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IMPLEMENTING THE SCIENCE OF LEARNING

Teacher Experiences

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SCIENCE OF LEARNING
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Contents

Executive summary

The science of learning is a body of knowledge that connects a set of insights — derived from cognitive science and educational psychology — about how humans learn to effective teaching practices. Despite recent enthusiasm from policymakers and practitioners to promote the science of learning as a foundation for teaching and learning practices, evidence suggests educators in general have limited awareness and understanding of it.

Nevertheless, some individual educators — working on their own or within networks — encountered the science of learning, worked to embed it into their practice and to advance it within their own contexts.

This report draws on data from surveys, focus groups and interviews with a group of science of learning-oriented educators to learn about their experiences, and derive insights about barriers and enablers to the further advancement of the science of learning. These insights are organised into the following 'pathway':

Student need typically motivates teachers and leaders to change their practice.

- Teachers recognise students are struggling with learning and stumble upon science of learning practices as a potential remedy;
- Many science of learning practitioners are motivated by a desire to address educational disadvantage; and
- A case for change may be harder to build in certain school contexts.

Teachers and schools use informal and ad-hoc methods to advance the science of learning.

- Initial teacher education rarely equips early career teachers with knowledge of the science of learning;
- Schools must invest significantly to rectify poor initial training with science of learning knowledge; and
- Teachers and schools currently utilise informal networks and opportunities to build knowledge.

An accurate yet accessible knowledge base is needed to dispel myths and misconceptions.

- Science of learning practices become embedded in teachers' ideas of 'good teaching';
- Clear and common language about science of learning principles builds confidence in practice; and
- Myths must be busted to help build all teachers' understanding of the science of learning.

System-level support is currently insufficient to advance the science of learning.

- School principals and Department leaders can be seen as barriers;
- Well-informed leaders are vital to help drive change at a school level;
- Schools are not supported properly from the system to implement science of learning-based teaching; and
- Schools need system-level resources and support to effectively change practice.

School-level change must be carefully managed and demonstrated, and then shared.

- Change fatigue among teachers is a barrier that must be overcome;
- For change to be sustainable, it should be incremental;
- Better assessment tools can track student progress and measure impact on learning; and
- Schools need effective ways to demonstrate change and share learning.

The report also makes recommendations in the following areas:

- Communication of how the science of learning is intrinsic to creating equitable educational opportunities;
- Continuation of efforts to align initial teacher education with the science of learning;

- Effective translation of science of learning knowledge;
- Reforming teacher standards, accreditation and registration procedures to align with the science of learning;
- System-level support with the 'curriculum to practice' pipeline and assessment tools; and
- Creating case studies of 'lighthouse' schools so others know what success can look like.

Introduction

There is a growing body of evidence and policy initiatives to scale what is known as the science of learning; connecting a set of insights about how humans learn to effective teaching practice. But despite recent enthusiasm — from both policymakers and some teachers themselves — to promote the science of learning as the foundation for teaching and learning practices, available evidence suggests educators generally have limited awareness and understanding of science of learning insights and the implications for teaching practice.

Australian surveys of teachers indicate that, while the majority of teachers believe they are consistently implementing evidence-based practices, this practice typically derives from observational evidence rather than research evidence.[1] The reasons for this are multi-faceted, but relate most strongly to the content of current initial teacher education, current teacher professional standards, and the way 'evidence-based practice' has been used to drive a range of teaching approaches with mixed results — creating a sense of scepticism and cynicism within the profession.

Though too many teachers are not well-informed of what practices align with the *best* available research, individual and networked educators have engaged with, and are at various stages of implementing, science of learning-aligned practices in their schools. Their experience can be analysed to generate insights for others.

To do this, CIS conducted a series of interviews and focus groups with teachers and school leaders (mostly from NSW) who identified as interested in, or implementing, science of learning practices. CIS also partnered with social purpose organisation, Knowledge Society, to survey teachers about their experiences with the science of learning. The data from this survey has been used to inform discussion on the key figures (academics, teachers and researchers) whose work influenced research participants' knowledge acquisition of the science of learning.

Following an overview of the current context regarding policy and teacher knowledge, the data is analysed to gain insight into the barriers to, and enablers of, advancement of the science of learning and its practices. By understanding what motivated these teachers and analysing their experiences, it is possible to outline a 'pathway' that shows both how grassroots, bottom-up mechanisms can combine with policy-focused, top-down mechanisms to move the education ecosystem forward towards greater adoption of science of learning practices. The report creates practical recommendations for policymakers and practitioners alike.

Background and Policy Context

This section will briefly outline some key terms and definitions that form necessary background for the purposes of this paper. A detailed explanation of the science of learning, the practices supported by that body of knowledge, and the history of education methods can be found in CIS Analysis Paper 63, *What is the Science of Learning?*

The term 'science of learning' refers to the connection between: 1) insights from cognitive science and educational psychology; and 2) the teaching practices that are supported (and not supported) by those insights. Key cognitive science concepts include:

- **Biologically primary knowledge (BPK) and biologically secondary knowledge (BSK):** BPK includes things like basic social relations and problem-solving skills and does not need to be taught; BSK (what schools are for) must be taught explicitly;
- **Domain-specific and domain-general skills:** domain-general skills overlap with biologically-primary knowledge but critical thinking and analysis are specific to domains such as Maths, History etc;
- **Working memory and long-term memory:** working memory is severely limited and can only handle small amounts of new information, making it a funnel to long-term memory. A strong long-term memory can help strengthen working memory; and
- **Cognitive load theory:** given these models of human cognition, teachers should design instruction in a way that optimises the burden on working memory in a way that best helps learning.

The teaching approach best supported by the evidence is *explicit instruction* of a well-sequenced, knowledge-focused curriculum. Some key features of explicit instruction include:

- Careful ordering of curriculum content so that new information and concepts are built sequentially;
- Explanation of new information in small steps, taught through modelling and worked examples, with student practice after each step;
- Asking questions and checking for all students' understanding of what has been taught before gradual release of students for independent work and more complex tasks; and
- Regular review of previous content to ensure retention.

Unfortunately, progressive education — a philosophy of education that emerged in the 18th century but became dominant in the 20th century — has advanced a set of beliefs that are now contradicted by the latest evidence. Such beliefs include that students learn best when they direct their learning and it aligns with their interest, rote learning is harmful, learning should be based on projects or experiences, and that doing this will result in critical and creative thinkers. The set of instructional practices that flow from these principles uses various names, but for the purpose of clarity and consistency, will be referred to as 'inquiry learning' in this paper.

These beliefs and practices are still reflected in parts of the education ecosystem, such as the current provision of initial teacher education in most providers, the Australian Professional Standards for Teachers (APST), as well as much curriculum, syllabus and pedagogical guidance provided by governments.

Where there has been a shift towards science of learning practices in many individual schools and some school systems, this has required a lengthy and costly process of unlearning and relearning, often at significant cost in terms of time and money.

The Catholic education diocese of Canberra Goulburn — the only known Australian example of an attempt to implement the science of learning at a system level — reportedly spent between $3,000 and $4,000 per teacher retraining its workforce,[2] which covers more than 1,700 teachers spread across 56 schools and two jurisdictions (NSW and the ACT).

Another indicator of strong latent demand for science of learning-informed practices is the number of participants in short courses from Latrobe University's Science of Language and Reading (SOLAR) Lab. As of July 2023, 8,000 teachers had done at least one SOLAR short course.[3]

Instead of leaving schools to figure out and fund changes in practice, there is an onus on policymakers to implement considered changes to policy that would enable these shifts across all Australian schools and ensure a consistent opportunity for all Australian students to succeed.

A pathway to advance the science of learning

Waiting for the desired policy changes and for those changes to flow through down to the individual teacher level is by no means guaranteed. Against that context, individual schools and teachers are carving out their own path to implement and scale these practices for the benefit of their students. Through the analysis of the qualitative data, a set of common experiences of science of learning practitioners relating to motivations, actions and responses emerged. This is summarised below.

Need: Current teaching methods aren't providing results; a need to do something different arises.

Awareness: Become aware that there is a different method available; often that it is evidence based and shows measurable student improvement.

Resistance: Either hear negatives about alternative methods or encounter resistance in practice from peers or leadership – can give up or continue.

Understanding: Learn and understand more about evidence-based teaching methods

Lexicon: Exposure to key lexicon e.g. Cognitive Load Theory, Explicit and Direct instruction, Science of Reading. Not used as often: science of learning.

Permission and belonging: Self-immersion in further learning, exposure to other practitioners, joining groups, powerful sense of belonging and permission to learn more/practice despite resistance.

Improvement: Further practice and learning towards mastery.

Advocacy: Teaching others science of learning, advocating the methods to other teachers in close and far proximity. Less often: attempts to advocate for change at the system level.

This report will translate this into a usable framework for teachers and leaders, focusing on five main areas:

1. Student need is what typically motivates teachers and leaders to change their practice;

2. Teachers and schools use informal and ad-hoc methods to advance the science of learning;

3. An accurate yet accessible knowledge base is needed to dispel myths and misconceptions;

4. System-level support is currently insufficient to advance the science of learning; and

5. School-level change must be carefully managed and demonstrated, and then shared.

At each stage, relevant aspects of the policy context are identified and analysed, and science of learning practitioners share their own experiences about the barriers and enablers they encountered. Recommendations relevant for policymakers and practitioners are made throughout.

FOCUS AREA 1: Student need is what typically motivates teachers and leaders to change their practice

Finding 1: Teachers recognise students are struggling with learning and stumble upon science of learning practices as a potential remedy

Faced with students not making the desired amount of progress, teachers may undertake their own research into alternative approaches, and essentially 'discover' for themselves a set of SOL practices that could be beneficial.

This was described by some as beginning with a sentiment that their school's existing approach to learning and teaching was not helping their students; especially those students with additional learning needs. As one research participant said, "if you throw more of the wrong medicine at a patient, it's not going to help them. It's the wrong medicine."

As a result, practitioners describe themselves as "stumbl[ing]" on to explicit teaching methods or knowing that something wasn't right but not "hav[ing] all the information". As one Deputy Principal commented, "I just started to listen to my gut that something wasn't right, but I couldn't fully articulate it and didn't have all the information yet to go."

This observation may emerge from a bird's eye view of school data, experience with an individual student or group of students, or can sometimes take a more personal form, as exemplified by one current Assistant Principal in New South Wales:

> *My own son failed to learn to read. He was quite articulate and it didn't make a lot of sense. I did everything that I was trained to do in my own degree… I thought was how things worked because that's what my university degree had prepared me for. But it wasn't working… So I then had to go looking for something else and it was then that I stumbled across explicit teaching principles.*

Several research participants revealed uncertainty and discomfort when first beginning to question the typical approach to teaching and learning often promoted in their schools and, generally, within the Australian education system. For instance, the pedagogical guidance provided to educators about how to teach reading and address reading difficulties, has included programs such as L3 (in NSW) and Reading Recovery, both of which rely on a method of teaching reading not supported by the best evidence.[4] In the case above, the personal confrontation resulted in a recognition of the inadequacy of the interviewee's own training and knowledge base, which in turn forced a professional reckoning.

Regardless of the context, the initial identification of a problem appears to trigger what can be a prolonged and emotional process where educators (in their early engagement with science of learning) question themselves and their existing training. This then culminates in a desperate — and generally individual — search for alternative approaches to teaching and learning that will help students who are not making sufficient progress. This search can include internet searches that assist in finding formal and informal professional networks, conferences and social media groups. This is explored further later in the paper.

However, what is also clear from this is that students' educational progress is being left too much to chance. The responsibility for policymakers is therefore twofold: firstly, to ensure that practitioners who are confronted with struggling students know where and how to access the best advice about how to intervene effectively; secondly, that practitioners be equipped with the knowledge and teaching methods to deliver the most effective instruction to the first place — thus reducing the number of students who struggle.

Finding 2: Many science of learning practitioners are motivated by a desire to address educational disadvantage

Even if there is not a specific student or group of students exhibiting clear signs of educational struggle, other teachers may be concerned about equity and helping to address educational disadvantage.

