.sri.com/index.html), which is concerned with the assessment of secondary computer science outcomes (Rutstein, Snow, & Bienkowski, 2014). This approach involves designing 'assessment tasks to measure important knowledge and practices by specifying chains of evidence that can be traced from what students do' (Bienkowski, Rutstein, & Snow 2015, p. 2; see also Grover, Pea, & Cooper, 2015; Grover, 2017). PACT is based on design patterns for major CT practices and involves judging the quality of the instructions (or coding steps) that have been assembled.

There have also been other approaches to the assessment of CT. Chen et al. (2017) developed an instrument for primary school students to assess CT that was based on coding in robotics and reasoning of everyday events and linked to a 'robotics curriculum'. Zhong, Wang, Chen, & Li (2016) developed a three-dimensional assessment framework based on the concepts of directionality, openness and process. The assessment included three pairs of tasks that were based on a three-dimensional programming language: i) closed forward tasks and closed reverse tasks, ii) semi-open forward tasks and semi-open reverse tasks, and iii) open tasks with a creative design report and open tasks without a creative design report. Students' codes were assessed by the research team based on sets of rubrics reflecting elements of CT. They concluded that semi-open tasks were more discriminating than others, but that a combination of tasks was needed to assess the various elements of CT. What appear to be common elements in assessments of CT are the capturing of instructions developed by students (almost always using a computer environment) and the judging of the quality of those instructions against a set of criteria reflecting aspects of CT.

Visual coding approaches are of relevance for assessing CT, as they focus on the algorithmic logic underpinning coding across all coding tasks. A visual coding environment is also considered to be accessible to novice users and translatable (code block names can be translated into the target languages) while eliminating the confounding effect of keyboard errors because no typing of code is involved. Assessments of CT are typically set in computer environments because those facilitate the capturing of the data that reflect the steps in problem-solving. These steps usually involve developing or assembling instructions (often including blocks of code) that are necessary to accomplish a task (Brennan & Resnick, 2013).

The ICILS 2018 included two assessment modules that assessed two strands of CT: one on conceptualising problems and the other on operationalising solutions (Fraillon et al., 2019). The tasks in the CT module focused on conceptualising problems related to planning aspects of a program to operate a driverless bus. This included visual representation of real-world situations in ways to support the development of computer programs to execute automated solutions. Examples of these are path diagrams, flow charts, and decision trees. Further tasks related to the use of simulations to collect data and draw conclusions about real-world situations that can inform planning the development of a computer program. In the operationalising solutions module, students worked within a simple visual coding environment to create,

test and debug code (blocks of code that have some specified and some configurable functions) to control the actions of a drone used in a farming context. In this module, the tasks were incrementally more difficult as the students advanced through the assessment. The difficulties of the tasks related to the variety of code functions that are available and the complexity of the sequence of actions required by the drone for completion of the task objectives.

Scoring students' responses to a task involved capturing how many of the task objectives were completed, whether any irrelevant actions were performed by the drone and the efficiency with which the objectives were completed. Students that could develop an algorithm that completed exactly all the objectives with the minimum necessary code blocks received the highest score. Students that used more code blocks than necessary, completed some of the objectives or included irrelevant actions for the drone received partial credit.

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What can early childhood education and care settings teach us about skills for the 21st century?

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Abstract

Early childhood education and care (ECEC) settings are naturally oriented towards promoting 21st century skills. This can be seen in Australia, where learning is defined as the development of identity, social and emotional skills, problem-solving, and communication skills. A 21st century orientation is also seen in the play-based pedagogies implemented in ECEC settings. A gap, however, exists in the ability of the ECEC sector to communicate its successes. This gap relates to the lack of measurement tools to quantify the quality of the adult–child interactions in ECEC settings, and children's growth in these 21 century skills and abilities. This paper presents evidence on the assessments available to measure children's social and emotional skills and concludes, that while there are assessment tools available to Australian ECEC educators, there is an immediate need to develop new tools that support educators to collect evidence of their impact and to quantify children's growth. This would have the benefit of developing a common language to understand the skills and abilities being fostered in ECEC settings, and support more effective communication with the school sector.

Introduction

Australian ECEC programs are distinctive educational environments that implement holistic practices, supported by pedagogies such as play, to foster thought, interactions and challenge to build new understandings (Department of Education, 2009; Victorian Curriculum and Assessment Authority, 2016). This is seen in the Early Years Learning Framework (EYLF), where learning is described in terms of the development of identity, social and emotional (SE) skills, problem-solving and communication skills (Department of Education, 2009). In order to support this learning, ECEC practitioners aim to implement pedagogies that support both the development of domain general skills – both interpersonal and cognitive – with the recognition that these support lifelong outcomes as well as latter academic (domain specific) achievement. Where the Australian ECEC sector is successful in implementing pedagogies that support the development of these domain general goals, there is much for the Australian education sectors to learn.

Australian early childhood frameworks and national quality standards are written to outline key outcomes that connect learning across developmental domains of children from birth to five years of age. In such documents, the focus is on child growth in the knowledge, skills, dispositions and values that supports their current development and prepares them for life and learning. When the outcomes of the EYLF are presented alongside the general capabilities from the Australian Curriculum and 21st century skills (Binkley et al., 2012), strong alignment can be seen. Table 1 illustrates how the 21st century skills of citizenship, personal and social responsibility, and creative and critical thinking are essential elements of teaching and learning across all education sectors. This paper focuses on the SE domain and the contribution that the ECEC sector can make in establishing a strong base for lifelong development in this area.

