Mathematics Education Research Journal (2022) 34:767–787
https://doi.org/10.1007/s13394-020-00361-8

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Mathematics success against the odds: the case of a low socioeconomic status, rural Australian school with sustained high mathematics performance

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Received: 8 April 2020 / Revised: 14 November 2020 / Accepted: 17 November 2020 /
Published online: 12 January 2021

Abstract
Mathematics education is seen as a right for all children, and important to ensure a prosperous future. However, in Australia and other nations, rural students and students from low socioeconomic backgrounds both perform less well in mathematics and are less likely to pursue advanced mathematics. This paper presents a case study of a low socioeconomic status, rural government school that has high engagement and achievement in senior mathematics, despite its setting. The study uses a conceptual framework informed by Appreciative Inquiry and the theory of Practice Architectures to explore the activities and facilitatory elements that have likely contributed to the school's mathematics success. Rather than being attributed to one or two key programmes, the school's mathematics success seemed associated with a collection of whole-school factors. Setting high expectations while providing proactive learning support, differentiating instruction, emphasising the value of mathematics, linking mathematics to careers, and building mathematics teacher capacity were all associated with the school's higher than expected mathematics performance. Rather than hindering the school's mathematics programme, its small size and rural context were used to enable practices that contributed to mathematics success.

Keywords Mathematics education · Rural education · Socioeconomic disadvantage · Strengths approach · Secondary school

Mathematics education is seen as a right for all children, and important to ensure a prosperous future. However, in Australia and other nations, rural students and students from low socioeconomic backgrounds both perform less well in mathematics and are less likely to pursue advanced mathematics. This paper presents a case study of a low socioeconomic status, rural government school that has high engagement and

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achievement in senior mathematics, despite its setting. The study uses a conceptual framework informed by Appreciative Inquiry and the theory of Practice Architectures to explore the activities and facilitatory elements that have likely contributed to the school's mathematics success. Rather than being attributed to one or two key programmes, the school's mathematics success seemed associated with a collection of whole-school factors. Setting high expectations while providing proactive learning support, differentiating instruction, emphasising the value of mathematics, linking mathematics to careers, and building mathematics teacher capacity were all associated with the school's higher than expected mathematics performance. Rather than hindering the school's mathematics programme, its small size and rural context were used to enable practices that contributed to mathematics success.

Mathematics is widely viewed as important for critical citizenship (Goos and Kaya 2020), and there is a call for a workforce with strong mathematics skills and associated skills in data analysis, coding, and engineering (Australian Industry Group 2015; Morgan and Kirby 2016). At the same time, the governments of many nations express concern about low student participation and achievement in mathematics, including the USA (Committee on STEM Education 2018), the UK (House of Commons Science and Technology Committee 2017), and Australia (Education Council 2018). The 2018 *Programme for International Student Assessment* (PISA) testing shows that only 15 of the 51 participating nations have an established trend of improvement in mathematics performance, and 14 show a sustained negative trend in mathematics performance (OECD 2019). The USA and the UK have no significant average trend over more than a decade, while Australia is amongst the nations with a negative trend in mathematics performance. This underperformance in mathematics is generally more pronounced amongst rural students. On average across the OECD countries, students in city schools outperform students attending rural schools, though in some countries, including the UK and the USA, rural students do better than their urban counterparts (Echazarra and Radinger 2019). In Australia, metropolitan grade 8 students significantly outperform their non-metropolitan counterparts in mathematics (Thomson et al. 2017b). In Victoria, when completing the Victorian Certificate of Education[1] (VCE), rural students are less likely to participate in advanced mathematics subjects, such as Specialist Mathematics and Mathematical Methods, and more likely to enrol in elementary mathematics subjects, such as Further Mathematics (Murphy 2019a). Further, metropolitan students outperform students attending rural schools in all VCE mathematics subjects (Author 2019).

The underperformance of rural schools in mathematics is attributed to various factors. Some studies suggest rural students feel less competent and less engaged in mathematics, and that their mathematics teachers are less supportive (Hardre 2011). Rural students and their parents tend to have lower educational aspirations (Centre for Education Statistics and Evaluation [CESE] 2013), so may be less likely to pursue mathematics as a pathway to further study. It is also difficult to recruit and retain qualified mathematics teachers in rural areas, and to provide these teachers with appropriate professional learning (McPhan and Tobias 2011). While the underperformance of rural schools in mathematics is

[1] The Victorian Certificate of Education (VCE) is generally completed by Victorian students across the last 2 years of secondary school (Victorian Curriculum and Assessment Authority [VCAA] 2020). Results from the final year of the VCE are commonly used by tertiary institutions to determine student entry into further education (Victorian Tertiary Admissions Centre 2016).

relatively well investigated, there has been only limited research into factors that improve mathematics education in rural contexts. The majority of this focusses on effective professional learning for rural mathematics teachers (e.g. Goos et al. 2011; Jorgensen 2016; Pegg and Panizzon 2011).