The research shows a sense among educators that there is a group of students — sometimes referred to as 'instructional casualties' — missing out on the kind of educational practice that could successfully

help them make progress. This is supported by broader evidence. A recent Australian Education Research Organisation (AERO) study that tracked the subsequent achievement of students who were assessed as low performing (at or below the old National Minimum Standard) on Year 3 NAPLAN Reading and Numeracy showed they would continue being low performers to Year 9 (37% and 34% respectively). When combined with those who showed variable outcomes (sometimes below, sometimes performing well), it shows a clear majority of students who were behind by Year 3 are unlikely to perform at expected levels — only 17% for Reading and 19% in Numeracy.[5]

Indeed, the response from policymakers and politicians has been to dedicate resources to remedying these achievement gaps in various forms but, as one Victorian principal commented, "[t]hat gap which they [politicians] focus so much on reduces [with explicit teaching]."

Paradoxically, well-meaning and motivated teachers are encouraged to adopt teaching methods that worsen inequity rather than reduce it. The progressive pedagogy of inquiry learning is particularly detrimental to disadvantaged students. Inquiry learning predominantly benefits students who already possess a solid foundation of prerequisite knowledge as they have the necessary foundations to make the 'discovery' they are being guided towards.[6] Conversely, students with limited knowledge (disproportionately represented by disadvantaged student groups) cannot make the same progress and thus disengage from the task or develop a misconception that then becomes difficult to shift. These students therefore face persistent challenges and thus fall behind their peers and contribute to the widening performance gap.[7]

This is also important for overcoming educational disadvantage for priority equity groups in the Australian context, such as Indigenous students. Lorraine Hammond's CIS paper, *Confronting Indigenous educational disadvantage: A Kimberley perspective*, identified programs centred upon 'high impact instruction' that focused on direct and explicit instruction as key to alleviating educational disadvantage for indigenous communities in the Kimberley region of Western Australia. As noted by Hammond:

> *Instructional models such as explicit instruction and direct instruction have been consistently found to be effective. Yet there is still opposition, despite five decades of evidence proving effectiveness of this teacher-directed approach regardless of student population... Direct instruction produces superior results, and for majority-Indigenous community schools to not include this pedagogy is a tragic waste of instructional energy.*[8]

More broadly, educational research has similarly demonstrated the benefits of explicit instruction in reducing the attainment gap for various disadvantaged students and across several subject domains. For example, research into how to best intervene to support students who lack proficiency in Mathematics is consistent and conclusive regarding the importance of direct and explicit instruction. "At the centre of the intervention recommendations is that instruction should be systematic and explicit. This is a recurrent theme in the body of valid scientific research", notes a 2009 report from the Institute of Education Sciences.[9] A subsequent report on how to assist primary school-age students struggling with mathematics focuses on the importance of "incremental and intentional" design of materials to address the needs of these students.[10] It follows that if systematic and explicit methods of instruction are necessary for struggling students, these same methods must also be helpful when those same students are receiving initial instruction in a whole-class context.

Evident in the data is the centrality of student success to teacher professional identity. As one of our research participants said, "[a]ll teachers want to be effective. Everybody wants to be effective. That's really what you go into teaching — to make that difference."

Wider dissemination of science of learning principles can, therefore, act as a vehicle to a sense of moral achievement among teachers as they feel they are working towards more socially just outcomes. One Assistant Principal commented:

> *We have a moral obligation to ensure that our kids are learning to read and learning maths and learning to write because that's*

what they need to be able to be highly functioning citizens. We actually have an obligation to do something, and I feel that's a moral obligation because we have expectations that these kids are going to go out there and contribute to society.

Similarly, Ross Fox, the Director of Catholic Education, Archdiocese of Canberra Goulburn, told the *Sydney Morning Herald* in December 2022:

"I felt a huge moral imperative to turn things around. We had to think deeply about why what we were doing in the past wasn't translating into improved results, particularly in reading."[11]

When examining the evidence related to academic achievement gaps, research participants questioned the efficacy of inquiry learning:

Tell them things such as multiplication and division are just facts that are non-disputable. They're non-negotiable. Don't waste time letting them ponder about them for themselves. Give them those facts so that they can have time later on to think more creatively about complex thoughts. [Only give inquiry learning a chance] once they have a good grounding in those basic and foundational literacy and numeracy skills.

[W]hen I was doing inquiry, it really was leaving a good chunk of the class behind. So, you'd have your students at the top end, who just produced amazing things, no matter how bad your instruction was. And then your kids at the bottom just got nothing… All the emphasis was on all the other things, but they're 'exploring', they're 'engaging with the world', and they're 'doing authentic tasks' and you're kind of thinking, 'okay, but they can't really read, and they're not really writing either'.

Our research participants and the academic literature make it clear disadvantaged students need access to teacher explicit instruction in order to retain parity with their more advantaged peers. Recognising that disadvantaged student groups routinely face structural challenges such as limited access to educational enrichment and family to assist their learning outside of school, explicit instruction assists in bridging these attainment gaps by offering an equitable learning experience for all learners. By providing clear and structured instruction of a well-sequenced, knowledge-focused curriculum, explicit instruction provides a solid foundation to develop knowledge and cultural capital.

Therefore, how science of learning principles are framed by policymakers (when communicating with schools and systems) and practitioners (when communicating within their schools) is critical to creating the sense of 'need' or motivation required to embark upon far-reaching changes.

Finding 3: A case for change may be harder to build in certain school contexts

While individual teachers and schools have developed motivation to change by building on these ideas, not all educational contexts may reward that same approach.

The data showed a clear driver towards the science of learning more broadly was the science of reading — an evidence-based approach to the teaching of reading which emphasised the systematic and explicit teaching of reading skills.[12] Once science of reading practices were adopted and embedded in the literacy teaching of primary schools, it became easier to make a case to extend those principles to other learning areas too:

[Science of reading meant] we could keep referencing back to the success of this one bit of explicit teaching in the school. And people believed in that. And we've had amazing results because of it. So people had a bit of a buy in already. I think that's what made it easier for us [to implement broader change].

However, schools that are not primary schools (or F-12 schools) typically don't engage with the science of reading in this manner, so the driver is absent in those contexts. It is possible science of learning practices are simply more common in primary schools than in secondary schools. This is supported by the sample of our research participants; as out of 19 participants in total, only four were from a secondary school context. The Grattan Institute's work on whole-school planning approaches, which features five schools whose practice typically aligns with the science of learning, also includes only one

secondary school, Aveley Secondary College in Perth, WA and one F-12 school, Ballarat Clarendon College, in Ballarat, Victoria.[13]

Though the most common pathway to science of learning began with some sort of detection of academic need — such as low NAPLAN scores or high proportions of struggling students — some research participants who taught in more advantaged contexts such as high-fee independent or selective schools observed that these 'needs' didn't present themselves as obviously. As a consequence, student results were not showing the impact of poor practice:

> *[Y]ou can, in independent schools in high SES areas, just bumble around and do anything… [S]ome of the worst teaching practices can continue in those schools because the children are compliant [like] in the girls' school… they were very compliant! Well, in the classroom, they present as if most of their learning has been done outside of school with the cultural capital of their parents and their tutors. And so, there's some very dusty, old fashioned teaching practices, and no assessment and no need to challenge those. And when you do challenge them, you've got teachers that are like, "they're sitting there, they're quiet, they're learning and we're getting band sixes [in the HSC]. What's your problem?"*

Instead, participants theorised that perhaps there was a different way to make the case for change in these contexts, particularly by appealing to a need to reduce workload pressures and improve efficiency:

> *[I]t's not just [student] needs. In the schools that I teach, where people don't want to abandon certain practices or ways of doing things… I think if they can be positioned where it's actually going to make your job more streamlined and simple [then that might help].*

Other comments from a participant at a selective school related to lower levels of cultural capital; theorising that the cultural and linguistic diversity at their school may not feed into obviously lower scores but might nevertheless present a discrepancy with peers in high fee independent schools. More research is needed to understand the dynamics at play that may enable or present a barrier to further adoption of science of learning practices in these contexts.

Recommendations

- Provide practitioners with evidence-based methods to teach foundational skills as well as guidance on how to best support learners who struggle even after receiving effective instruction.
- Policymakers should reframe the science of learning as fundamental to educational equity and as a strategy to reduce achievement gaps, and do so in its official guidance to schools.
- Practitioners attempting to build a case for the science of learning in their context should be clear that it is a non-negotiable for disadvantaged students, but also reinforce that it benefits all learners and is harmful to none.

FOCUS AREA 2: Teachers and schools use informal and ad-hoc methods to advance the science of learning

Finding 4: Initial teacher education rarely equips early career teachers with knowledge of the science of learning

A key theme in the qualitative analysis was that teachers stumbled upon science of learning principles because formal training — in particular initial teacher education — had not delivered this knowledge. Some common ways of encountering the science of learning were a book, at a conference, through a colleague or in a journal article. Those in a leadership position were quite frank about the quality of ITE, as exemplified in a comment from one participant: "[d]epending on where you got your undergrad degree, forget everything that you [learned]."

The current policy architecture insufficiently emphasises science of learning principles, which means graduate teachers enter the Australian education system ill-equipped for success. In turn, our data showed this puts pressure back on to schools to rectify these knowledge gaps. As one educator reflected on their ITE, "I thought [I knew] how things

worked because that's what my university degree had prepared me for. But it wasn't working."

For example, student teachers in their undergraduate and postgraduate teaching qualifications in Australia are most frequently taught a "Balanced Literacy" approach to early reading instruction rather than the science of reading; the popularity of short courses on reading science as previously discussed clearly illustrate the desire for greater training in this area. As one primary school Principal commented:

> *… There's a lot of unlearning to do… Student teachers are still being taught methodologies that you just shouldn't use [such as Running Records]. They're just not very helpful. They're time consuming, they're a waste of teacher time. They're a waste of everybody's time.*
>
> *They [graduate teachers] don't understand the reading process…They're trying to work on comprehension strategies without going back to decoding. You know, they just didn't understand [Scarborough's] reading rope.*

However, the criticism extended beyond early reading instruction to other aspects of ITE. The majority of research participants, especially leaders, nominated ITE as a significant barrier to SOL practices and expressed a desire to see reform to university coursework and the pre-service teaching program to align with SOL principles:

> *Certainly if you don't know about [the science of learning], then that would be a barrier [to adopting it]… it's still not taught in all universities where they train teachers, so a large majority of teacher training.*
>
> *[W]hat they're teaching at universities, they're not learning any of this stuff. They're not being about cognitive science at uni… [the] science of learning, none of it.*
>
> *[W]e really need universities involved, right, initial teacher education. That is so fundamental key to bringing forth real change over time.*

When asked to describe barriers to more widespread adoption of science of learning practices, an almost universal comment was the content and quality of ITE — specifically, that it did not teach pre-service teachers or graduates what they did need to know and, in many cases, actively taught them things that would hamper their ability to be effective teachers. Where there is a desire for change at a leadership level of a school, the burden of retraining and professional development becomes significant.

In cases where graduate teachers have been employed at SOL-oriented schools, the workplace training and advice they receive appears to be well-received by those teachers. One leader from a school with large graduate intake remarked that these teachers are willing to learn:

> *I find the new grad[uates] are actually quite good because they have zero experience and so they're ready to suck up any advice that we give them.*

Initial teacher education is one of the policy areas where significant strides have been made to ensure the course content more closely reflects the science of learning. There have been several attempts to more closely regulate and mandate content and practices in ITE, and the latest of these is the *Strong Beginnings* report, from the Teacher Education Expert Panel. The report advised that ITE courses contain core content in four areas, two of which are 'the brain and learning' and 'effective pedagogical practices'. Education ministers have resolved that ITE providers to have until the end of 2025 to change their courses to reflect the core content, which is an extremely positive development. However, questions remain about the strength of the accreditation process and how providers will be held to account.

Finding 5: Schools must invest significantly in school to rectify poor initial training with science of learning knowledge

The shortcomings in ITE cannot be fixed overnight, but even if they could, teachers already within the system have gaps in their knowledge that need to be fixed if science of learning practices are going to be more widely adopted. Therefore, it is necessary to consider what can be done to support all teachers to build their capacity in science of learning-based practices.