Table 1 Mapping of 21st century skills against the Early Years Learning Framework and the general capabilities from the Australian Curriculum

	21st-century skills (Binkley et., 2012)	Early Years Learning Framework (EYLF)	Australian Curriculum: general capabilities
Living in the world	Citizenship – local and global	Children are connected with and contribute to their world	Intercultural understanding Ethical behaviour
	Life and career		
	Personal and social responsibility	Children have a strong sense of identity Children have a strong sense of wellbeing	Personal and social capability
Ways of working	Communication Collaboration (teamwork)	Children are effective communicators	
Ways of thinking	Creativity and innovation Critical thinking, problem solving and decision making	Children are confident and involved learners	Critical and creative thinking
Tools for working	Learning to learn, metacognition Information literacy ICT Literacy		Information and communication technology capability

Social and emotional development

It is vital for young children to be able to establish familiar and safe relationships with peers and significant adults, while expressing, experiencing and regulating emotions (Ashdown & Bernard, 2012). The development of SE skills is fundamental as they relate to the embedded social nature of almost all other skills and abilities. There is a strong theory that children who can establish safe and secure relationships are more advanced in their SE development, but such skills also facilitate interactions that support learning in other domains (Barnett, 2008; Heckman & Kautz, 2012; O'Connor, Cloney, Kvalsvig, & Goldfeld, 2019). Therefore, it can be seen as a strength of ECEC environments for young children to have the freedom to interact with adults and peers in situations that are centred around their individual SE development and other learning needs.

SE skills can be thought of as a progression of increasingly more complex knowledge, skills, and abilities, ranging from early attachment to more advanced social competence (Thompson & Goodman, 2011). Defining exactly what SE skills are, or whether there are many sub-domains, is unclear. The literature describes SE skills in terms of broad concepts such as self and social management and, self and social awareness (Australian Curriculum, Assessment & Reporting Authority, n.d.; Zins, Bloodworth, Weissberg & Walberg, 2007). It also uses phrases such as 'positive peer influences and friendships', 'meaningful adult-child relationships', 'emotional self-regulation skills', 'resilience to cope with stress and challenges' (Organisation for Economic Co-operation Development [OECD], 2005), and the absence of negative behaviours including hyperactivity, introspection, and conduct problems (Goodman, Lamping, & Ploubidis, 2010). However, there is no coherent or agreed description of the sequence of advancing SE skills and abilities (particularly for children aged 0–8 years).

Social and emotional skills assessment

It is a professional expectation that Australian educators will collect evidence to promote children's learning (Department of Education, 2009; Victorian Curriculum and Assessment Authority, 2016). Cloney, Jackson, and Mitchell (2019) have identified tools that are not only appropriate for measuring SE learning, but are accessible and appropriate for Australian educators to use in the classroom. Their recent analysis found several tools that fit this description, including open-source measures such as the *Measuring Early Leaning Quality and Outcomes* (MELQO) (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2017) and the Social Skills Improvement System (SSIS) (Anderson & Catroppa, 2016). However, only one tool contains a well-described continuum of SE learning – the Early ABLES – a measure currently only available to educators supporting the learning of children with identified additional needs (Department of Education and Training, 2015).

In ECEC settings, desirable assessments would be those that map children's growth in specific SE skills and have classroom application in making decisions about what comes next in learning. Such assessments would provide educators with a shared understanding of how SE progresses and a common language to discuss the knowledge, skills, dispositions and values that young children are learning. It would allow educators to remain true to the beliefs about young children's learning and development by identifying what children can do; as well as for planning and reporting purposes. The assessments would be designed to be used in environments where children play and learn, by mapping development so it could be shared with other educators and service providers, parents/caregivers and the children, to communicate successes and future goals.

This paper will therefore explore the challenge in the ECEC sector effectively measuring children's social and emotional development in order to demonstrate the relationship between high quality ECEC practice and children's developmental outcomes. Such evidence is critical to not only the ECEC sector, but also to the education sector, if it is to collectively learn from the practices of the ECEC settings. This manuscript addresses this through two research questions:

1. What skills are measured by the SE assessments available to ECEC professionals?
2. Can measures of SE assessment that are available to ECEC professionals be used to measure growth?

Method

This manuscript implements a mixed method to address the research questions using a:

1. Qualitative literature review and critique of the available social and emotional instruments
2. Quantitative assessment of one measure of social and emotional skills.

The quantitative data are taken from a five-year longitudinal research project in a southeast Asian country on which ACER is providing technical leadership[1]. This study collected data on the learning and development of more than 3400 children in maths, literacy and social and emotional skills.

1 Prior to release of the final report, the partner has requested that their name and country not be revealed.

Analytical approach

Assessment tools are identified using the criteria established in Cloney, Jackson, and Mitchell (2019). For each identified assessment tool, the main constructs were measured and compared, along with any published examples of the tool being used to describe growth in SE development.

A linear mixed model (LMM) is fit to the quantitative data to account for the complex residual variance–covariance structure in the estimation of data with repeated observations within children using the lme4 in R (Bates, Mächler, Bolker, & Walker, 2015). As the interest is only in modelling the average trajectory, a second-order polynomial is chosen as the best fit to the data (given by the change in AIC), and the mean intercept and slope parameters are plotted.

Results

Measures of social and emotional development

The instruments identified are summarised in Table 2. It is clear that each of the first three measures (SDQ, SSIS, MELQO) include detailed assessments of negative behaviours. Each also relies predominantly on Likert style items. In the cases where prosocial or helping behaviours are measured, these are limited to simple frequency style assessments, such as: 'How often does (name) offer to help someone who seems to need help? (Never, sometimes, often/always)' (UNESCO, 2017). None of these three measures focus on specific behaviours in specific social contexts and none of them is associated with SE learning progressions or detailed descriptions of SE development. Conversely, the Early ABLES is designed to align with a described scale; however, the measure is severely restricted in its availability and is only available to educators working with children with a developmental delay or diagnosis for a range of disabilities.