This paper contributes to addressing the dominance of a deficit view of rural mathematics education in the literature by presenting a case study of a low socioeconomic status rural Victorian government school, referred to here as Sweeping Plains College, that has had sustained high participation and high achievement in VCE mathematics. The paper explores the mathematics education practices of Sweeping Plains College, along with the factors that enabled these practices, addressing two research questions:

1. What mathematics education practices contributed to the sustained mathematics success of Sweeping Plains College?
2. What factors enabled the practices contributing to Sweeping Plains College's sustained mathematics success?

This study was part of a wider research programme investigating the practices of high STEM performing rural schools (Author 2020a).

Literature review

Mathematics performance in rural schools

The impact of rurality on student performance in mathematics varies internationally. On average, students attending rural schools tend to perform more poorly than students from metropolitan areas (Echazarra and Radinger 2019). A study of PISA 2000 data found that a linear relationship between mathematics and community size was most common internationally (Williams 2005). The same study also found that socioeconomic status accounted for the underperformance of rural students in all but 4 of the 24 countries examined. In the USA, socioeconomic factors seem strongly associated with mathematics performance, with students from disadvantaged rural and urban school underperforming compared to students from relatively advantaged suburban areas (Graham and Provost 2012). A study of Latin American countries found that urban students on average scored higher than rural students in mathematics tests; however, after adjusting for student background, rural students outperformed urban students in Argentina, Chile, and Peru (Luschei and Fagioli 2016). An Australian study found that non-metropolitan locations may have a moderating effect on the impact of socioeconomic status on achievement in senior school mathematics (Murphy 2019a).

Similar to rural students in many countries internationally, rural Australian students score lower in mathematics tests than their urban counterparts in mathematics. PISA testing suggests the average gap between metropolitan and rural 15-year-olds is the equivalent of a year or more of learning in mathematics, and that metropolitan schools have a far larger proportion of high-performing students compared to rural schools, and significantly fewer low-performing students (Thomson et al. 2017a). *Trends in International Mathematics and Science Study* (TIMSS) testing suggests that both grade 4 and grade 8 rural students also underperform in mathematics relative to metropolitan students (Thomson et al. 2017b). The 2016 *National Assessment Program – Literacy and Numeracy*[2] (NAPLAN), which aims to test all Australian children, showed that average grade 3, grade 5, grade 7, and grade 9 numeracy results deteriorated the further students lived from major cities, while the proportion of students just at or below national minimum benchmarks increased dramatically (Australian Curriculum Assessment and Reporting Authority [ACARA] 2017). On average metropolitan schools had higher results than non-metropolitan schools in every grade 12 mathematics subject offered in Victoria from 2014 to 2016 (Author 2019). Further, non-metropolitan students are more likely to enrol in entry level mathematics, and less likely to take advanced mathematics, when offered, than metropolitan students (Murphy 2019a). Similar disparity in the participation of rural students compared to non-rural students is observed in the USA (Anderson and Chang 2011) where an analysis of National Assessment of Education Progress (NAEP) data showed rural students earned credit for fewer years of high school mathematics than other students.

Factors impacting rural school mathematics performance

There are a range of factors believed to contribute to the underperformance of Australian rural schools in general, including the socioeconomic status of rural communities, smaller school size, higher proportions of Aboriginal students, high teacher turnover, school isolation, and lower educational expectations (CESE 2013). These factors interrelate and interact, impacting the learning and opportunities of rural students (Halsey 2018).