Leaders in SOL-oriented schools are cognisant that the problems in ITE represent a significant problem in mindset and training among teachers at all career stages that the school then has to work hard to address:

> *If [science of learning] was in ITE then we wouldn't have to keep fixing the problem when they finish uni.*
>
> *If teachers come out with that [wrong] knowledge because of whatever they learn at uni, they think is the this is gospel. So, it's very hard; it's like you have got to work double time to change any of that pedagogy or the ideology. So, if they had it at uni that's where [the change] has got to start.*
>
> *[Y]ou've got new grad teachers [and you] come out and say, 'Well forget everything that you've learned, and the fact that you've spent X dollars [in fees], you now need to… unlearn and relearn.' It's not even just 'learn more'. It's actually unlearned. I mean, nobody wants to be told that after three or four years…*
>
> *[W]e just know we're training [graduate teachers] up when they come in. So we have a really intensive program and we do take on a lot of new grads… look, even the experienced teachers that we have come in, we train them up. [Even with experienced staff] our interview questions are always around 'how willing you are to learn how to teach in a different way than you might currently know how to do?'*

One teacher, who was a graduate in their first year at a SOL school in 2022, was frank about the progressive educational methods they had learned at university, and how their school required them to change their thinking:

> *I'd just come out of uni when I heard about [SOL at my school] and I'd been taught only constructivist principles… like I planned whole constructivist lessons about discovering math principles and stuff… I just got [out of] uni, having studied all these things, and then had to learn a whole other thing about teaching.*

While the induction and professional coaching experience for this graduate appears to have been well-received, this level of intensive support would be difficult for many schools to replicate:

> *… one of the things I did in the first couple of weeks is I got to observe [the deputy principal/instructional leader at that school, also a research participant] and another teacher… we do like observations of each other all the time. So, it was really good, seeing what a good lesson looks like, modelling the practice. We [graduate teachers] also get observed quite a lot. So, I have two different teachers, like [the deputy principal] and another teacher in my room observing me three times a week or something. So, they told me what I need to work on.*

While data on SOL-practicing schools is hard to establish, it is safe to say that every SOL-oriented school will not have the same capacity to provide specific support in this manner. Therefore, policymakers could better clarify aspects of professional development and accreditation to provide support for teachers who may not be at these schools.

Finding 6: At present, teachers and schools utilise informal networks and opportunities to build knowledge

In keeping with the notion that teachers discover the science of learning accidentally in response to ineffective practices, teachers often have to find their own solutions:

> *I think once teachers find out or other people discuss with them what doesn't work – for example, when they realize that L3 doesn't work, Reading Recovery doesn't work – often teachers don't know what to do instead, they don't have the access to places where they can find that out.*

To do this, teachers rely on informal networks including social media, podcasts, books, and conferences to build up actionable knowledge:

> *I was listening to a podcast about Rosenshine's Principles and I almost cried. I remember thinking to myself 'Oh my God, this is it.' It's so simple. Like, it's so simple. And the simplicity of it almost made me angry. Because I thought 'Why haven't I had this before? Like, why has no one just said this is huge?'*
>
> *I came across the Reading Science in Schools Facebook page.*

[S]ocial media probably helped a bit, like starting to connect with people on Twitter and Facebook, and seeing that other people were also on the journey.

There is the Facebook group called the Science of Reading group. That's one that has started. There's now others spinning off about science of learning… Think Forward Educators. There's more people being able to connect through social media and whether that be Facebook or Twitter. I think those things have been really valuable.

Awareness of a different method of teaching and a desire to implement it is not the same as having institutional or formal support. Australian SOL practitioners have attempted to overcome the challenge through constructing professional networks, conferences and PD events as well as informal online communities.

Many nominate academic figures or educational experts whose names they had encountered during professional development. Some have also looked into further university-level study to formalise and build on their knowledge — but with mixed success.

i) Professional networks & conferences

The most common formal opportunities used by SOL practitioners and interested observers are conferences and the formation of professional networks through these conferences. Observed in our data is the Science of Learning Leadership Accelerator (SOLLA) conference, hosted by Knowledge Society in Melbourne and in Sydney. One research participant commented "[C]onferences are great. It's nice just to connect with like-minded people."

Other networks mentioned in the data include Think Forward Educators, Sharing Best Practice (conferences which in 2023 expanded to many parts of NSW and Victoria, including regional areas) ResearchED conferences (hosted in Sydney, Melbourne, Perth and Ballarat). For those whose entry point into SOL was through the science of reading, advocacy organisations like Learning Difficulties Australia, various SPELD groups, and the Australian Dyslexia Association were nominated as influencing and enabling networks.

ii) Online networks and resources

There are Facebook pages or groups associated with many of the professional networks and conferences mentioned above, such as ResearchED Australia, Sharing Best Practice and Think Forward Educators. Many respondents to our survey also nominated specific Facebook groups such as Reading Science in Schools. Twitter was mentioned in a general sense, as a way to follow the work of SOL practitioners, academics and experts, both Australian and overseas. Some of the common names listed were Lorraine Hammond, Lyn Stone, Pamela Snow, Tanya Serry, Louisa Moats, Jocelyn Seamer, Natalie Wexler, Anne Castles, Greg Ashman, Ollie Lovell. Podcasts (specifically Greg Ashman's Filling the Pail and Ollie Lovell's Education Research Reading Room) also emerged as a method of building knowledge about SOL principles and practices and, less common but still present, blogs.

However, online networks were not simply used as a method of connecting people and building a sense of community. Practitioners within these networks will often share unit and lesson resources to help others avoid 'reinventing the wheel' with planning.

One of the things that they're doing, which I think is also really important, is that there are a few key people…schools that are writing good quality units for teachers to be able to share, so they'll be a unit on morphology. There'll be a unit, lesson plans on morphology, their lesson plans on teaching, decoding, teaching all sorts of things. How to write a sentence. Writing sentence stems, paragraph writing… The Writing Revolution. [Programs] that use methodologies… that are supported by research…. I think it's fantastic that these people are sharing these things on social media.

The use of shared online resources through these networks was more often observed by teachers from a primary or early literacy context, whereas others would still nominate lack of readily available resources as a key barrier. Another concern was the lack of quality control in such environments, which could result in teachers putting trust in resources that are not much better than other commonly-used websites (Twinkl and Teachers Pay Teachers).

iii) Books and literature

Many of the online influencers mentioned above are also published authors, but research participants also nominated particular authors and titles used to help them grow their knowledge of SOL principles and practices. *Principles of Instruction* by Barak Rosenshine is the name of a magazine article, but a practice guide based on that work (Tom Sherrington's Rosenshine's *Principles in Practice*) was also evident in the data. Other authors and titles mentioned cognitive scientist Daniel Willingham's *Why Don't Students Like School*, John Hollingsworth and Silvia Ybarra's *Explicit Direct Instruction*, ED Hirsch's *Why Knowledge Matters*, Natalie Wexler's *The Knowledge Gap*, John Sweller's articles on cognitive load theory, Paul Kirschner and Carl Hendrick's books *How Learning Happens* and *How Teaching Happens*.

One research participant, a Deputy Principal, articulated the role of the work of Rosenshine and Hollingsworth and Ybarra to provide a consistent language at school:

> *I felt like [explicit instruction] was a little bit of a catch [all term], like… everyone's got all these different definitions of what it means… I felt like as a school, you know, the research was saying we needed to use explicit instruction, but… all the teachers seemed to have their own definitions of what that was. And I felt that we needed something that we could have a shared common language around. So, we first of all, started looking at Rosenshine's work. And then we then we actually landed on Hollingsworth and Ybarra's EDI framework. We just decided as a school that we'd adopt that.*

iv) Additional university study

Our research indicated that university study, typically at a higher level than ITE (specialist Masters of Education), could be the site of exposure to science of learning principles, as one primary school Deputy Principal observed:

> *I also studied a Masters degree in special ed[ucation] as well. And like when I did that degree [I thought] 'Ohh this is called explicit teaching'… I understood how the research came from that informed all of that practice… In that degree we had to learn to pick good research from not so good research… Generally, that's not in a standard undergrad degree.*

But that same person observed a difference in quality between universities for the same course:

> *Everything that I did at Macquarie University was absolutely fantastic. And you know, lots of research papers and I understood it, loved it. Fantastic. When I went to Wollongong, it depends on the units that I was studying as to whether they were what I would consider quality or not.*

For some participants, further study was a method of further developing their knowledge and expertise, which provided some exposure to science of learning:

> *I just enrolled in a master of instructional leadership at Melbourne [University]… from there, I moved more towards literacy and numeracy and the research in that space.*
>
> *I did a Masters in Education and I did research into reading and all and literacy development.*

Others sought out additional university study for more formal knowledge acquisition only to find the offerings generally inadequate for the type of specific knowledge they were after:

> *I did a lot of my own research around it [initially] and I was seeking out stuff… I did actually enrol in a cognitive psychology graduate certificate… I was finding it a little bit frustrating because [of] the way they wanted to structure the course and in the end I thought I just really want to learn about this [science of learning] stuff I don't want to be forced into writing assessments that weren't helping me to just learn what I was trying to learn.*

Only a handful of universities and educational programs were remarked upon by research participants as having some role for the science of learning and/or science of reading. These were the University of New South Wales (due to its association with John Sweller), La Trobe University (where the Science of Language and Reading or SOLAR Lab is run by Pamela

Snow and Tanya Serry) and Edith Cowan University (under Lorraine Hammond).

This substantial variation between university education departments in the extent to which SOL is taught within higher education degrees seems to be a result of faculty personal preferences more than anything else.

Our research also suggests that while SOL practicing teachers ultimately find the process of building SOL knowledge rewarding, they recognise that it can be a drain on individual practitioner time and resources. The lack of centralised support, from universities or from within schools, makes solidification of SOL principles and integration into professional practice a challenge. As one Assistant Principal commented: "having to learn on your own is pretty onerous."

Recommendations

- Building on existing progress, policymakers must ensure ITE providers are strongly held accountable for the quality of their provision of the new mandated core content.
- Reform state-based teacher registration/ accreditation requirements and induction programs for early career teachers to align with science of learning principles.

FOCUS AREA 3: An accurate yet accessible knowledge base is needed to dispel myths and misconceptions

Finding 7: Science of learning practices become embedded in teachers' ideas of 'good teaching'

Research participants who practice, or are otherwise invested in, the science of learning align their definitions of good teaching with science of learning principles. One teacher described good teaching in a nutshell as "teaching that leads to improved student outcomes", where the relevant 'outcomes' relate primarily to academic growth and achievement.

A more comprehensive view of good teaching that emerged from the data contained the following themes:

Knowledge is important for both teacher and student

- Teachers should have expertise in what they are teaching.
- Teachers should instruct in a way that is explicit, purposeful, efficient and sequenced in small steps.
- Students should connect new knowledge that builds on what they already know and teachers should be checking for how well students are doing this.
- Students should ultimately be able to retain knowledge in their long-term memory.

Caring and focused learning environment

- Teachers should care about their students and work to achieve progress for them.
- Teachers should set up a physical learning environment that minimises distractions and has clear routines and expectations for students.
- Students should be engaged in their learning.

Preparation for the future

- Teachers should teach in a way that is compliant with curriculum and syllabus, and also key educational milestones such as the HSC.
- Students should learn things that equip them well for the future.
- Students should learn what they need to know in order to critically engage with content, through synthesising varied information and formulating well-supported opinions and arguments.

SOL practitioners urged the need for contemporary, twenty-first century educators to consider teaching akin to a complex yet ultimately calculable science. In reference to teaching a young child how to read, one educator highlighted the need to "break down the skills and explicitly

and systematically teach the sets of skills that build cumulatively to teach them that incredibly complex skill of reading." Nevertheless, early reading is not the only place for this approach to teaching: one interviewee defined good teaching as "using explicit and direct instruction, especially around new material."

While some of the above elements of good teaching are emphasised in the APST (such as engagement, critical thinking, monitoring student progress), overall the document is ambiguous as to how students learn and provides no guidance as to the pedagogical techniques best supported by evidence: the centrality of explicit instruction, frequent checking for understanding and the idea that learning is related to what is in long-term memory are absent from how it guides practitioners to conceptualise good teaching.

In particular, engagement of students in learning is seen as an end in itself rather than a byproduct of effective, explicit teaching combined with clear routines, classroom expectations and minimal distractions. For example, the federal government's Mathematics Hub website lists 'fostering engagement' as a key principle and suggests 'games and storybooks' as a way of achieving engagement. Though explicit teaching and other SOL-aligned practices are also recommended, only the latter is supported by evidence for student achievement; they should not be presented as equal contributors to effective learning.[14]

Given that the APST is quite vague with respect to SOL principles, there is capacity for it to be reviewed to account for the shifting emphasis in ITE. Such a review should address the ambiguity of its current form and seek to more clearly set standards of what teachers at various levels should know and be able to do.