When considering growth in SE skills, Figure 1 summarises the differences in two measures' (one for mathematics, the other for SE skills) ability to describe growth over time. The social and emotional assessment has serious ceiling effects and erroneously suggests there is no growth in social skills over time. Both curves are second order polynomials, but in the case of SE skills the growth is essentially flat after approximately one year. This is not because the growth of these children has reached a peak (these children are age 4–5 years at entry to the study), but rather evidence of a measure where the majority of children are in the category 'always' for Likert-style items that mostly reflect the absence of negative behaviours or simple rule-following behaviour.

Conclusion

This manuscript makes the case that Australiana ECEC settings are strongly aligned with the promotion of 21st century skills, especially SE skills. SE skills are prioritised in the EYLF. The focus of pedagogies embedded in play, and oriented to discovery and interactions are theoretically strongly aligned with the promotion of these skills. Together, it is clear that where there are

Table 2 Summary of common social and emotional assessment available to ECEC educators in Australia

Assessment tool	Informant	Sub-domain	Items (no.)
SDQ	parent or teacher (self-report for children 11 years and older)	hyperactivity/inattention	5
		emotional symptoms	5
		conduct problems	5
		peer problems	5
		prosocial behaviour	5
SSIS	parent or teacher (self-report for children 8 years and older)	competing problem behaviours (externalising bullying hyperactivity/inattention, internalising, autism spectrum	38
		social skills (communication, cooperation, assertion, responsibility, empathy, engagement, self-control)	46
MELQO	parent or teacher (direct observation of child by enumerator for perspective-taking/empathy understanding feelings)	perspective-taking/empathy	3
		understanding feelings	1
		social and emotional development	20
Early ABLES[2]	teacher	personal and social capability	

2 The Early ABLES is not a publicly available tool and users are required to register with the Victorian Department of Education to access materials. Assessment takes approximately 30 minutes.

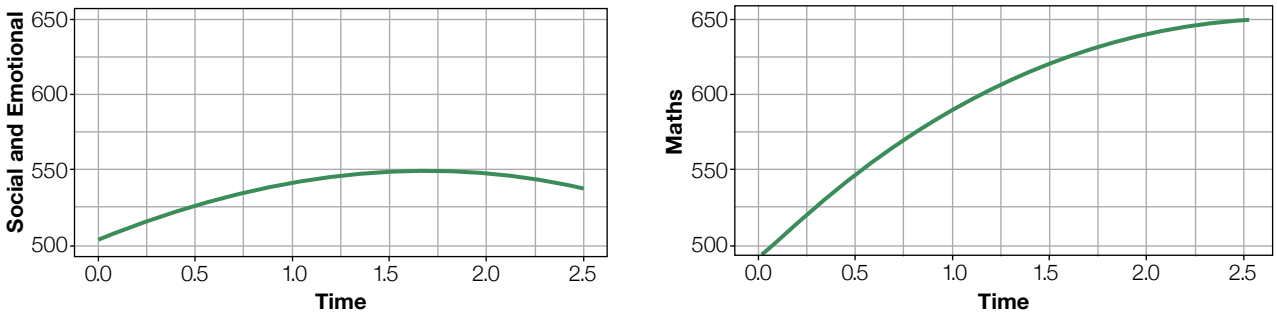

Figure 1 Comparison of mean growth trajectories of children's mathematics and social and emotional development

high quality ECEC settings in Australia, there is much potential for the modelling of best practice in the scaffolding of SE skills.

There are, however, barriers to the ECEC sector demonstrating its impact. There is, at present no coherent description of what SE skills look like as they develop. There is little clarity about what specific curriculum material and pedagogies are optimal for children at different levels of SE development, resulting in there being little in the way of high-quality assessment of SE skills for young children. There is even less if it is considered a perquisite of assessment that it be available and accessible to educators to use themselves.

The available assessment tools that ECEC educators can realistically use in Australia are limited and tend to focus on minimising problem behaviours and knowing classroom rules. Consequently, these tools err on the side of a deficit focus, and place children above and below cut-offs for different clinical definitions of social and behavioural problems (Goodman et al., 2010; Goodman, 1997). While some measures do include aspects of positive behaviours, these are limited to narrowly scoped helping behaviours like sharing (Anderson & Catroppa, 2016; Greenfield, Iruka, & Munis, 2004; Goodman, 1997) and do not focus on more nuanced SE skills, such as navigating conflict and working well in groups (Coles-Janess & Griffin, 2009; OECD, 2005).

Because of this, the data presented in this manuscript show that children's SE skills seem to hit a ceiling. This lack of growth over time is unlikely to do with the acquisition of the full gamut of SE skills, but rather a lack of quality in the measurement to capture higher order SE knowledge, skills and abilities.

Recommendations

The Australian ECEC sector needs to be supported to demonstrate the impact it has in promoting children's SE skills. This support should come from the development of a national SE learning progression, describing children's SE learning. From this, a set of measures should be developed to allow educators to assess the growth of young children and to communicate this learning to ECEC communities and families. A common learning progression would also provide a shared language and understanding for Australian ECEC educators to engage in continual quality improvement through peer interactions and feedback processes (Cloney, 2018; Cloney & Hollingsworth, 2018).

Any such learning progression should be linked to the national school curriculum, to demonstrate that the growth and acquisition of SE skills is part of a lifelong progression. Such a linkage would support the esteem of the ECEC sector, as it would determine how early learning impacts school and lifelong learning.