The literature points to various interrelated factors particularly impacting mathematics education in rural schools, including access to mathematics subjects, mathematics teacher capacity, demands on mathematics teachers, and learning expectations. Rural Victorian schools are less likely to provide their students with access to advanced mathematics subjects (Author 2019). Where rural schools do provide advanced mathematics, they are more likely than metropolitan schools to run these classes as combined classes where grade 11 and grade 12 students are taught in the same group (Lyons et al. 2006). Teachers, school leaders, and parents alike do not view such composite classes as desirable (CESE 2013). In particular, composite class arrangements are felt to deliver inadequate preparation and learning time, and poorer academic achievement. Rural students view composite classes as a deterrent to enrolling in advanced senior mathematics classes (McPhan et al. 2008). Differentiated instruction is sometimes promoted as a mechanism for responding to the challenges of composite classes in rural schools (Goddard et al. 2019). However, the evidence for the impact of differentiated instruction in rural mathematics classrooms is scant. One study of 22 Swiss rural schools found that differentiated instruction is rarely practiced, and where it is, there is no conclusive positive impact on student mathematics achievement (Smit and Humpert 2012). Distance education is also more likely to be employed in rural

[2] The National Assessment Program – Literacy and Numeracy (NAPLAN) aims to assess all Australian grade 3, 5, 7, and 9 students' abilities in Literacy and Numeracy (ACARA, 2017). NAPLAN tests are set and assessed centrally, and all schools administer the tests over the same 3-day period.

schools, and is viewed unfavourably by students, as it is seen to require more self-discipline and effort (CESE 2013; McPhan et al. 2008).

A partial explanation for rural schools' poorer mathematics performance is the difficulty rural schools have in staffing these subjects (Prince and O'Connor 2018; Weldon 2016). Rural schools have difficulty recruiting qualified mathematics teachers (Handal et al. 2013). The further a school is from a metropolitan location, the more likely it is to run subjects taught by out-of-field teachers, particularly in mathematics (Weldon 2016). Rural schools also have difficulties building the mathematics teaching capacity of their staff. Mathematics teachers in rural schools report they have limited opportunities for professional networking and poor access to professional learning opportunities (Handal et al. 2013; Pegg and Panizzon 2011). Rural school mathematics teachers report higher levels of unmet professional development needs than mathematics teachers in metropolitan schools (Lyons et al. 2006).

Rural schools confront difficulties in maintaining high learning expectations, particularly in mathematics. Rural students, and their parents, tend to have lower expectations that they will progress to tertiary education (CESE 2013). Rural mathematics teachers raise concerns about the challenge of holding high learning expectations where local employment opportunities do not require strong academic achievement (Pegg and Panizzon 2011). The smaller size of senior mathematics classes in rural schools poses difficulties in establishing appropriately high benchmarks for student achievement (Pegg and Panizzon 2011). Sustaining high expectations requires a broad range of curriculum offerings and opportunities for extension (CESE 2013), both of which rural schools struggle to offer, particularly in mathematics (Murphy 2019a). Rural students themselves nominate restricted senior school offerings and a lack of high performance expectations amongst peers as factors contributing to lower career aspirations (CESE 2013).

Mathematics education success in rural schools

There is a dearth of published research into successful mathematics education in rural Australian schools, or in similar contexts internationally. The little that is available focusses either on effective professional development for rural mathematics teachers or on utilising the strengths of schools' rural locations and communities to enhance mathematics learning.

Research literature argues that mathematics professional development for rural teachers should have particular characteristics. Effective professional development for rural mathematics teachers connects them to other teachers and supports them to learn as part of active, collaborative teams (Elle and Meissel 2011; Goos et al. 2011; Pegg and Panizzon 2011). This learning should be ongoing, and driven by local demands, such as student learning needs or other teacher-identified issues at their schools (Jorgensen 2016; Pegg and Panizzon 2011). Professional learning for rural mathematics teachers requires shared respect, trust, and autonomy, and should be supported by experienced staff with high levels of content and pedagogical expertise (Jorgensen 2016). Effective professional learning for rural mathematics teachers is also supported by adequate time and space (Goos et al. 2011; Pegg and Panizzon 2011). While none of these characteristics is particularly rural in nature, these findings highlight that rural mathematics teachers need to be professionally empowered to work together to respond to the particular learning needs of the students in their schools.