An international example of an early career teacher development framework based on SOL principles can be seen in England's Early Career Framework. Published in 2019, it has five focus areas for early career development: behaviour management, pedagogy, curriculum, assessment and professional behaviours. These can be linked to the eight Teachers' Standards, which are somewhat similar to the APST: 1) set high expectations; 2) promote good progress; 3) demonstrate good subject and curriculum knowledge; 4) plan and teach well-structured lessons; 5) adapt teaching; 6) make accurate and productive use of assessment; 7) manage behaviour effectively; and 8) fulfil wider professional responsibilities.

However, the ECF is not intended to be used as an assessment tool, rather as "an entitlement to additional support and training."[15]

The document combines statements or principles, based on evidence, that students have to learn and connects them with specific actions, techniques and strategies. An extract of the document for *How Pupils Learn* is provided in the table on the facing page.

Many features of the document — the nature of learning, the Working Memory Model, retrieval, worked examples, modelling, the importance of prior knowledge, careful sequencing, review and practice, gradually building challenge — are aligned with the science of learning as explored in CIS Analysis Paper 63, *What is the Science of Learning?*

Practitioners surveyed in our data distinguished between the 'why' and the 'how' of science of learning, in a manner similar to the distinction made by the TEEP report: the 'why' corresponds with the concepts of learning science and the 'how' is the translation of those into effective classroom teaching practices. The majority of advice given to teachers about evidence into practice relates to the 'how'. For example, the Victorian Department of Education's list of 10 High Impact Teaching Strategies are based on John Hattie's seminal work *Visible Learning*; a meta-analysis of educational practices and translating them into effect sizes to enable comparisons between practices.[16] Though the findings of Hattie's work often align with science of learning practices, the lack of clarity and understanding for teachers as to *why* these are effective can create uncertainty about implementation and potential resistance. Research participants agreed that understanding the underlying cognitive science would have been helpful before being exposed to or

being encouraged to adopt the practices in isolation.

Finding 8: Clear and common language about science of learning principles builds confidence in practice

Informal or ad-hoc methods of building knowledge risk teachers developing misconceptions about science of learning principles and practice, and lack the deep and precise knowledge base to assess evidence critically. Consequently, a balance between accuracy and accessibility needs to be found in communicating SOL knowledge.

Firstly, it is important to communicate that teaching practices need to be adopted on the basis of how well they reflect key principles of human cognition. Teachers note that in the education ecosystem at large, one can find a range of practices being endorsed with no clear sense of which is more effective or what makes these more effective. One research participant expressed frustration at the woolliness of a lot of discussion around educational practices and pedagogies:

> *I always described to people that weren't teachers, the white noise that exists in teaching, I had never worked in an industry that had so much sort of like, noise and different views and trends. I was like, it was ridiculously hard to work out where you went and what you believed in and what practices and… there wasn't really any guidance, and every school was structured with this sort of, like, pedagogy from on top, like this template and philosophy. And it was just, it was just so crowded and difficult to work out exactly what you should be doing in the classes.*

How Pupils Learn (Standard 2 – Promote good progress)	
Learn that…	**Learn how to…**
1. Learning involves a lasting change in pupil's capabilities or understanding.	**Avoid overloading working memory, by:** • Taking into account pupil's prior knowledge when planning how much new information to introduce. • Breaking complex material into smaller steps (e.g. using partially completed examples to focus pupils on the specific steps) • Reducing distractions that take attention away from what is being taught (e.g. keeping the complexity of a task to a minimum, so that attention is focussed on the content). **Build on pupils' prior knowledge by:** • Identifying possible misconceptions and planning how to prevent these forming. • Linking what pupils already know to what is being taught (e.g. explaining how new content builds on what is already known). • Sequencing lessons so that pupils secure foundational knowledge before encountering more complex content. • Encouraging pupils to share emerging understanding and points of confusion so that misconceptions can be addressed. **Increase likelihood of material being retained, by:** • Balancing exposition, repetition, practice and retrieval of critical knowledge and skills. • Planning regular review and practice of key ideas and concepts over time. • Designing practice, generation and retrieval tasks that provide just enough support so that pupil's experience a high success rate when attempting challenging work. • Increasing challenge with practice and retrieval as knowledge becomes more secure (e.g. be removing scaffolding, lengthening spacing or introducing interacting elements).
2. Prior knowledge plays and important role in how pupils learn; committing some key facts to their long-term memory is likely to help pupils learn more complex ideas.	
3. An important factor in learning is memory, which can be thought of as comprising two elements: working memory and long-term memory	
4. Working memory is where information that is being actively processed is held, but its capacity is limited and can be overloaded.	
5. Long-term memory can be considered as a store of knowledge that changes as pupils learn by integrating new ideas with existing knowledge.	
6. Where prior knowledge is weak, pupils are more likely to develop misconceptions, particularly if new ideas are introduced too quickly.	
7. Regular purposeful practice of what has previously been taught can help consolidate material and help pupils remember what they have learned.	
8. Requiring pupils to retrieve information from memory, and spacing practice so that pupils revisit ideas after a gap are also likely to strengthen recall.	
9. Worked examples that take pupils through each step of a new process are also likely to support pupils to learn.	

One school leader expressed a desire for "access to really good quality, simplified versions of the research that I could then use as sort of talking points in faculty". Our research participants were enthusiastic for practices based on the best evidence, and noted how empirical support for practices help shift teacher's views of what informs their work:

> *But [your practice is based on] what you believe in. It's very difficult to change [beliefs]. So that's why AERO was so important, because [their work shows] it's not about our belief, it's about what the evidence is.*

However, they also expressed concern at how the term 'evidence' can be loosely applied:

> *I think AERO needs to be the tick of approval and I think any program that's introduced in a school needs to get the AERO tick of approval, because I think there's too many people saying evidence based and it's not necessarily you can find evidence for anything. So it's [based on] evidence, has it been peer reviewed? What is the research, what is the evidence that you're using?*

There are some potential solutions to this problem. One is to adopt a practice similar to the US-based organisation 'EdReports', a non-profit that evaluates and reviews instructional materials (textbooks, courses) to help support schools to make better decisions about what they teach and how they teach it. However, this does not address the problem of deepening teachers' science of learning knowledge.

Another option is for systems to be clearer about what key insights or principles are derived from cognitive science and how these are used to inform specific instructional practices, thus allowing schools to evaluate new practices according to those principles. One research participant noted that Catholic Education Canberra Goulburn's Catalyst program has a set of 'big ideas', principles about learning, which perform this role:

> *So, the Canberra Goulburn diocese has got principles instead of just saying everything is evidence based. And they've sort of tried to lay out their principles so that you can test whatever this [new] research is against those principles and see if it fits with those principles… And if it doesn't, we're not [doing it].*

The Catalyst team examined research and evidence from educational experts such as ED Hirsch Jr, Barak Rosenshine, Dylan Wiliam and John Sweller to develop 8 'big ideas' for learning:[17]

1. School is where we learn biologically secondary information;
2. Learning is a change in long-term memory;
3. Teaching is a profession that should be informed by the evidence;
4. Knowledge matters, it's what we think with;
5. The most efficient way to teach knowledge is to teach explicitly;
6. High quality whole class instruction will help all students learn;
7. Reading is essential for students to acquire knowledge; and
8. Curriculum should be ambitious, coherent, sequential and cumulative.

AERO's latest work in this area is the report *How students learn best* (September 2023), which proposes four evidence-based principles for learning and teaching informed by cognitive science:

1. Learning is a change in long-term memory;
2. Students process limited amounts of new information;
3. Students develop and demonstrate mastery; and
4. Students are actively engaged when learning.

Finding 9: Myths must be busted to help build all teachers' understanding of the science of learning

The data showed negative perceptions around the science of learning and explicit

teaching practices held by non-practicing SOL teachers according to their SOL-practicing peers. These 'myths' are typically based on an incomplete understanding of what the science of learning is and, crucially, what it looks like in the classroom. Despite not being based in reality, they remain significant barriers to wider adoption of SOL practices. This section therefore outlines these myths, what makes them myths, as well as recommendations to overcome them.

Myth #1: "Explicit instruction is not student-centred"

One pervasive misconception held by Australian educators is that EDI is not student-centred, on the basis that students are not taught in ways that align with their interests, that they do not have agency over learning activities and consequently are not engaged in learning. One Head of Pedagogy described the 'myth' as follows':

> *[It's] like crushing the individual style of the student. You know, they have to conform. They have to listen… it's not allowing the students to the agency and the and the democratic approach of [choosing] what they learned. They choose when to learn. They choose [how] to be assessed and so forth.*

Inherent in this is the underlying notion that student learning is best achieved through student-directed activities, whereas the evidence supports the notion that student learning is best achieved through teacher direction. However, not all teaching activity or attempts at explicit instruction necessarily represent best practice. As one research participant said, "Just because you've taught it doesn't mean that they've learned it".

Consequently, while EDI may be teacher-directed, it is still 'student-centred' in the way that it focuses on assisting student learning and knowledge acquisition. Advocates of explicit instruction, Anita Archer and Charles Hughes, note the false dichotomy created by the term 'student-centred': "[t]he implication of these labels is that one approach is more concerned about students than the other… We contend that appropriate use of explicit elements of instruction is indeed 'student-centred,' in that it incorporates what we know about how students learn new material and about the skills they need in order to be successful."[18] Similarly, one research participant noted "[student-centred learning] is a problematic phrasing… from my mind, focusing on the student is evidence based instructional techniques."

One research participant emphasised the responsive nature of explicit teaching in addition to the planning that takes place outside of the classroom, saying "you are very organised with what you want them to learn, but you need to be able to adjust very quickly to the students' learning."

Also evident is the necessity of reframing the conversation. Another interviewee made a similar observation, commenting "… the conversation shouldn't be about what [the teacher has] taught, but what about the kids – what have they learned?... It completely changes the way you look at what's happening in the classroom."

A related myth is that because explicit instruction is not driven by students, it is not concerned about student engagement and wellbeing. However, as one research participant observed, engagement and wellbeing can both be products of effective explicit instruction practices:

> *People think that if you are explicitly teaching that kids are not going to be engaged or happy or but actually children like the routines and they like feeling success… if explicit instruction is done well and it's not the sage on the stage or the teacher doing all of the work. The students actually have to be engaged, and they have to do their share of work in the learning.*

This same participant went on to address mental health and wellbeing benefits of explicit teaching practices, observing that student success helps to create a sense of wellbeing:

> *[With explicit teaching] they actually are successful, and when they are successful, that contributes so much to their mental health. A lot of people think that especially teaching is not engaging and they're going to have mental health problems, but they'll have mental health problems if they're not learning and they're not successful.*

Myth #2: "Explicit teaching is just rote learning and doesn't allow critical or creative thinking"

An additional myth regarding explicit instruction is that it is equated with rote learning which stifles critical or creative thinking. This criticism is based within two related myths.

First, this critical assumption about explicit instruction being equated with rote learning is not based in contemporary explicit instruction, but instead stem from simplistic and outdated notions from historical teaching practice. Second, this view also stems from progressive educational theory that focuses on the need for student development of critical and creative thinking as a 'transferable skill' which, when mastered, can be applied to any subject. Some of our research participants described it thus:

> *They think it's rote learning, it's spoon feeding. It's not allowing children to, 'own' the knowledge by discovering it for themselves.*

> *I tell my other friends who graduated in this year as well about EDI [and] they think it sounds really boring, not creative. 'Why would the kids even be engaged in that?' Whereas when they're doing this constructivist stuff, they think, 'yeah, [I'm] really engaging the kids.'*

Instead, the evidence shows that 'general capabilities' like critical and creative thinking are not based in a sound understanding of cognitive science. Cognitive scientists such as Dr Daniel Willingham and Dr John Sweller have continued to highlight how critical and creative thinking is not a separate skill, but rather a domain-specific skill that is developed through deep knowledge within a field.[19] In simple terms, critical thinking in Mathematics is entirely separate from critical thinking in English.