Limitations

It should be noted that the associations presented in the quantitative analysis are not conditioned on a full set of contextual covariates and may be impacted by selection effects and this may introduce bias in the magnitude of the effects of the standard errors (Duncan & Gibson-Davis, 2006).

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Poster presentations

Evaluating I2S2: An inquiry-based Indigenous science program for Years 5 to 9

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CSIRO

Program overview

The Indigenous STEM Education Project, funded by BHP Billiton and implemented by CSIRO, aims to increase participation and achievement of Aboriginal and Torres Strait Islander students in science, technology, engineering and mathematics (STEM) education and career pathways. It consists of six programs that cater to the diversity of students as they progress through primary, secondary and tertiary education and into employment. One of these programs is I2S2 (Inquiry for Indigenous Science Students).

I2S2 is an inquiry-based science program for Years 5 to 9 that has involved over 7600 Aboriginal and Torres Strait Islander students and 1154 teachers since 2016. It aims to engage students in STEM by using a strategy centred on the combination of knowledges, multimodal learning and alternative assessment techniques. These techniques allow all students to demonstrate their higher-order thinking skills in diverse modalities. The CSIRO I2S2 coordinators also work with schools to train and support science teachers in their delivery of authentic learning inquiries, and deepen their understandings about broader Aboriginal and Torres Strait Islander cultures.

Background

Research shows that students achieve better learning outcomes in school – that is, they are more engaged, achieve higher academic results and have improved attendance levels – when they are active learners in contexts that are authentic and related to their everyday lives (e.g. McInerney et al., 2011). For Aboriginal and Torres Strait Islander students, then, drawing on both Indigenous and Western knowledges has shown to improve learning outcomes and is particularly relevant for STEM subject areas (e.g. Throsby & Petetskaya, 2016).

Central to the program is the strength and value of Indigenous knowledges, which are often drawn from local languages and cultures. They are strongly place-based and ecological (Yunkaporta & McGinty, 2009) and consider evolving meaning making via inquiry practices in place (Nakata et al., 2014). Capel (2014) notes that Indigenous knowledges tend to be retained within particular communities due to their origins in the local context, whereas Western science and pedagogy are considered universal in comparison. I2S2 provides an opportunity to support the long-term continuation of both areas of knowledge for current and future students, teachers and communities, so that they are relevant to a broad range of contemporary social contexts. As part of this process, professional learning sessions are organised in order to share pedagogies and practices that have been shown to improve engagement and knowledge building.

Methodology

The evaluation of the I2S2 program involved the collection and analysis of student results (grades), engagement (on a scale of 1 to 5) and attendance (percentage of classes attended) in the term prior and term during inquiry delivery. Jurisdictional administrative data from Queensland (i.e. grades, attendance and engagement or effort measures) for participating and matched comparison schools have also been collected to support findings.

Findings and conclusions

Results from the evaluation of the program reveal that schools participating in I2S2 experienced an increase in student engagement in classrooms and many students demonstrated improved academic achievement, after they had participated in the program. These improvements were apparent for Aboriginal and Torres Strait Islander students and non-Indigenous students; however, the largest improvement was seen for students assessed as 'low-achieving' prior to their participation in the project. Student attendance in I2S2 classrooms was also measured, but no apparent positive influence on student attendance was observed. Taking into consideration that I2S2 lessons constitute only a portion of total class time over a year, and the potential influence of a range of factors on attendance not related to classroom activities, this indicator may not provide the most robust measure of I2S2 success.

The I2S2 program provides an opportunity for schools within a region to collaborate and share knowledge and experiences, therefore developing or enhancing relationships between teachers and their school communities.

Fostering metacognitive skills: A longitudinal cohort study

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In secondary education there is a great deal of attention paid to fostering effective teaching skills, but less focus on the need to help students develop their learning skills. Metacognitive awareness, which is part of self-regulated learning, includes the domains of knowledge of cognition and regulation of cognition (Flavell, 1979). Students with effective metacognitive skills are more aware of their strengths and weaknesses and strive to further improve their learning skills (Bransford, Brown, & Cocking, 1999). Knowing how to learn, as well as how to regulate one's learning, is closely related to academic achievement (Biggs, 1988).

Metacognitive skills generally increase during adolescence, plateau during early adulthood and then decline in older age (Palmer, David, & Fleming, 2014; Weil et al., 2013). Therefore, intentionally fostering, with the aim of raising metacognitive skill levels during the secondary school years, appears essential.

This longitudinal cohort study uses the Junior Metacognitive Awareness Inventory (Jr. MAI) to measure student metacognitive awareness across Years 7 to 10 in a north Queensland girls' Catholic college (Sperling, Howard, Miller, & Murphy, 2002). Each year cohort completes the Jr. MAI to measure their base-line metacognitive awareness levels at the start of the academic year (Sperling et al., 2002). Teachers at the research school undertook a series of professional development interventions to assist them in integrating metacognitive skills coaching into their lessons. It is hypothesised that student metacognitive awareness skills will improve significantly compared to the baseline results of the cohort one year older.

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A model for how students choose or reject subjects at school and what it means for science

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There has been concern expressed by educators, researchers and policymakers that too few students are choosing science in their final years of school. Science study at school has been linked to the supply of a scientifically skilled and literate workforce necessary for Australia's prosperity into the 21st century. This study breaks new ground in exploring how students choose subjects for their final years of school and applying this to the choice of science. Specific strategies are suggested to encourage students to continue studying science at the time subjects are chosen.