Other literature suggests that the characteristics of rural locations and communities can be used to enhance rural mathematics education. There is evidence from the USA that local rural contexts and partnerships with local organisations can be used to enrich student learning in mathematics (Avery and Kassam 2011; Clark et al. 2015; Hardre 2011; Howley et al. 2013; Ihrig et al. 2018), though there is very limited evidence in Australian contexts. Hardre (2011) argues that the close community relationships typical of rural locales provide opportunities to improve rural mathematics education. There is minimal mathematics education research to support this assertion; however, there is solid general education research that suggests this may be the case. Strong family-school connections and supportive relationships between rural schools and their communities can positively impact the educational outcomes of rural students (Barley and Beesley 2007; Halsey 2018; Hardre et al. 2009; Semke and Sheridan 2012). Rural students' relationships with their friends and support from their teachers are strong predictors of aspirations (Watson et al. 2016). Teacher support is a strong predictor of student motivation (Hardre et al. 2009). Unfortunately, Hardre's (2011) study of 25 rural American secondary schools found that rural mathematics teachers have a relatively poor understanding of how motivated their students are, and how to motivate their students, compared to teachers of other disciplines, and their students perceive them as relatively unsupportive.

Conceptual framework

The research programme that this study is part of was guided by a conceptual framework informed by aspects of Appreciative Inquiry and the theory of Practice Architectures. Appreciative Inquiry is an approach to organisational research that assumes "in every society, organisation, or group, something works" (Reed 2007, p. 18), and that an understanding of these strengths can inform future improvements. In this research, the "something" that "works" is rural schools performing better than expected in STEM subjects, including mathematics. Appreciative Inquiry adopts a positive orientation to enquiry, inviting participants to explore achievements, rather than to examine problems, as a way to engage participants for longer and more deeply (Reed 2007). Further, Appreciative Inquiry draws on a social constructivist orientation, assuming individuals' personal understandings of the world shape their practice, while at the same time their practices shape elements of this world (Reed 2007). Informed by this, principals, teachers, and students in this study were viewed as having unique personal understandings of the practices contributing to their school's success, and as contributing to the factors that shape these practices.

To systematically analyse practices that contributed to the school's STEM success, and the factors that enabled these practices, the conceptual framework draws on some aspects of the theory of Practice Architectures (Kemmis et al. 2014). Practices are socially recognisable activities that involve distinctive actions (*doings*), understood through characteristic discourses (*sayings*), enacted by actors that relate to each other and the wider world in characteristic ways (*relatings*) (Rönnerman and Kemmis 2016). The theory of Practice Architectures holds that these three elements of a practice, *sayings*, *doings*, and *relatings*, are interconnected and "hang together" (p. 95) in a distinctive form (Rönnerman and Kemmis 2016). In order to understand practices, it is also necessary to understand the practice architectures that prefigure them. Practice architectures are composed of three corresponding arrangements: cultural-discursive arrangements, material-economic arrangements, and social-political arrangements (Kemmis et al. 2014). Like the three elements of practice, these arrangements interact with, and impact upon, each other. Cultural-discursive arrangements directly shape *sayings* and include the traditions, theories, and jargon of education. Material-economic arrangements most directly influence *doings* and include both products and the processes of production, such as facilities, resources, budgets, timetables, and unit plans. Socio-political arrangements are comprised of social networks and power relationships and impact upon *relating* aspects of practices. It is important to note that not only do practice architectures prefigure practices, practices themselves shape practice architectures (Kemmis et al. 2014). Sayings can overtime become traditions, doings can have material impacts, and relatings can alter social networks. The relationships between the elements of practice and associated arrangements are summarised in Table 1. By identifying and analysing the practices contributing to rural school success in mathematics, and STEM more broadly, as well as the practice architectures that enabled these practices, this research developed a comprehensive understanding of the factors contributing to high STEM performance in rural schools.

Method

Broader research programme

As noted above, this study is part of a broader research programme investigating the practices of high STEM performing rural schools (Murphy 2020a). As part of this programme, several rural Victorian government schools were identified as high STEM performing through the analysis of senior school enrolment and achievement data. These schools were then studied to understand the factors that had contributed to this STEM success. This research found that participants at the different rural schools' emphasised the role of different aspects of the curriculum in accounting for their schools' high STEM performance, for example science (Murphy 2020b), or environmental education. Only participants at one school, Sweeping Plains College, reported that mathematics was central to the school's STEM success. While participants from Sweeping Plains College were asked questions about the contributors to the success of their STEM education programmes, they most often gave responses that focussed solely on mathematics education. This paper is concerned with the practices contributing to Sweeping Plains College's success in mathematics education.