If the ability to think critically or creatively about a topic or task is based on domain knowledge, then the way to enhance these capabilities is to enhance knowledge of that domain. Secondary English and History teachers who participated in our research emphasised the role of knowledge-rich teaching as being the necessary precondition for 'higher-order' tasks like critical analysis, evaluation and senior essay-writing:

> *Well, I argue that students can only have creativity and critical analysis and do any of the high-level cognitive things is if they have deep domain knowledge. And my approach is ensuring the most efficient way of [teaching them] so that they get the knowledge as quickly and as efficiently as possible so they can do the next stuff that's creative and problem solving.*

A senior History teacher outlines how to use modelling and scaffolds in a gradual release process to set students up for success in extended response writing:

> *[I use] the content I've covered over a number of lessons to make [students] do some problem solving, some critical analysis, via an essay or an extended response, and all of the [underlying] skills I would explicitly teach them by modelling it. I'd do it, I write it, then we write it, and then they write it, and then I'll give them extensive feedback to ensure that they are improving.*

Despite a common criticism that explicit teaching is unsuited for subjects like English and History which are less hierarchical, or more creative and open-ended, teachers of these subjects at a senior level were clear about the utility of these methods even in these domains:

> *[I]n the staff room, there's a lot of discussion about the need for creativity and freedom. And 'let's let those students find their personal voice.' And it's like, 'they don't know their personal voice, they don't know [the] subject, verb object [structure]'.*

> *I always intuitively found discovery learning a little bit messy. And I didn't instinctively trust it, because I'm like, Yeah, I've seen it go very stupidly wrong and a waste of time in the classroom. Just instinctively, I did not believe that learners can find their own way to some of the complex issues that I need to teach and senior modern history. I didn't think [they learned that] through osmosis.*

Some schools and teachers, despite generally pursuing inquiry techniques or favouring student-directed learning, may change their approach in senior years as high-stakes exams like the HSC and VCE approach. One research participant

described how they gradually became comfortable with explicit teaching when they started teaching at this level:

> *When students got into [Years 11 and 12], suddenly all the inquiry was out the window, and it was very much about like, 'okay, behind this closed door, we knuckle down, and we teach things and people learn things'… When the stakes got high it became, in our department, important to [teach explicitly]. And people didn't talk about it as the thing they did once the stakes became high.*

Myth #3: "We need to differentiate for students, but explicit teaching doesn't allow that"

Another myth that emerged from the data was teachers who found that an element of resistance towards science of learning techniques was the belief that they did not differentiate between students for different levels of student ability or need. 'Differentiation' is a contested term, where it can sometimes look like ability groupings within a class or different activities given to certain students. This form of differentiation was described by a research participant:

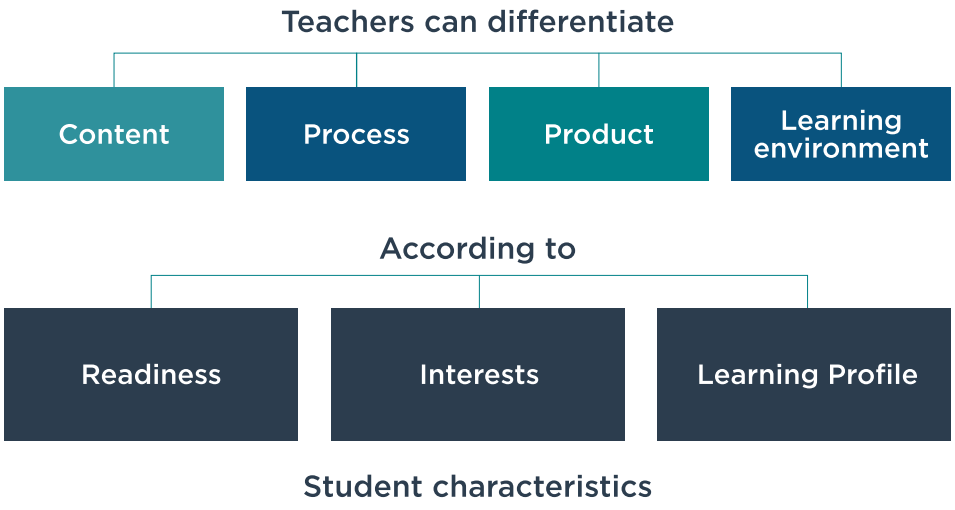
> *Teachers know that differentiation didn't work, I worked that out after about five minutes. I was like, what is it you want me to do? You want me to have four different versions of a text about the Russian Revolution – where am I going to find those, for a start? And then you know, you can tell me to have a quarter you want me to have four different learning activities that go on and on in my classroom based on those four different tiered versions of the Russian Revolution [textbook]? Teachers are exhausted, they know it doesn't work. But that's been posited as science and research based.*

On the other hand, differentiation as communicated by education departments is often less explicit. The Victorian Department of Education's High Impact Teaching Strategies, based on *Visible Learning* and meta-analysis work of Professor John Hattie, state:

> *Differentiated teaching provides appropriate challenge for all students in a class. It does so by responding to student differences in readiness, interest and learning profile. To ensure all students master objectives, effective teachers plan lessons that incorporate adjustments for content, process (how students make sense of content), and product (how students demonstrate what they know and understand).*[20]

According to the NSW Department of Education (probably also drawn from Hattie, given the alignment with the above), teachers are 'differentiating' when they:

- provide several learning options or different paths to learning, to help students take in information and make sense of concepts and skills; and/or
- provide appropriate levels of challenge for all students including those who are behind, those in the middle and those who are advanced.[21]



Source: NSW Department of Education, "Differentiating Learning"

While both examples attempt to clarify this does not mean 'watering down' the curriculum or the learning objectives, it is difficult to see how differentiating the content or product of learning for some students based on some unclear characteristic does not entail expecting some students to do achieve less — counter to the 'high expectations for all students' language also found in these evidence-based guides.

Nevertheless, our research participants discussed how, even within an explicit teaching framework, differentiation in a mixed-ability class occurs:

> *[D]ifferentiation means differentiating your questioning and your scaffolds for the students. So providing, more faded response; you might provide more worked examples for the kids. So the content that you're teaching is the same.*

> *[W]e're using a tiered approach… So we have little things like little markers [embedded in the lesson] like we're going to pace our lesson at a certain level before we go on to independent work, we're going to wait till 80% of the kids are showing that…. we did a whole day [of professional development] just on differentiating and using peer-to-peer work within the mixed abilities [setting] and having the communication going on in the classroom at that explicit level.*

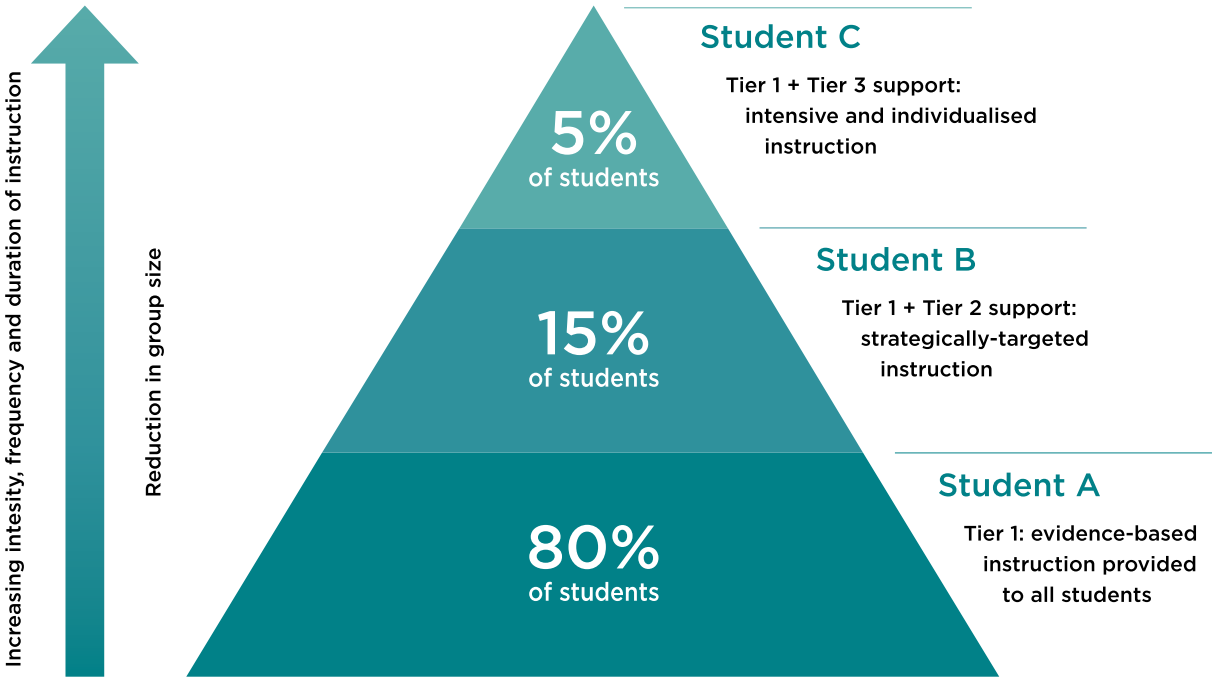
> *So it's more scaffolding for [struggling] kids and providing what they need within the same lesson but keeping the pace up and keeping everyone moving. And what we've found is actually, if you're really explicit in your instruction, there's a lot less of those kids that need that extra [tiered] support.*

The 'tiered approach' mentioned in the above comment relates to the Multi-Tiered System of Supports (MTSS). AERO depicts MTSS in the graphic below:[22]

In this model, all students are receiving explicit instruction (Tier 1), but those who may be struggling with particular aspects of literacy and numeracy can receive small-group instruction targeted at their specific areas of weakness (Tier 2), and students who need support beyond that can access intensive and individualised support (Tier 3).

While small-group tutoring is a popular policy option for students showing gaps in their learning, it is important to note it is not designed to make up for the lack of

Figure 1 How tiers of support work in a multi-tiered system of supports



Source: de Bruin and Stocker (2021)

the most effective teaching methods — explicit teaching with a carefully-sequenced and systematic approach to curriculum development — being used at the whole-class level.

Myth #4: "Explicit teaching is politically-driven and reflects 'right-wing' ideology"

One perception of the science of learning that emerged from our research is its reputation as a 'right-wing' ideology, that people who practice it are 'conservative' and it is driven by politicians for their own ends:

> *I got a bit of feedback that it was a way for politicians to control teachers. Like 'you're just trying to control that practice and tell us how to do our job'.*
>
> *[I]f you just say, for instance, you believe that the science of learning may be, or is, the most effective [practice]… they may also think you could be sort of conservative in your social view. You're right wing politically.*
>
> *People associate it with the Right… and they will think that I will vote for Scott Morrison… They don't want to be associated with that and will get caught up with that baggage when it should just be about learning.*

This myth undoubtedly has complex origins, but one obvious one is ITE, where pre-service teachers are actively encouraged to view some pedagogies as 'progressive' and some as 'conservative', a dichotomy that dates as far back as the 18th century.

Pre-service teachers are also taught about educational theorists such as Paulo Freire, whose theory of 'critical pedagogy' focuses on the power dynamics within the classroom and the need to 'democratise' a hierarchical relationship where the teacher outranks the student — which he called the "banking method."[23] The work of Freire is often cited in research from education faculties, and is embedded in textbooks such as *Teaching: Making a Difference*, which is a text in many education degrees. Below is an extract from a chapter of this textbook, describing external accountability measures on schools:[24]

> *These broader pressures on schools and teachers provide a context towards better understanding the current realities of classroom practice (as outlined earlier). Such pressures work against teachers' efforts for a progressive practice that supports students' active and critical engagement with the broader world — indeed, they encourage a focus on basic skills, prescriptive, superficial and disconnected learning, teacher-directed classrooms and the reduction of equity concerns to improving academic outcomes.*
>
> *[External accountability] pressures encourage a conservative approach to education that is counter to the equity and citizenship mandates of broader education policy (MCEETYA 2008). Such pressures encourage a 'banking concept' of schooling (Freire 1993) where teachers are positioned with authority and power; where selective knowledge is legitimised and transmitted; and where students are positioned as lacking. These broader pressures also shed some light on why low-level pedagogies persist in so many contemporary classrooms despite many progressive educational reforms and initiatives. Socially critical pedagogy is non-prescriptive and draws on complex theorising and knowledge of social identity, the social world, teaching and schooling. Such pedagogies have been resisted in schools as they have been resisted by advocates of conservative education...*

Inquiry learning is not based on empirical evidence of impact, but normative beliefs about education based on philosophy and theory. When pre-service teachers are being taught that pedagogy is political, that teacher authority is linked to oppression, that a focus on 'basic skills' limits 'critical engagement with the broader world', it is clear where the conflation of teacher-led explicit instruction with conservative ideology originates. Indeed, this helps to partially explain the origins of other myths explored so far as well.