The research was conducted with 5 schools in the Sydney region using 10 focus groups with 50 students, interviews with 15 adult stakeholders within schools, 7 subject selection event observations and a survey completed by 379 students.

The students in the study consistently described the subject choice process as two staged. In the first stage, most students started by rejecting subjects they disliked and then chose the subjects they enjoyed. Enjoying or liking a subject was a frequently cited factor for choosing subjects. The first stage of the decision making appeared to be substantially emotive.

In the second stage, students described a more detailed evaluation of the subjects about which they were unsure. Students included the subjects that they considered to be 'core' and would contribute to their future study or career path. Students described a more detailed and rational evaluation of their options and indicated they would seek advice as needed. Older peers were considered a good source of advice as was general advice from adults. Subject-specific advice from teachers recommending their own subject was viewed with suspicion.

The model for science subject selection suggests that enjoyment of science in the first stage of the decision process leads to consideration of the subject for future study. However, in the second stage this choice is tempered by the student's assessment of their ability to achieve good marks in the subject and the usefulness of the subject in the future. It is in this light that science choice is problematic. Science is generally perceived as an onerous subject where obtaining high marks is more difficult than for other subjects. This means students are less likely to choose the subject unless they feel they need it for future study. In this respect science is also at a disadvantage as it is viewed as a subject that is useful in a narrow range of careers.

To address these disadvantages, it may be advantageous to address these perceptions by promoting science as enjoyable, achievable and valuable in the weeks immediately prior to students choosing their subjects. This may take the form of enjoyable practical sessions, talks from peers and trusted adults on the benefits of science in a range of careers and information on how students will be supported to succeed. These strategies rely on timely information to students to help them reappraise the value of science and decide that science has a place in their future.

Building the capacity of teachers for supporting 21st-century learning

Laureate Professor Jenny Gore, Michelle Ware, Sui-Linn White, Lee-Anne Collins, Lloyd Bowen and Carole Hansen
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There is a clear mandate for teachers to continuously improve and update their knowledge and skills, in order to ensure they prepare students for learning in the 21st century.

This cannot happen without high quality professional development (PD) that respects what teachers already know and do, and provides real guidance for how they might do things differently. Professional development is widely embraced as necessary for enhanced teaching, but not all PD comes with powerful evidence of positive impact (Gore et al., 2015). Quality Teaching Rounds (QTR) provides strong evidence.

Quality Teaching Rounds combines key features of effective PD, including professional learning communities (PLCs): a form of instructional rounds, with the Quality Teaching (QT) model of pedagogy to substantively guide collaborative analysis of practice.

The QT model, developed by Jenny Gore and James Ladwig in 2003, has three dimensions and 18 elements, representing a synthesis of robust research that empirically links the qualities of pedagogy in the model to improved student learning; namely, pedagogy that promotes high levels of intellectual quality, establishes a high-quality learning environment, and generates significance by making learning more meaningful to students. It is applicable across subjects and stages, offering a coherent vision of pedagogy (NSWDET, 2003).

Quality Teaching Rounds was first conceptualised by Julie Bowe and Jenny Gore in 2007. It involves teachers working in PLCs to reflect on their classroom practice through the lens of the QT model. This teacher-led process builds capacity for quality teaching with novice and experienced teachers alike (Gore & Rickards, forthcoming). Following a set of protocols and adhering to essential features of the approach, one PLC member teaches a lesson, observed by all others. The lesson is coded individually and then collaboratively analysed, using the shared language of the model.

This poster presentation graphically highlights evidence from several research studies conducted by the University of Newcastle over the past 15 years. The strong body of evidence demonstrates that QTR has positive effects because, not despite, the fact that it brings teachers together across stages and subjects (Gore & Rosser, forthcoming). The 2015 randomised controlled trial (RCT) demonstrated positive effects of QTR on teaching quality, teacher morale, and teaching cultures across a range of primary and secondary schools in diverse communities (Gore et al., 2016).

Currently, the researchers are embarking on a ground-breaking program of research, Building Capacity for Quality Teaching in Australian Schools, concluding in 2022. This research employs mixed methods, including RCTs, to test the impact of QTR on student outcomes, sustainability of effects, efficacy of trainer and digital delivery, and transition to new jurisdictions. Teachers across Australia have access to two-day workshops, equipping them with the evidence base and knowledge to implement QTR in their schools.

The QTR approach to teacher development will support thousands of teachers across Australia to engage in powerful professional work with colleagues to refine their teaching, placing them in a strong position to build their capacity for quality teaching while enhancing student learning into the future.

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How teachers engage with student assessment data: Understanding antecedents to data-driven decision making

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Theoretical background

In recent years, education systems internationally have been encouraging data-use initiatives with the aim of improving student learning through data-driven decision making (DDDM) (Means, Chen, DeBarger, & Padilla, 2011). The use of student assessment data in particular has been promoted to guide teaching practices and progress student learning (Datnow & Hubbard, 2015). Despite this, the adoption of data-use practices by New South Wales classroom teachers has been slow. A review conducted for this study on current DDDM models emphasised that recent research endeavours tend to focus on the later stages of data use, such as decision-making skills and targeted instruction. However, the activities that precede the ability to utilise data are not well understood. Targeting outcomes without understanding the context or procedural mechanisms that produce them yields constrained insight into how to support and enhance teachers' data use practices. To examine the underlying causes, the study adopted a unique approach to understanding teachers' data use through the integration of core change management and organisational psychology principles (Lewin, 1947) together with underlying psychological and social determinants of behavioural intent (Ajzen, 1991).