Case selection

Using Victorian Certificate of Education (VCE) participation and achievement data, Sweeping Plains College was selected for this case study as a rural Victorian government school that sustained high mathematics enrolment proportions (compared to all VCE subjects undertaken), and high mathematics study scores, from 2014 through to 2016 (see Table 2). Sweeping Plains College was a rural co-educational P-12 school with 136 students in 2016, 41% of whom were in the primary school, and 59% in the secondary school. Five percent of students identified as Indigenous Australian or Torres Strait Islander, and 1% had a language background other than English. The Index of Community Socio-Educational Advantage (ICSEA)[3] for the school was 963 (ACARA 2015), indicating the average Sweeping Plains College student came from a relatively low socioeconomic background compared to the rest of Australian students. Sweeping Plains College served a farming community more than 200 km from Melbourne and more than 100 km from the closest regional city. The nearest independent secondary school was approximately 1 h and 20 min drive away; however, there were five other government secondary schools within a 30 min drive. These government schools collaborated as part of a network, sharing resources including the Technical Trade Centre (TTC) built on Sweeping Plains College's site.

From 2014 to 2016, the school's average achievement levels were well above the state average in all mathematics subjects. Table 2 shows that the enrolment proportions were well above state average in Mathematical Methods, and Specialist Mathematics, and slightly below state average in Further Mathematics, counter to the trend of rural students choosing less advanced mathematics (Author 2019). As Sweeping Plains College is a small school, the cohort responsible for achieving these strong mathematics results comprised just 25 students who completed VCE from 2014 to 2016. This cohort achieved a mean study score of 31.7 across all grade 12 VCE subjects. NAPLAN data shows that in grade 5 this cohort's results were similar to the state average in numeracy (489 compared to 492) but above state average in grade 7 (571 compared to 551) and in grade 9 (616 compared to 604). Sweeping Plains College attracts additional enrolments at the beginning of secondary school, causing an average 67% increase in student numbers from grade 6 to grade 7, which may account for the improvement in grade 7. However, an investigation of the publicly available grade 5 NAPLAN data from the school where most of the additional enrolments come from suggestion that recruitment is unlikely to be the explanation for the increase in Sweeping Plains College's numeracy performance at grade 7.

Participants

Once the principal agreed for the school to participate in the study, he extended an invitation to all teachers of secondary school mathematics, science, or technology to participate in interviews using participation information sheets and consent forms provided by the researcher. The principal and six staff teaching across mathematics, science, and technology subjects gave consent to be interviewed (see Table 3), representing 46% of the staff teaching these subjects. The principal also invited all students currently studying grade 12 level mathematics, science, or technology to participate in a student group interview. Six female and six male students, representing 100% of potential student participants, gave consent to be interviewed. After the researcher's school visit, the principal forwarded a link to an anonymous online survey

[3] The ICSEA is a measure of social advantage calculated for each Australian school, factoring in parental occupation and income, as well as school remoteness, proportion of Indigenous students, and proportion of students from language backgrounds other than English (ACARA, 2015). The ICSEA has a mean of 1000 and a standard deviation of 100.

to all teachers of secondary school mathematics, science, or technology. Five teachers, or 38% of the teachers of mathematics, science, and technology subjects, took the opportunity to complete the survey.

Data collection

Data were collected from various sources. School-level quantitative data were obtained about participation and achievement in VCE subjects in 2014, 2015, and 2016 from the Victorian Department of Education and Training (DET). Publicly available National Assessment Program – Literacy and Numeracy (NAPLAN) data for the relevant cohorts were extracted from the MySchool website (Australian Curriculum, Assessment and Reporting Authority [ACARA] 2019). Qualitative data were gathered during site visits through semi-structured interviews with participants (Gideon and Moskos 2012). The teachers and the principal were interviewed individually and were asked open-ended questions about perceived contributors and impediments to STEM education success at the school. These questions included "What do you feel are the largest contributors to student engagement in STEM at your school?"; "What about the contributors to achievement?"; "How do you think the elements contributing to your school's success in STEM were developed?"; and "How are these elements maintained?" Students were interviewed as a group and asked open-ended questions about their learning experiences and participation in STEM. These questions included "What are some of the best learning experiences you had studying Science, Maths or Technology before you began VCE?"; "Describe how the teachers of Science, Maths and Technology teach at your school"; "Describe how the students at your school learn Science, Maths and Technology"; and "How does your school encourage student interest in STEM?" All interviews took place in the school's careers room and varied in length from 20 to 40 min. The interviews were recorded and transcribed, and the transcripts were used for analysis. The school's annual report, college profile and philosophy, student subject selection booklet, and timetable were also collected for analysis. The researcher also toured the school accompanied by the principal, taking field notes and photographs of resources, displays, and facilities. Additional quantitative and qualitative data were collected from staff using an anonymous online survey. Volunteer sampling (Hibberts et al. 2012) was used. All STEM teachers were invited to complete the survey after the researcher had visited the school, via an email with a link to the survey, forwarded by the principal.

