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## How long do we carry an ineffectual teacher?

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## How long do we carry an ineffectual teacher?

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Siegler et al. (2012) demonstrated that primary school students' experiences with fractions and division, can reliably predict their mathematics achievement in high school, five or six years later. This research, a major international comparative study, sounds a dire warning, when we know such topics are frequently taught poorly. As student engagement with mathematics and science in upper school plummets, much of the disengagement can be linked to poor prior teaching and learning experiences. This is directly related to teacher competence, and specifically to teachers who lack the necessary content knowledge to teach these subjects effectively. The 'elephant in the room' is our current cohort of teachers, many who lack the necessary skills and knowledge, and the systems which have allowed this to occur.

### WHAT IS THE PROBLEM AND HOW HAS IT DEVELOPED?

Firstly, there has been a mistaken belief that fractions do not need to be taught, because we live in a metricated world. In the days of an imperial measurement system, we used fractions regularly in everyday numeracy tasks. However, we now tend to speak in decimals, rather than fractional quantities. Underpinning this is a keenness to dismiss topics on the basis that we might not regularly use those skills (as adults). This is a flawed argument.

- The first part of this erroneous belief is that you only need to learn things because they have some practical or ongoing use; learning is far richer and more interesting than this narrow view.
- The second aspect is mathematical – where topics (which one may or may not directly use) develop other concepts which are not necessarily taught separately. For example, proportionality is a fundamental concept of mathematics, and is developed through topics such as fractions and division. Therefore, in not teaching one (e.g. fractions), the second (e.g. proportionality), fails to sufficiently develop. With a subject like mathematics (and science), the knowledge itself is important in developing conceptual understandings. A teacher with solid mathematics themselves understands and appreciates this point, and realises that not all learning has a direct application – but can simply provide a bridge to further learning. We do our students a disservice if we only teach content with a direct application, but to appreciate that, you need a deep understanding of the curriculum area.

Secondly, mathematically, fractions are a division problem. A teacher needs to understand this to develop the concept from earliest 'hands on' activities, so that misconceptions are not instilled. Students often develop misconceptions around fractions and division (and a range of other topics) due to incorrect language being used, and in

some cases, taught explicitly. Too often the words 'share' or 'sharing' are used in tasks when the better word would be, 'divide'. Unless deliberately connected, many children fail to make the connection between 'sharing' and 'dividing'. Too many pre-service teachers fail to correctly name a fraction – describing a quarter as "*one over four*", with genuine confusion about the '1' and the '4' being whole numbers. Likewise, mathematical misconceptions are developed by terms such as 'borrow' and 'carry', when the correct language of regrouping can easily be understood by children. However, this necessitates that their teacher understands regrouping, and has an in-depth understanding of place value, which they can impart to their students.

Many early childhood and primary school teachers lack the mathematical competence to teach the more complex areas of fraction and division. In workshops I have run over the years, nearly all teachers and pre-service teachers have struggled to create fractional and decimal representations – for example, using paper strips or straws. Once they've engaged in those activities, they bemoan not having done so before, determined to ensure children in their own classes have such fundamentally important experiences.

As a presenter of professional development, it's been a challenge to see teachers struggle, or, worse still, give up on the tasks, when they are responsible for the mathematical development of their own students. Too many wear the 'I am not good at maths' tag with inappropriate pride. In three day courses, over a spaced-learning model, attending teachers were provided a pre-test and post-test so they could identify their own skill improvement. On more than one occasion, early childhood teachers failed to attempt a single question, painfully aware of their own inadequacies. This was despite knowing the test result was private, and solely for their own information and professional development.

It is not uncommon for the less mathematically to be drawn to early childhood teaching, rather than primary teaching, which shows a tragic lack of understanding of the importance of early childhood education. There is a strong argument that we need our very best teachers with our youngest students, both to insulate them from misconceptions, and to provide the necessary foundations.