Research question

The study qualitatively examined two core foundational activities that affect New South Wales classroom teachers' use of student assessment data, referred to as assessment data collection (ADC) practices, and assessment data analysis (ADA) practices. Specifically, the study sought to answer: What are the processes that New South Wales teachers follow to a) collect and b) analyse student assessment data to inform their teaching practices?

Methods

A qualitative exploratory multiple case study design was used for this study, with one-on-one semi-structured interviews being the primary data collection method. New South Wales classroom teachers were asked to provide their opinions regarding how they collect and analyse student assessment data and why they performed the tasks in their respective ways. Such a design encouraged the deeper exploration to multiple perspectives (Yin, 2014; Denzin & Lincoln, 1994) through understanding the meaning participants hold to specific behaviours. This process encouraged an intricate view of existing practices and processes to consequently determine suitable points for future change.

Results

Data is being collected and analysed concurrently. The poster presentation will report on the study's theoretical framework and the exploratory multiple case study design utilised. Similarly, the preliminary data of the thematic analysis and cross case synthesis of results that mapped prominent existing ADC and ADA processes will be presented.

Findings

The works of Little (2011) and Datnow and Hubbard (2015) assert that if teacher practice is properly traced and understood from a micro perspective, then dynamics for change can begin to occur. Consequently, this study's enhanced insight into current practices provides a foundation that guides fit-for-purpose change initiatives to foster and augment data use in the classroom.

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Negotiation strategies to support misbehaving kindergarten children: The 'deal' strategy

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Purpose

To negotiate behavioural changes with children, while developing an attitude of personal accountability for progressing the kindergarten program.

Method

The child is asked about their favourite fruit, the name of which is then used as a code for a deal on a behavioural change. The child becomes excited to share what their favourite fruit is, for example, a banana. When this child misbehaves, a negotiation process commences that entails asking them to demonstrate an improved behaviour. The agreement will then be known as the 'deal banana'. Henceforth, calling out 'deal banana' prompts the child to modify the behaviour specified in the 'deal banana' agreement.

Each deal is linked to a specific behavioural change by a specific child, for example, 'deal watermelon' equals 'child X not to throw rocks at others'.

Results

Children were excited about the strategy and started negotiating their own deals with peers. Furthermore, they held each other accountable for their actions and behaviours, by reminding each other of the deals they negotiated.

Discussion

This strategy supports Outcome 2 of the Early Years Learning Framework (EYLF) as children develop an understanding of the reciprocal rights and responsibilities necessary for active participation. Moreover, they become socially and emotionally competent, thus aligning with Outcome 3 of the EYLF, and preparing them for more challenging schooling encounters.

This strategy could be a modified example of Pavlov's classical conditioning. However, the learning process here involves some cognitive component and social negotiation where the child is given some power and the ability to choose. First, they choose their code, then choose to enter the behavioural modification agreement, and then decide to honour that agreement when prompted by the deal call out. The process involves an elaborate set up, where several points of exit are available to the child to end the agreement. Yet, it has been observed that most children decide to honour the 'deal' and continue to demonstrate the modified behaviour agreed on. They quickly develop a sense of ownership of the decision and become accountable for the deal they formed.

The social context in which 'deals' are formed may have contributed to the success of the strategy. This is because children start to become aware of each other's deals, share stories about how they negotiated their behavioural changes, and their favourite fruits. They then start encouraging each other to adhere to their behavioural changes, mostly in a funny manner. They seem to have fun holding each other accountable by calling out the deals they formed.

Conclusion

This 'deal' strategy proved to be successful in managing children's behaviours, while involving them in a negotiating process. Children felt they were given the choice to decide, and they indeed would decide to honour their deal and adhere to the negotiated behavioural plan.

Furthermore, the strategy fostered a sense of collaboration and teamwork among the children, as they became more autonomous in collectively honouring the deals they negotiated, thus facilitating their daily routine and curricular activities.

Conference program

DAY 1 SUNDAY 4 AUGUST

Masterclass: Assessment in General Capabilities

Dr Claire Scoular and Jonathan Heard, ACER

Melbourne Convention Centre, Level 1, Room 109

8.00 – 8.30	**Registration**
8.30 – 10.00	**Masterclass Part 1:** A framework for assessing and teaching General Capabilities
10.00 – 10.30	**Morning tea**
10.30 – 12.00	**Masterclass Part 2:** Applying the framework in your own classroom

Research Conference 2019: Preparing students for life in the 21st century: Identifying, developing and assessing what matters

Melbourne Convention Centre, Level 1, Rooms 105 & 106

12.00 – 1.00	**Registration**
1.00 – 1.15	**Welcome to Country**
1.15 – 1.30	**Conference opening:** Dr Esther Care, Senior Fellow, Brookings Institution
1.30 – 1.45	**Graduation ceremony:** Graduate Certificate of Education, Assessment of Student Learning
1.45 – 2.45	**Keynote: Educational reform – Scottish style!** David Leng, Professional Adviser, Scottish Government Learning Directorate
2.45 – 3.15	**Afternoon tea**
3.15 – 4.15	**Panel session: 21st century skills: Curriculum and learning** Dr Esther Care, Brookings Institution; Professor Barry McGaw, The University of Melbourne; David Leng, Scottish Government; Emma Ross, Canterbury Primary School; and Dr Claire Scoular, ACER. Moderated by Catherine McClellan, Director of Assessment and Psychometric Research, ACER

4.15 – 5.15	**Presentation session 1**
Session 1A Rooms 101 & 102	**Session 1B** Room 103
21st-century skills: Realising the potential of the Australian Curriculum Robert Randall, Director of Rob Randall Group	**Digital literacy skill development: Prescriptive learning analytics assessment model** Associate Professor Elspeth McKay, RMIT University
Session 1C Room 104	**Session 1D** Room 107
The impact of physical learning spaces on student development of 21st century learning skills Associate Professor Wesley Imms, The University of Melbourne	**Conversation with a keynote** David Leng, Professional Adviser, Scottish Government Learning Directorate