Our respondents also observed the danger of this politicisation of the science of learning:

> *[The politicisation] just closes off lots and lots of minds and I think that's one of the huge stumbling blocks to it, because people who see it as part of an identity, a cultural*

identity issue. And if they don't want to be associated with the centre right it then they will not buy into [the science of learning].

One research participant emphasised the value and contributions to the discussions around science of learning by an individual school system leader identified by a research participant, whose understanding is not tainted by teaching degree learning and an entrenched professional identity:

So, I think that I think one of the enablers there for him is that he's not wedded to a particular practice. He hasn't been taught this as best practice in his university degree. He's come at it from a different level. He hasn't had that same level of investment tied up in 'my identity as a teacher' or 'my philosophical beliefs as a teacher'.

Therefore, it becomes important to emphasise the false framing of the pedagogy on the basis that, firstly, those who practice it are not necessarily political and, secondly, that — contrary to common beliefs — inquiry learning hurts disadvantaged students the most and these students conversely have the most to gain from explicit methods:

[F]rom talking to people at [the] ResearchED… conference, I mean, they seem to come from all over the place… they were just people there that were interested in the topic and looking to introduce [explicit teaching] into schools. It looked like a pretty broad political spectrum.

One teacher actively challenged the notion that inquiry learning was superior, noting that those methods produced ignorance in young people which, in their view, supported right-wing belief systems:

I'm teaching [George Orwell's] Nineteen Eighty-Four at the same time that I'm hearing people say, 'let them be creative'. This idea [from the book] 'Ignorance is strength' is kind of the paradox that I think constructivist teachers don't even realise that they're operating in… as a consequence, [it's perceived] as a left wing ideology, but [paradoxically] it ends up compounding right wing belief systems.

Many research participants, as explored in an earlier section, linked their adoption of SOL practices to social justice and argued their compatibility with left-wing ideas:

[I]t's best for students who are in the low socioeconomic background. You'd think it'd [fit] on the centre left… [there are] schools where the demographics are such that [the students are] really relying entirely on school to provide the gateway to that canon of information and knowledge that is their entitlement as a citizen of this nation.

Nevertheless, this false politicisation has created a political impasse that could hinder system-level change to adopt SOL principles and will require work from both policymakers and SOL practicing teachers to overcome.

Myth #5: "Explicit teaching damages my professional identity as a teacher"

Some teachers will believe in the myths canvassed above because they have an incomplete understanding of what explicit teaching looks like; but for others, the concern relates more strongly to tightly held beliefs about what education should be about and how teachers conceive of their identity. For many teachers, it will require a deeper mindset shift to redefine good teaching as teaching aligned with the science of learning.

Where teachers conceptualise their role as equipping students to succeed outside the classroom, or to help provide "that canon of information and knowledge that is [students'] entitlement as a citizen of this nation", showing the practical and moral benefits of the science of learning to that self-concept is likely to assist.

However, if teachers have a fundamentally different view of what education is about and their role as teachers — such as the lesson of ITE that teaching is "progressive practice that supports students' active and critical engagement with the broader world" —these beliefs may be much harder to shift. One approach may be to emphasise the common goal of all teachers: to be effective for students. When asked about the way SOL practices affected their identity as a teacher, research participants said:

It's fantastic… It's what gets me out of bed every day. All teachers want to be effective.

Everybody wants to be effective. That's really what you go into teaching for and to make that difference. And when you do see it happen for a student, there is nothing better, absolutely nothing better than that.

Everyone wins. And when you have students making those fantastic gains you get better behaviour, you get better classroom engagement. Teachers feel more effective. There's so many benefits to it. I don't understand why anybody wouldn't do it once they find out about it.

Recommendations

- Recommendation: Create accessible and accurate outlines science of learning and its implications for teaching that is applied consistently across the education policy landscape, so teachers have an unambiguous understanding of what best practice looks like.
- Recommendation: School systems should adopt a set of principles, similar to the Catalyst model, that connect the 'why' of cognitive science with the 'how' of effective practices.
- Recommendation: School leaders should work proactively in their schools to identify and dispel the myths and misconceptions about science of learning.

FOCUS AREA 4: System-level support is currently insufficient to advance the science of learning

Finding 10: School principals and Department leaders can be seen as barriers

Many research participants saw the lack of SOL knowledge among key leaders — as well as other figures in the education ecosystem — as a barrier to change. There was specific criticism of the Department of Education's regional directors:

The main barriers without a doubt are the people at the top.

I know our regional director has no understanding of the science of reading… [and] he is in a key role.

[I]t's also above the school leaders. It's the directors isn't there? These directors of the department…

I still think you need some key stakeholders to be persuaded. It is a compelling argument. I don't know that there are that many important people like Ministers, state ministers, federal ministers, heads of schools, heads of departments… If key people in in those institutions, NESA, AIS, the unions, principals' councils… people that like that, if they are persuaded, then I think things will change quickly.

Unfortunately, they're the ones in the power positions and, yeah, and we've got to basically fix the mess fat our level.

Evident here is that SOL-practicing teachers and leaders see obstruction at higher levels of the hierarchy. In particular, they identified the significant barrier of uninformed educational leaders:

Some of the barriers would be [that]... they don't know what they don't know, [and] you can't fix what you don't know. It's really important to increase their knowledge base. But how are you going to increase their knowledge base? They're obviously not going to go back to university.

What is clear from this is that SOL-oriented teachers and leaders find it frustrating when mandates or accountabilities are imposed by leaders they perceive as uninformed or out of touch, as these are viewed as pushing schools in the wrong direction. Some describe hostility from fellow schools and leaders of their local networks:

We are completely isolated within [our local network]… If I went along to an instructional leader conference and I might challenge some of the things that they're sharing, you can visibly see them just like prickle up like that, they go silent. You can see the wall, and it comes from the director, the director is not on board with it, none of the schools are on board with it and we're [the only ones]. We feel like our school is very isolated within that [network] and we're kind of put at arm's length, we've never [been] invited to share

and we haven't [had] schools approach us to come and visit our school from within our network.

In this context, it seems clear a broader and deeper knowledge of science of learning principles and practices is required at all levels, not just for teachers and school leaders.

Finding 11: Well-informed leaders are vital to help drive change at a school level

Given the strong evidence of positive impact for student outcomes, an important consideration is how to prioritise school improvement in line with science of learning principles. The data revealed leadership is a key lever: school leaders need to be able to build consensus in their school communities for this sort of change.

Education leaders are gradually adopting SOL principles in individual schools and school clusters, primarily from a bottom-up approach. One consistent theme among educators was the need for directive educational leadership within at least a school wide context.

One senior school leader commented, "getting educational leaders on board is crucial... It would be so much better if the leadership in any school is on board and embraces it." This aligns with a wealth of literature that suggests the centrality of leadership, particularly the role of Principal, to effective schools and highlights that instructional leadership is a key element of this.[25]

Several of our respondents, who are either Assistant Principals or Principals themselves, have already brought SOL principles to their schools and are educating their teachers on these practices:

[O]nce I started to implement things in my own classroom, my impact was still very limited, [on] just those students in front of me. And even, like, the things I could do, I was still controlled in a way, by the whole school, whatever their systems and policies were of the whole school.

[I]f we're looking at it from the curriculum perspective, you want to have a whole school curriculum so that it's sequential and it's being followed through. So it's actually being enacted. And so then that way like personally teaches know what's being taught and then student knowledge is being built on from year to year at the moment in, especially in primary schools.

A big enabler for me has definitely been… we've got the executive team… our learning support teacher and our principal are very much on board with all of this and we've pretty much all been learning at the same time and have got a very common and shared kind of vision of where we going with it all.

It helps them [teachers] to understand that it [SOL] can be done. I think it's critical that they have people, their leadership teams and above them. It's even going to directors of regions, regional directors, who know this knowledge and are able to better support and ensure that people are carrying out practices that would be considered SOL.

Evident here and discussed prior is that the regional director, who works most closely with school principals in the relevant cluster, can be an enabler of or a barrier towards greater uptake of science of learning principles depending on their own knowledge. This is a feature of the way government schools in NSW (which formed a large proportion of the sample for this study) are governed: they have a great deal of autonomy over budgets and programs in order to be responsive to their school communities but are accountable to the Director of Education Leadership (DEL).

If the relevant DEL does not understand or appreciate the goals of SOL schools, this can present a barrier to implementation. It is therefore important that school systems should ensure their own staff provide support to these schools, or at least do not interfere with the changes they are making.

Consequently, school systems should view broadening the knowledge base of science of learning as a job for multiple layers of leadership: the departmental officer responsible for working directly with school leadership teams (e.g. SEIL in Victoria, DEL in NSW), the principals, and other school leaders (such as the Assistant Principal Curriculum and Instruction, a designated position in NSW) each have a mutually-

reinforcing role to play in creating the leadership consensus necessary to sustain a shift towards the science of learning.

To support this, the improvement plans schools are expected to develop could utilise science of learning as a way of measuring whether these shifts are taking place. As observed by one Assistant Principal:

> *[I]f you look at school improvement plans, I don't think you'll find any of them that actually include the phrase science of learning… [it'd] be pretty rare to find one that does have that as a focus area. So it's just not in the language of schools at the moment.*

Finding 12: Schools are not supported properly from the system to implement science of learning-based teaching

Over the past few decades, Australian state school systems have decentralised decision-making around teaching the curriculum. Decisions about how to teach the content in relevant curriculum and syllabus documents are now typically left up to schools, with only some guidance from the school system level (typically the Department of Education).

This has the effect of leaving schools to do the significant work of turning the curriculum into something classroom-ready. Unfortunately, many of the supports provided by school systems, particularly curriculum materials and professional learning, at best do not adequately support schools in this work and at worst lead them in the wrong direction.

i) Curriculum and materials

State governments are currently releasing teaching resources and professional learning that are not informed by evidence. One particular concern was the most recent New South Wales K-2 Mathematics syllabus:

> *I can't think of any policies or procedures that the State or Federal government is introducing on SOL [and] I'm actually quite concerned by some of the documents that are coming out of the NSW Department of Education… There's a new mathematics curriculum coming out and all of the professional learning and resources are basically the opposite of what the science of learning is saying.*
>
> *[W]hat all of our learning as an instructional leader is all based on all the professional learning modules that have been released about the department of education around the new K-2 [Maths] syllabus, they're all grounded in that pedagogy, which is all inquiry learning open ended tasks, you know, productive struggle, all that kind of stuff…*
>
> *In terms of l that government level, there needs to be some sort of policing around what things we are pushing forward… [the Department] is trying to say that the new syllabus or the curriculum that is coming out is backed by the research, but it's not actually backed by the sort of evidence that is reliable.*
>
> *Teachers need their department of education to also understand the Science of Learning. Any documentation or any recommendation or any guides or anything… Scope and sequences or units of work that are actually informed by the Science of Learning and not by such things as inquiry-based methods.*

ii) Professional learning offerings

NSW teachers must do 100 hours of professional learning to be accredited with NESA, and 50 of those hours must consist of Department-accredited professional learning. Our research participants expressed concerns about the professional learning that is recommended from the school system, because it was insufficiently aligned to the science of learning:

> *Another barrier is professional learning from the department is not aligned to evidence based practice.*
>
> *All the stuff I've I looked for professional learning throughout the year, there wasn't a lot [aligned with SOL].*

One research participant said they felt confused and had to reconcile the contradiction between the new (informal) learning they were doing about the science of learning, and the professional learning they were receiving in their capacity as an instructional leader:

I also probably felt very confused [about science of learning initially], because it was very contradictory to a lot of the professional learning, and the Department of Education, New South Wales Department of Education resources that are put out there. And as an instructional leader, I was receiving a lot of professional learning around how I needed to, you know, run professional learning with my teams, and what that needed to look like. But that was very contradictory to what I was learning myself.