### WHERE TO FROM HERE?

We need a major focus back on concepts and topics like fractions and division within the primary curriculum. Good teachers want a tight curriculum that specifies content, skills and knowledge, and ensures a linear and sequential design. Mathematics is linear, and concepts build on preceding ones; a reality that effective teachers not only understand, but use to help students make progress. It

is well known that “to go forwards you sometimes need to go backwards”, in mathematics teaching, or for students, having gaps which, if large, result in stalled academic progress. Our old, discarded syllabus documents did this superbly for many years, providing well structured, linear approaches to developing knowledge, skills and understandings. Sadly, in faddish times, these documents were removed from use, in many places replaced by nebulous documents which needed to be “unpacked” to make sense. The new Australian national curriculum offered great hope, but seems likely to be too broad and global to be of real use.

It is the combined duty of mathematicians and mathematics educators to collaboratively create, for practitioner use, a detailed, high quality syllabus. Needless to say, such a document will need to be adapted for local use, but might well begin to address the significant variations in expectations in different locations. Such a document should not need to be “unpacked”; it should be clear, concise and ready for practitioner use. As an example, Western Australia’s recent curriculum documents all required multiple in-services just to be able to make sense of them, contrasted with outstanding documents such as the Singapore Mathematics syllabus which many Western Australian teachers clandestinely downloaded and used.

We need to ensure that our teachers have both the pedagogy to teach well, but also the content knowledge to deeply understand the mathematics. We cannot have teachers who wear that “*I am not good at maths*” tag with pride; they must be both motivated and required to develop their skill set to a level of professional competence, or they should not carry the accreditation to teach. They are doing untold damage to long term educational outcomes and national good.

For too long we’ve hidden incompetent teachers, and failed to provide the necessary content training to enhance their professional skills and knowledge. We cannot continue with such a system, in particular, as entrants to teaching nationally do so with lower and lower minimum entry standards. In many institutions, the entry requirements are so low that failing every Year 12 subject, or completing only vocational training courses, will meet the requirements for entry into teaching.

This has, and will continue to, result in the public devaluing teachers as a professional group, and this in turn, will discourage bright and capable school leavers from pursuing a career in education.

Two years ago, I experimented with an Australian contextualised version of the UK teacher competency testing, required for their teacher registration. The test was simple - ten questions - numeracy based, with real life problems teachers would deal with on a daily basis (e.g. recording marks, excursion costs) and could be completed in fifteen minutes at a staff meeting, with staff then left to privately mark their own, to gauge their skill set. Despite providing this test to a number of colleagues and schools, I am not aware that it was ever used, and the reason is plainly clear; a low standard of performance was accepted as the natural outcome. Moreover, the schools perceived there was little they could offer as content-based professional development, which is only partially correct. There are a wide range of free online programs, and systems and sectors could easily provide content courses, if teachers were both willing and required to engage. It is easy to appreciate the concern that current teachers might have identifying their lack of skills. Far easier is having content knowledge testing, prior to awarding certification, and renewal, to ensure that new graduates, and current teachers, have taken up opportunities to develop their own mathematical knowledge and skills.

How long do we carry an ineffectual teacher?

How long do we leave cohorts of students to be damaged by an incompetent teacher?

The outputs of Siegler’s research team, has a very positive use through the identification of the topics that are of pivotal importance for long term success. This is knowledge which can position us to achieve significant improvement with student outcomes.

### REFERENCES

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## Why music really matters

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As we move forward, there is much need for some national direction on the teaching of the Arts. The current work on the Australian national curriculum documents, for the Arts, is a sign of great hope. The time is opportune for a review of the role of music in child development outside the narrow dimensions of the place of “music” as a subject.

The importance of music has long been understood by Early Childhood and Primary teachers. Early Childhood teachers, in particular, have traditionally embedded music into daily teaching and learning routines. Songs, dance and movement to music have been much loved activities. Instruments have had a place encouraging improvisation with a joyous lack of sophistication. Many teachers’ understandings were simply intuitive while others grasped the central importance of music. Of perhaps greater importance, participation brought children and teachers together in group experiences that encouraged each child to participate and communicate.

Anecdotally, we know that many high achieving students develop music as a central part of their broader development. It is fascinating

to find the number of doctors who play an instrument at a standard that could have led to an alternative professional career had they so chosen. There has been much speculation over the relationship between music and mathematics, and music more generally, with academic achievement. We also know that, as in every aspect of learning, these correlations do not, necessarily, indicate causality. This observation does not diminish the value of music more generally nor does it diminish the role that learning has in the building of an inventory of skills in the art of learning.