5.15 – 7.15 **NETWORKING FUNCTION**

Entertainment by Savore Quartet Latin Jazz

END DAY 1

DAY 2 MONDAY 5 AUGUST

8.30 – 9.00 **Arrival tea/coffee**

9.00 – 10.00 **Keynote: The science behind the art of teaching: Evaluation as inspiration**
Dr Michele Bruniges AM, Secretary, Australian Government Department of Education and Training

10.00 – 10.30 **Morning tea**

10.30 – 11.30 **Presentation session 2**	
Session 2A Rooms 101 & 102	**Session 2B** Room 103
Teaching and assessing the general capabilities in a secondary school context Loren Clarke and Melissa Hughes, Eltham High School	**Not just for the kids: Adult skills in the 21st century** Juliette Mendelovits and Dave Tout, ACER
Session 2C Room 104	**Session 2D** Room 107
Using learning analytics to measure 21st-century skills Professor Dragan Gašević, Monash University	**Conversation with a keynote** Dr Michele Bruniges AM, Secretary, Australian Government Department of Education and Training

11.30 – 12.30 **Presentation session 3**	
Session 3A Rooms 101 & 102	**Session 3B** Room 107
Assessing and understanding social and emotional skills: The OECD Study on Social and Emotional Skills Dr Sue Thomson, ACER	**WII-MA-LI (light the fire): The impact of the Connected Communities Strategy on Hillvue Public School** Chris Shaw, NSW Department of Education
Session 3C Room 103	**Session 3D** Room 104
Assessment in the interpersonal domain: Experiences from empathy assessment in medical education Neville Chiavaroli, ACER	**Digital literacy: Myths and realities** Julian Fraillon, ACER

12.30 – 1.15 **Lunch**

12.45 – 1.00 Bring your lunch to Room 107 and learn about professional certification for principals - assessing leadership for the 21st century

1.00 – 1.15 Bring your lunch to Room 107 and learn about graduate study with ACER.

1.15 – 2.15 **Presentation session 4**	
Session 4A Rooms 105 & 106	**Session 4B** Room 103
Key skills for the 21st century: An evidence-based review Esther Doecke and Quentin Maire, Victoria University	**Assessing computational thinking** Daniel Duckworth, ACER
Session 4C Room 107	**Session 4D** Room 104
Can designing video games help students prepare for life in the 21st century? Experiences from the Australian STEM Video Game Challenge Laura Crawford, Swinburne University; Ben Wynne, St Anthony's Wanneroo; and Andrew Mannion, ACER	**What can early childhood education and care settings teach us about skills for the 21st century?** Dr Dan Cloney and Kellie Picker, ACER

2.15 – 2.30 **Break**

2.30 – 3.30 **Karmel Oration: On with the 21st century! Preparing Australian education for the 2020s and beyond**
Professor Neil Selwyn, Monash University

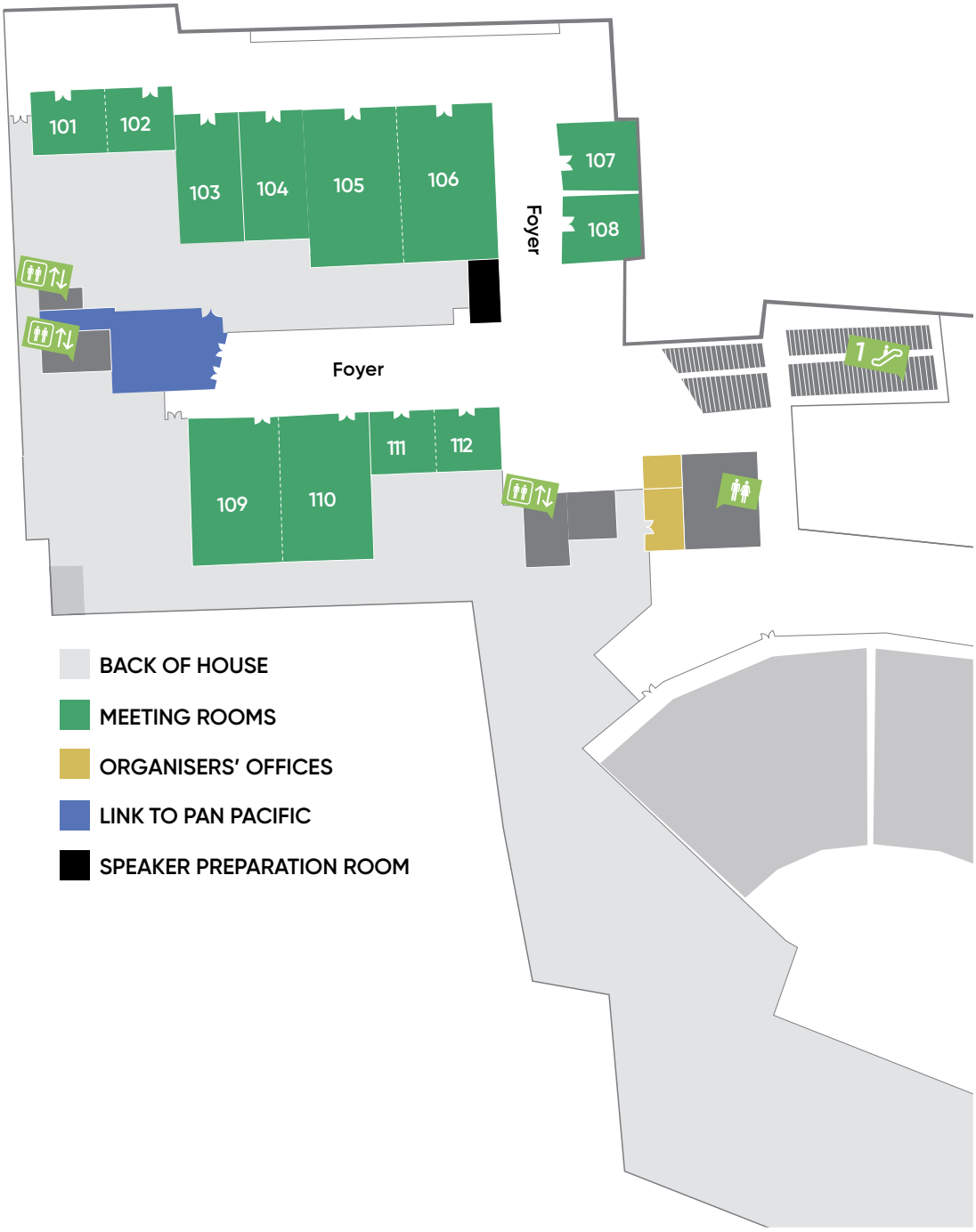
3.30 – 4.15 **Conversation:**
Professor Geoff Masters AO, CEO, ACER and Professor Neil Selwyn, Monash University