In general, there was observation of internal contradiction of policies and directives from the Department where some might align with evidence-based practice, but others compete:

[W]hat I observed from the department is that there's policies around evidence-based practice. And there's also policies around student led learning, and they're competing. And so you can go to a department website and see both. A girlfriend of mine actually just did some training that said, 'people need to be performance management, they're not doing students enough student-centred learning, gosh! So there's a lot of contradiction within what they publish themselves. You could have all the policies in the world and if they are contradicted by other policies, or other practices, then it weakens the overall policy.

One research participant observed that with such poor quality control of professional learning opportunities, money is going to waste:

I'd love to have some sort of organisation which is properly policing and supporting the professional learning that's happening at schools. You know, we're literally throwing away thousands, if not millions of dollars every single year on professional learning, which is ineffective.

While professional learning can be a useful tool to develop teacher skills, when it encourages teachers to develop misconceptions about evidence-supported practices — and for this to inform their practice — it is more than just a waste of time and money. By encouraging such shifts in practice that are unlikely to improve teacher capacity and student outcomes, teachers are missing out on the opportunity to engage in learning that will help them improve.

Existing professional learning requirements adopted by teacher registration authorities such as NESA and VIT should be explicitly aligned with the science of learning. This includes the more complex and cumbersome requirements for initial full registration of graduate teachers.

Currently, graduate teachers must apply to their teacher registration authority (NESA in NSW, VIT in Victoria) for a baseline level of accreditation, and then must apply for full registration aligned to the APST's Proficient standard. The procedure for doing so is different, with NSW's requirement for five to eight pieces of evidence aligned to the APST much less onerous than Victoria's requirement for an action research/inquiry project report and documentation aligned to the APST.

iii) The APC&I Initiative

A relatively new initiative from the NSW Department of Education is the APC&I, Assistant Principal Curriculum and Instruction, allocated to all government schools. In theory, it is a good idea to have someone with responsibility for these areas in a school when principals and other assistant principals may have specific areas of responsibility.

However, some of our respondents raised questions about the exact nature of the role and the nature of the professional learning these leaders are receiving:

But there's not really a lot being done about [detail]. What are they meant to be doing in that role…. what sort of knowledge do they have to support teachers as well?

I assist APC&Is… it would be great if whoever was training them, giving them that professional learning, was giving them the science of learning research to implement [because] it would actually get a lot of schools that way, but they're not they're clearly not on board. Because when I asked my APC&I I you know, 'what's going on with your professional learning', [it was] a lot of inquiry. A lot of inquiry.

Finding 13: Schools need system level resources and support to effectively change practice

One of the most common barriers to implementation was practical: even if schools have identified the need, understand the learning science and know what practical changes need to be made to instruction, the resources need to come from somewhere.

A common response from our research participants was the desire to see the Department of Education do more to support schools in the area of curriculum resourcing:

> *My wish list would be that the Department of Education actually started to produce resources which were aligned to the science of learning.*
>
> *[W]e need like a like a science of learning hub.*
>
> *[We need] somewhere you can go or even a resource where you can go and say 'this is best practice'.*
>
> *Just tell us what we need to teach. Yeah, what is the content that you want us to teach?*

Not only does the lack of appropriate resourcing impact the ability of schools to introduce new programs along the lines of the science of learning, it impacts all teachers' ability to effectively teach their classes.

> *When it comes to maths, we've had to create everything. That's been a barrier. There hasn't been resources.*
>
> *I felt that there was a real lack of support materials, resources, whatever it was, to writing. I was expected to teach these kids to write, but I didn't know how exactly. And so, I started doing my own research.*

Schools that are already on the science of learning journey are doing the work of curriculum design and implementation and are aware it takes time and multiple iterations:

> *[T]here's still negatives. Like, you're still going to recreate all your resources. You know, there's a lot of time and energy that goes into not just that, but then up-skilling [teachers] to start to teach it properly.*
>
> *I guess that's what we're talking about is that content based knowledge and you keep building on it, you keep revisiting.*
>
> *I think for me, what would be amazing is the resources in terms of clearly laid out scope and sequence. Yeah, so looking at the syllabus and the department actually supporting us in getting the content and then teasing that out across all the ears because at the moment, they're just giving you the content and not showing you how to sequence that necessarily. [It's] so we don't have to go off and buy our own programs.*

One research participant noted the level of complexity of teachers' roles:

> *[W]hen we look at the jobs that teachers have to do, they're all very specific. So they've got to be expert lesson planners. They've got to be expert [classroom] teachers. They've got to be expert people in teaching teachers…*

The solution is to provide more consistency and clarity from the system level to support schools and teachers in making this change. A common sentiment in our research was:

> *The biggest barrier in this situation is the Department of Education.*

While it is important to highlight the actions that school systems could and should undertake, our research participants perceived several aspects of current Departmental offerings (largely NSW, as most participants were NSW-based) including syllabus and curriculum materials, levels of knowledge among leaders and professional learning offerings, were either absent or not aligned with science of learning principles. These deficiencies must be rectified because, as one research participant put it:

> *[I]f you're going to have a big impact on a whole system… the way to do it is not make people fight their way from grassroots up. But actually, do a bit of top down. 'This is the practice, we're doing it.' Stop worrying about offending people.*

This has benefits for schools and teachers in the context of workload being a key concern for teachers and for broader workforce issues. Systems can provide more science of learning-aligned assistance to schools, particularly in the areas of lesson planning and teacher professional development, then this would take some of the guesswork out of teaching and free up teachers' time and mental energy to focus on translating that work for their classroom and their school.

Therefore, school systems should collaborate with subject experts, high-performing schools and other services like Ochre and Shaping Minds to ensure teachers have classroom-ready resources such as scope and sequence, unit plans, lesson plans and assessment materials available for their use.

School systems could potentially look at assisting schools with high needs that desire a high-quality, packaged program to implement those:

> *[P]repared programs like InitiaLit, for example, for whole school instruction, some of the Corrective Maths programs or you know the Direct Instruction Maths programs or Direct Instruction in Reading and Spelling. Those things are actually really good. They give you back so much time. You don't have to go and plan all these units of work. They're already done for you, and they're done by people who know what they're doing. And you can implement that with confidence.*

Recommendations

- Develop and implement a sequence of professional learning for key school-based (including APC&I) and relevant departmental leaders that emphasises the importance of the science of learning and how to lead change to promote it.
- Align ongoing teacher accreditation/ registration processes with science of learning principles through the creation of professional learning and observation opportunities.
- Review syllabus and curriculum guidelines to ensure consistency with the science of learning.
- Departments of Education to conduct an audit on the most popular suppliers of professional development and teaching and learning programs to assess alignment with the science of learning.

FOCUS AREA 5: School-level change must be carefully managed and demonstrated, and then shared

Finding 14: Change fatigue among teachers is a barrier that must be overcome

If schools are better supported by the system in the manner explored above, this can help to address the challenge of change fatigue among teachers that school leaders must confront. In addition to the need to overcome myths and shift mindsets, there is also a degree of path dependency in schools — where the easiest course of action is to continue along with what has been done before — which can hinder large-scale shifts such as adopting SOL practices.

Our research suggests two main and mutually reinforcing contributors to this are the perception of teachers being overburdened and tired, and change fatigue arising from multiple and contradictory system-level directives.

For teachers and middle leaders seeking broader support from leadership to support a change in practice, a key theme that emerged was the resistance from the leadership team on the basis that society needs to do more to 'look after teachers' which includes not asking them to have to bear too much change.

> *Some teachers are resistant, but in general actually the teachers are less of an issue than the perception [among leadership] that teachers don't want to come on board with this or that they have got too much else to deal with…*
>
> *My biggest resistance was actually the Deputy and Head of Senior School. It wasn't that they were resistant to doing SOL because they could see the results we were getting… You can't argue when you see the results improving. But they were*

concerned that we can't put pressure on teachers to change their practice.

On the other hand, some leaders found some resistance from teachers where their work or students' outcomes was perceived as sufficient or 'good enough':

[S]ometimes the barriers are just that it feels like a hard slog sometimes when you're trying to work with people who don't [want to change], they [think they] do a good job. They don't really want to be told that they need to change how they're doing things. So that's the thing. People get tired – as in, the teachers – and they don't want to change things.

If you're not contemplating change and then change is forced upon you, you can go into that fight or flight mode.

This arises from a context where workload is perceived to be a significant burden on teachers and the idea of changing one's entire pedagogical approach — which could potentially involve unpicking and redesigning years' worth of lessons — seems like an additional demand on an already-burdened profession.

Resistance can also come from 'change fatigue', the idea that the Department of Education and sometimes individual schools have been asking teachers to bear change and additional accountability requirements, as well as the fact that the advice and directives given have not always been aligned.

I think the actual resistance is that what the incarnation that came before has exhausted [teachers] and jaded them. And now they're like, 'oh, my god is [science of learning] another one of those things that we know doesn't work in the classroom?'

You've got a lot of resistors and you can't blame them when they're basically had, you know, the Department [of Education] releasing all this stuff over the years, which has then been debunked as not evidence based. So they've had to go through these things, like L3, Reading Recovery, inquiry based learning. All these things that have been pushed out by the government, our teachers have had to implement. And so you know, if you just [put] out the science of learning, [teachers] just take it as, 'oh, this is just another thing that we have to do, it's going to be another phase.'

This shows missteps by the system have the capacity to engender further scepticism and change resistance. As one research participant noted about the role of the Department of Education, "we've got to kind of get upstream and work out what's happening at the start." The question of the kind of system level support required is an area for future work. Perceptions of change fatigue and path dependency is not limited to government schools. The following research participant worked in an independent school:

[P]robably in every school [there's a] baggage of past initiatives, there's this kind of an elephant graveyard of initiatives [from] the past 20, 30 years and some [teachers]… have lived through [those] and [they're like] 'yeah, here we go'… [It] doesn't matter what is [being pushed], there will be some sort of hesitancy because of that.

Consequently, it is important for changemakers — whether at a system level or at a school leadership level — to create a realistic path for change which starts small and builds incrementally. Our research participants emphasised the need for change to be sustainable:

It's a slow burn if you're actually trying to get [the science of learning] to happen in schools… teaching and learning is still happening, and you've still got these other changes, external curriculum changes and, like, teachers are busy as it is.

[But] once your school does start on that journey, how are you actually making it sustainable?

While this awareness can help contexts in which the primary barrier is perceived to be teacher capacity, school leaders must also be careful to position new strategies with reference to what is best for the individual school and avoiding the perception that it is being driven by the system. Practical strategies to support incremental change for both schools and the system are explored further in the next section.

In order to support schools with this work, education departments must be cautious in

their messaging and focus on enabling (at least initially) teachers and schools, rather than telling them. Our research participants were clear about the problem posed by telling teachers and schools what doesn't work but then not providing a practical solution or alternative:

> *[Teachers] were doing something a particular way that was known, just that particular way of teaching, and you're asking them to do something that was very different, to the point where the resources that we were using were all going to change. And the model; there was something it's called 'Guided Reading' where you do a little bit of reading with a little group, and everyone else is out there and doing inquiry learning and immersing themselves in literature. Supposedly, [students are] acquiring all this knowledge themselves without directly being taught that. So [leaders] were pulling that [model] away [and] it was hard because you were trying to rip the carpet from underneath them, but not putting something else there for them at the same time. So you're telling [teachers] all this [as a leader], but… in the meantime, the department wasn't supporting you, because they didn't give you the scope and sequence. They didn't give you the program to go with [the change]. I mean, you're only one person, you can't develop all the programs and the resources.*

However, it should also be noted that some research participants sought a more active role from the Department of Education to promote SOL practices. When asked what would enable more schools and teachers to adopt SOL practices, research participants said:

> *Some statement from somebody, somewhere, from a policy level that says '[science of learning] is the right way to go.*
>
> *[A]lignment, alignment, alignment! Between policy, curriculum, assessment [and] school practices.*
>
> *I do feel like policy is really key. And if policy is in place, it enforces an adherence. That can't be denied… [T]here's always resistance to policy, but if that's the condition of their employment…*
>
> *[We need] more accountability around the pedagogy that is being used at schools [because] you can basically do whatever you want… [but] before we get to that, we need to have a really good shared understanding on what good teaching practice is.*

Resistance is a normal part of any change process. One research participant, an Assistant Principal, offered this framing for leaders encountering hesitancy and scepticism:

> *We've just got to stop making it about the adults and make it about the kids. We should be making our decisions based on what's best for our students. And if that means that we need to be delivering professional learning better or we need to be delivering our teaching practice better, that's what we should be basing our decisions [on] and it shouldn't really matter how the adults feel.*

Finding 15: For change to be sustainable, it should be incremental

In the absence of system level support — or even despite it — the sort of school-level practice change undertaken in SOL-oriented schools is of significant scale. Schools that wish to go down that path must make change incremental, by starting in one small area and embedding that practice.