As music became devalued in many schools and as music specialist teachers became hard to find, it was frequently replaced by other subjects seemingly in ignorance of the value music offers to brain development for wider academic success. Many of these other subjects are isolated and self-contained, with little leakage to learning in other areas of the curriculum. Too often, they are denigrated to be simply mechanisms to provide the required “non-teaching times” for classroom teachers.

There is significant research showing that music and mathematics



success do go together for many students. Learning an instrument seems to be an indicator of academic achievement. There are four fundamental reasons why music is important to academic success, particularly in mathematics.

Firstly, research demonstrates that self-discipline is a better predictor of academic success than an IQ score. In order to develop self-discipline a student must be willing to delay instant gratification and, instead, strive with persistence for longer term goals. Numerous studies have highlighted that children as young as four, who are able to delay gratification are more successful in later academic achievements. There are few easier ways to delay gratification than learning a musical instrument. Learning to play a simple piece can demand hours while mastery requires far more. The better you get and the more complex the piece, the greater is the time required. There is a widely held view that there are 10,000 hours of practice required for proficiency in any pursuit. Children learning an instrument understand the hours of practice required to achieve high standards. They also gain continuing satisfaction derived from the recognition of significant adults.

Secondly, music and mathematics (and the sciences in general) are essentially all about patterns. In mathematics, when we understand the patterns it can all make sense. Mathematical high achievers all seem to share the characteristic of having an aesthetic experience, a cathartic moment, of discovering the beauty of mathematics, by seeing patterns that exist. It is this curiosity, aroused by pattern seeking, which leads one to become engrossed in a subject that others find dull and uninteresting. Likewise, music is intrinsically about patterns. When you understand the patterns within music, music is a joy to behold and the skilled musician understands the patterns of their instrument and sound. Competence with mathematics requires, as music does, repetition, practice and a willingness to delay instant gratification. The importance of rote learning in both subjects cannot be underestimated.

Thirdly, newer findings for neurology, confirm the relationship between music, mathematics and academic achievement. The human brain seeks patterns and seeks familiarity, using these assets to stream out external stimuli, including external noises. Humans seek out, and depend on patterns to make sense of their world. In 1869, the Russian chemist, Dmitri Mendeleev, created order in the chemistry of the elements in his periodic table. His historic work in pattern recognition was fundamental to the development of our understanding atomic and molecular structure. Music develops the auditory cortex, thalamus, and superior parietal cortex. More importantly, all three are critical for the development of pattern understanding and appreciation. Brain imaging shows that students working musically use these three parts of their brain. Research demonstrates the brain benefits of music and learning an instrument, with several studies also noting the capacity of music training to safeguard the brain against aging and disease.

Fourthly, the playing of music by the young creates natural interest in the composing of music. Creativity is lessened in much of the prescription that is modern schooling. Children's creativity is an asset that must be nurtured and maintained. Experimentation with the creation of students' own music should be strongly encouraged. Creativity is central to problem solving, which is, in turn, central to mathematics and science.

Whether students are successful with music, or persevere, will depend on many factors. A key factor is the quality of the teaching which occurs; great teachers inspire learners to persist, and provide learning which builds confidence and provides opportunities for students to make progress, and to enjoy Music. Sadly, many

students cease with Music, directly as a result of the teacher-student relationship, or when the quality of teaching is lacking. Quality Music teachers are a rare group – they are musically skilled, have excellent pedagogy, and, most importantly, have the personal attributes to build an excellent relationship with their students. Unfortunately, in many teacher education programs little time is devoted to the Music learning area, and that much of the career path is part time work (or requires working across schools) is limiting. When we fully value the worth of Music, we can find ways to deal with those structural issues.

Music nurtures self-determination while developing those parts of the brain relating to patterns, a pivotal asset in learning with unique application to mathematics, music and science. Music thus has a special place in school curricula. Beyond all these relationships in the learning of music, it creates heightened auditory skills. Additionally, students learn to count time and experience rhythm and beat. Auditory processes are one of the elements of human communication essential to both learning and teaching. There is much in common between learning music and the study of another language. Music is a language itself. Whilst some children are innately more musically capable than others, consistent, rich and regular musical learning experiences are central to a well-balanced curriculum, particularly from birth to twelve, when development occurs at such a rapid rate.

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