4.15 – 4.30 **Conference close**
Professor Geoff Masters AO, CEO, ACER

END DAY 2

Venue floor plan

CONVENTION CENTRE
LEVEL 1



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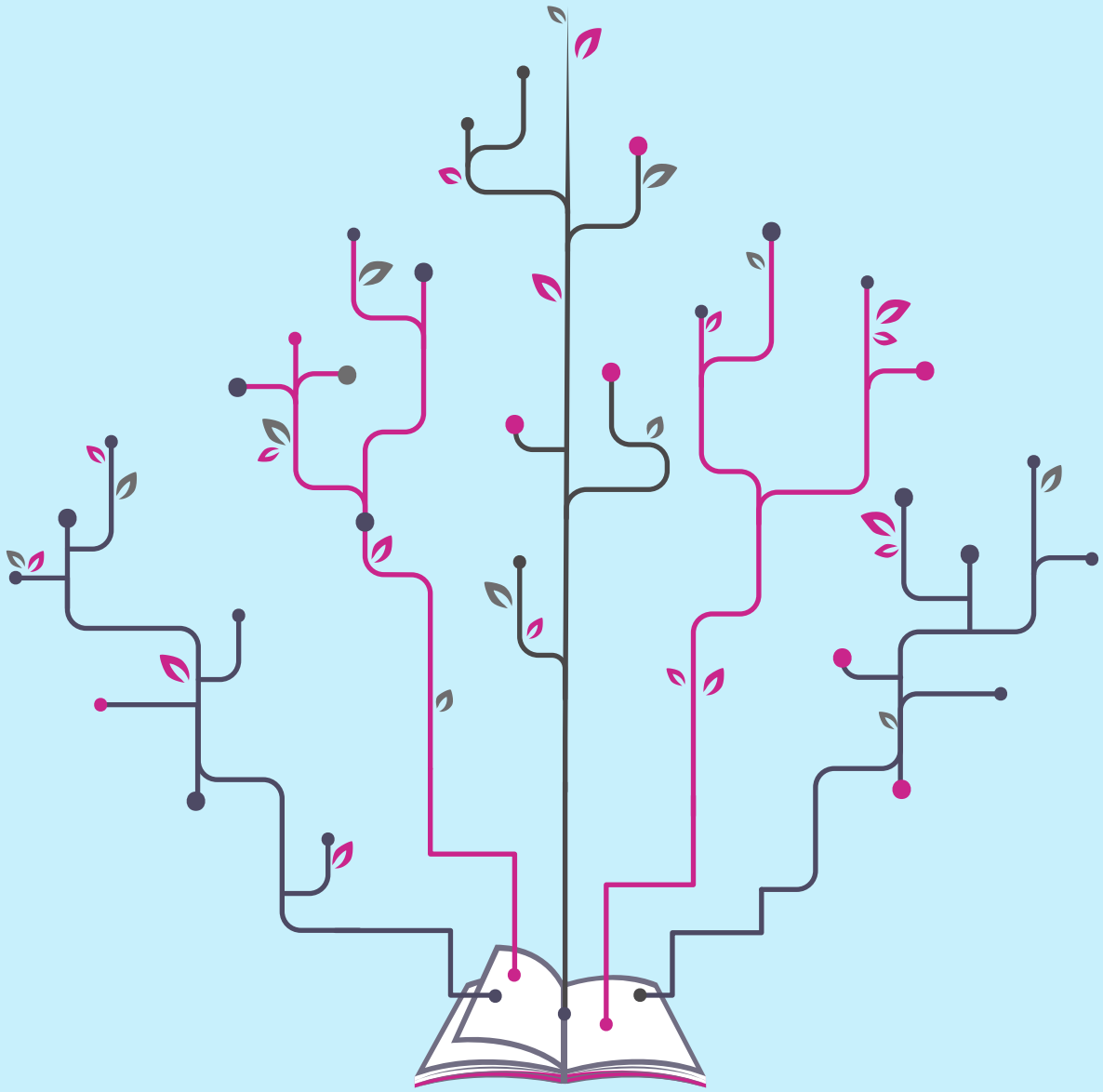
2020

Promoting and monitoring growth in student learning



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