One potential starting point was designing and explicitly teaching routines and engagement norms to students, to ensure they are focused on the learning:

> *The more automatic you can make those sorts of things happen, the easier it is for the students to then focus on the actual learning part of your lesson and not think about, well, 'what do I have to do now'? It's 'what am I learning about?'... even as simple as how to enter the classroom, where to sit? Where do you hand out your white boards? Or you know, how do you how do you do the turn and talk, or [show] your mini whiteboards. So having all of those routines… you can have consistency from teacher to teacher if you're moving from classroom to classroom as well.*

Other teachers spoke about implementing a small technique, like checking for understanding or the regular review:

> *Here are the 10 [Rosenshine Principles of Instruction], all of them, [but] just check*

for understanding. And I literally went back and changed my practice…. I did a whole series of lessons that ended up me putting together a presentation that I ended up giving to my faculty literally on like, my first day of being a head teacher. And I made my story of failure, a story of learning about check[ing] for understanding.

If a school is just starting out, maybe you could focus on a particular curriculum area to start learning how to implement the science of learning and the high impact strategies and reducing cognitive load. Because sometimes teachers can feel really overwhelmed if they have to change everything all at once.

[I started] doing this retrieval each time [and] I could see that the kids were getting it, you know, they were remembering things, and then they were applying it. And it wasn't becoming so hard for them to remember. It was in their long-term memory.

Research participants who were school leaders also spoke about the need to create a positive learning culture among the staff, where teachers were being explicitly shown what to do and how they could work together to improve practice:

We modelled everything that we asked our staff. So our professional learning, it's explicit teaching, it's using what's called engagement norms like from the very first one. Small steps, and the teachers tell us 'now we see in the professional learning, you [leaders] are doing what you're asking us to do with the students. You're doing our learning explicitly. Small steps. You're putting in all the things you're asking us to do.' And we did just do things in small bite size. Like we introduce a little bit, and [say] 'go and have a play with this' and then we keep coming back to it and refine it.

[T]eachers need time to actually learn about this stuff and talk about it and put it into and put it in practice… Teachers [feeling comfortable] being risk takers, actually. So, being willing to step out of their comfort zone, try something and being supported in that, having that culture within a school of 'we're working together on something'.

In-school networks can also be useful to build a case for change within the school where there are instances of scepticism, hesitancy or fear:

Try to get a team together so you're having those conversations amongst others in the school. Once you have those conversations, others are either curious or they're also starting to dabble with the science of learning as well.

So then if everyone's doing it in the same curriculum area, that provides another opportunity for all those conversations, you know, everyone's talking about the same thing.

Finding 16: Better assessment tools can track student progress and measure impact on learning

A common thread among many of the research participants in some sort of leadership role was the role of assessment, particularly that high quality assessment tools were integral to schools being able to measure the impact of instructional changes and to affirm practitioners on the journey.

On the other hand, low-quality assessments used at a school or classroom level could be used as a way to justify poor practices. One teacher spoke of attending a leadership event with other schools in the area and hearing stories of poor assessment practices:

Twinkl is a teacher repository where teachers will dump all of their stuff that they've been working on, and some of the stuff is resources they've made and assessments they're made. There's absolutely zero quality control, and these leaders — they're not just teachers, they're leaders in their schools — are going to somewhere like Twinkl to get assessment items.

When asked how the school assessed students' reading capabilities, one school leader told our research participant:

'I just use a PM reader', which is a predictable type. And I listened to them. I said, 'well, that's good, how do you measure it?' And she's like, 'oh, I've been doing this for so long, it's just gut instinct'… There's nothing scientific about somebody's 'gut instinct'!

Consequently, schools that have adopted science of learning practices typically either used valid and reliable quantitative measures or moved towards valid and reliable assessment in order to track their progress:

> *I think a bit of a theme that I've picked up on is that people who were using Science of Learning are focused on the data. They use the data which gives them regular feedback. All schools have NAPLAN data, but at my previous school which didn't collect additional data, we didn't actually know whether what we were doing was working other than anecdotal bits and pieces.*

> *[After transitioning to SOL] we've tried to use more external assessments, so 'OK, this is not just our judgment' and we're not creating assessments that are just a 'what we know our kids can do' sort of thing.*

Where schools have the resources to purchase external testing regimes (one independent school teacher mentioned Academic Assessment Services or AAS being used quite often in independent schools) that is one method of generating valid and reliable insights into student progress. However, for schools that do not have those resources, research participants said more assistance from the department to provide these tools and less focus on arbitrary certification:

> *[A problem is] the lack of consistent approaches to assessment, and [wanting] valid and reliable assessment tools across all schools. That would be good [for] really clear ways that we can measure growth. But because we don't know the impact that we're having, unless we can measure the growth that we're achieving, right? And I think we're just how do we compare that growth [with others]? I think schools are doing very different things and there's no consistency of those assessment practices.*

One theme that emerged from the data is that schools with access to high-quality, reliable and valid assessment tools — particularly in reading — were able to use this to definitively demonstrate progress at a cohort and individual student level:

> *One student that I started to work with at the beginning of 2020 has progressed from watching various videos to improve her literacy to where she is now. And when I first started working with her, I wasn't even sure we were going to be able to improve this. She was so severe that she's now doing very well… she's had more than 12 months' worth of growth out of one year.*

It was also clear student success and growth is strongly intertwined with feelings of success and self-efficacy for teachers:

> *[W]e're just seeing results in the kids we're teaching. And I feel like it's actually making an impact. Like, I've taught disadvantaged [students] before and I would feel like I'm saying things and they're not picking up on anything. You don't get to see it in their assessment results. But here, I feel like I've actually making a difference. You get to see it in their work results, in their academic results. And in their understanding, like when I'm teaching, the kids are following, and they're engaged, and they go to their desk to do their independent work, and they know what they're talking about. And I'm building background knowledge. And why I became a teacher l[is] to see kids excel, to see them learn. So, it's nice to feel like I'm actually doing what I wanted to do.*

> *[Using the science of learning] gives me a sense of my own intellectual purpose, I feel kind of challenged by it. Otherwise, I don't know if I could stay in teaching, if I didn't feel like I had something that elevated me.*

Finding 17: Schools need effective ways to demonstrate change and share learning

In addition to quality assessment and data assisting with tracking student progress and evaluating the impact of teaching at the school level, that data can also be used for other purposes.

Data is the cornerstone of Department-driven but school-based plans, such as Victoria's School Strategic Plan and Annual Implementation Plans, and NSW's Strategic Improvement Plan.[26] Data is assumed to be central to effective leadership and change management — an idea supported by research[27] — but schools aren't receiving enough support if they want to measure their impact in terms of the science of learning. This can then be part of what is communicated back to the school community about the progress of these whole-school plans.

In addition, the finding that there is a need to clearly measure and openly communicate success has implications for the broader practice of the science of learning. As one teacher commented: "I think they [teachers] need exposure to people who are doing this and having success. I think nothing makes people take notice more than schools who are sharing their results."

Sections of the education system, as well as researchers independent of government, currently do case study analysis of schools that are effectively leading change to improve student results.

Some examples of this are the work of ACARA in 2019 in creating a list of schools, across all jurisdictions and sectors, that had high NAPLAN growth in certain domains.[28] NSW CESE has developed a list of ten Ambassador Schools, selected on the basis of their strong performance when compared to demographically similar schools.[29] The work of AERO regularly references individual schools experiencing success across particular domains.

School systems could implement or expand existing mechanisms to promote successful schools and enable better sharing of their practices with demographically-similar schools. This could even take the form of commissioning case study research to understand the underlying practices required to create change. Further steps could include the creation of formalised professional learning opportunities for leaders to learn from the change processes at schools like theirs.

As discussed, making success visible and creating examples of practice are key factors in the adoption of science of learning at a school level. However, policymakers could assist by creating platforms — or repurposing/expanding existing ones — to show good practice being modelled by expert teachers. Our research participants reflected on the need for observation opportunities and thinking time in order to implement changes:

> *I think the biggest issue is that they don't know what it looks like in practice and what we found is… Once teachers can see how it looks in the classroom, that tends to give them confidence. Having that coaching around it, so the barriers are usually that they don't understand what it looks like.*

> *[S]omeone to help [teachers] like a mentor, someone who they know [is] going to show them what to do. Maybe some examples of what EDI would look, like some lessons that they could watch, some resources…*

> *[We could do with] release time to undertake research to consider best practice without the need for immediate implementation straight after. So genuine thinking time. So release time is very important. I think having a supportive team that you can turn to across executives. So for me in the secondary setting, that is the head teachers of faculties.*

> *[I]t's always release time, because teachers are so time poor.*

While school visits may be impractical and time-consuming for many reasons, instructional videos are possible. The AERO website contains some videos describing explicit teaching practices, but this is not quite the same as modelling.

Working with schools to capture and share effective practice could be a beneficial and more effective method of professional learning for schools and teachers.

Recommendations

- School leaders should develop plans for change that generate a shared purpose among staff and pace change in a sustainable way.
- School systems should commission research on effective assessment practices and generate an assessment library for use by schools to help track progress
- School systems should commission and publicise case study research of schools that have generated school improvement through science of learning principles, so these schools can act as 'lighthouses' that encourage and help guide other schools.
- School systems should create centralised digital platforms to help connect schools and enable them to learn from each other.

Conclusion

This paper has shown that teachers and schools are going on the science of learning journey individually and reaping the rewards both for their students and school communities, but also for themselves. The qualitative data used in this report allowed teachers to tell their own stories about how shifting their practices towards the science of learning enhanced and strengthened their professional identity.

Some specific areas of policy change are needed, to bring other aspects of education policy into line with the *Strong Beginnings* report and its recommendations for initial teacher education. These include professional standards and development (an area of future CIS research), as well as states and territories providing more detailed support in curriculum, pedagogy and assessment.

One alternative to the status quo is a more explicitly top-down approach, with mandates and accountabilities for schools and teachers. But a concerning thread evident in this report is the perception that school systems act as barriers, instead of responsive enablers of best practices. At best, the Department of Education is an intrusive object to be worked around; at worst, it is leading teachers and schools down the wrong path. Neither option aligns with how school systems see themselves, which is as a supportive partner in the shared mission of improving student learning.

Given this, the lack of shared understanding among policymakers and the internal inconsistency in policy (even within a single organisation like the NSW Department of Education) means any mandates would likely be met with confusion and resistance from the teaching profession and education sector.

This report advocates that the best option is a hybrid approach, where policymaker-imposed barriers are removed and targeted strategies — such as shining a spotlight on successful schools so others can learn from them — are implemented to enable scaling up of science of learning practice. Such an approach gives schools the support in the areas where they need it to implement change while using the authority of the school system to guide schools on the change journey.

By creating a shared understanding of good teaching and what success looks like, policymakers can help put schools on a path to deliver better outcomes for their students.

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Summary

The science of learning is a body of knowledge that connects a set of insights — derived from cognitive science and educational psychology — about how humans learn to effective teaching practices.

Despite recent enthusiasm from policymakers and practitioners to promote the science of learning as a foundation for teaching and learning practices, evidence suggests educators in general have limited awareness and understanding of it.

Nevertheless, some individual educators — working on their own or within networks — encountered the science of learning, worked to embed it into their practice and to advance it within their own contexts.

This report draws on data from surveys, focus groups and interviews with a group of science of learning-oriented educators to learn about their experiences, and derive insights about barriers and enablers to the further advancement of the science of learning.

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Related works

Trisha Jha. *What is the Science of Learning?*. CIS Analysis Paper 63, February 2024 https://www.cis.org.au/publication/what-is-the-science-of-learning/

Prof John Sweller, *Why Inquiry Based Approaches Harm Students' Learning*. CIS Analysis Paper 24. August, 2021. https://www.cis.org.au/publication/why-inquiry-based-approaches-harm-students-learning/

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