Case analysis

An explanation-building approach to analysis was employed for the case analysis (Yin 2014), where a set of causal links were sought to explain how and why Sweeping Plains College had achieved its mathematics education success. Qualitative data was analysed using thematic analysis (Braun and Clarke 2006). Data was coded using both deductive and inductive themes (Braun & Clarke). Initially, data was coded into practice elements (sayings, doings, or relatings) or practice architecture (cultural-discursive, material-economic, or socio-political) categories. Following this, inductive themes were identified through iterative engagement with data coded as relating to practices and practice architectures, a process Braun and Clarke describe as "organic thematic analysis" (p. 741). Five themes relating to practices emerged through this process: high expectations with support, differentiated instruction, valuing mathematics, careers education, and building teacher capacity. Seven themes relating to practice architectures emerged: rural location and small size, strong relationships, strong learning culture, local school network, unconventional timetabling and programming, resourcing, and staffing.

The quantitative data was analysed descriptively to corroborate and extend understandings gained from the qualitative data sources. The use of multiple sources of qualitative and quantitative data allowed for triangulation of findings (Yin 2014), enhancing the overall credibility of the study (Tracy 2010).

Results

The following results are presented in line with the conceptual framework developed for this research. Informed by elements of Appreciative Inquiry, the various perspectives of participants are given primacy through presenting the views of students, teachers, and principals in their own words. Informed by aspects of the theory of Practice Architectures, the sayings, doings, and relatings contributing to the school's success are treated as interrelated and inseparable elements of a practice. Practices contributing to Sweeping Plains College's mathematics success are discussed as whole entities rather than a sum of parts. Similarly, the cultural-discursive, material-economic, and social-political arrangements enabling these practices are not discussed separately, but rather as Practice Architectures.

Mathematics education practices contributing to Sweeping Plains College's mathematics success

While the broader research project this case study is part of explored STEM education (Murphy 2020a), thematic analysis of Sweeping Plains College interviews revealed a common focus on mathematics education. Of the themes to emerge, two—differentiated instruction, and valuing mathematics—were specific to mathematics education. Three other themes (high expectations with support, building teacher capacity, and careers education) were seen to impact significantly on mathematics education at the school. The following sections explore practices captured by these five themes.

High expectations with support

Several of the practices were associated with holding high learning expectations in mathematics while proactively providing learning support. In grade 10, many students are challenged to accelerate into VCE mathematics. Karen felt that this impacted on students' expectations for themselves, noting that "the ones that get pushed up know then, okay yeah I am here … because I've been performing and I can perform that little bit higher" (numeracy leader). These expectations that students take responsibility for their own learning progress in mathematics extend to pre-secondary school. Karen said, "Even in the six class that I've got at the moment, the students are very much in charge of their learning" (numeracy leader). Concurrent with holding high expectations for learning, the mathematics teachers are proactive in providing students with support. One student said, “Teachers will always offer assistance after school and they recommend it sometimes… Certainly does help you out, that’s for sure”. Another commented, “You get help whenever you want. After school you can go and see them, they’re pretty flexible”. Gerty said, “I think everyone’s kind of willing to put in that extra, because you kind of get that close relationship with the students, and want to see them thrive more” (teacher). This support was perceived to significantly impact student mathematics achievement.

Differentiated instruction

Potentially perceivable as a mechanism for holding high expectations with support was the use of a variety of strategies to differentiate instruction, in order to meet each student’s needs in mathematics. From grade 4 on, the mathematics programme involves students taking ownership of their learning and working in flexible arrangements at their own ability level and pace. Karen explained, “They’re building at a very early age that knowledge of, ‘okay there is more to learn and I can’, and building that independence and actually working towards achieving their goals and learning more and more” (numeracy leader). Pre-testing is used to help students set learning goals. They then access their learning programme via Google Classroom. The teachers make use of online videos, software, activities, games, and small-group instruction to resource the programme and support student learning. Student learning is monitored publicly. Karen described this:

> All their learning intentions [are] on a grid for the kids to see. It’s a visual thing with their name on the bottom, [they] colour in what they can do… and their goals are in a light colour... And they just go from one skill to the next as they progress… So today when I wrote on the board, I had I think about nine different things that people were doing in a classroom of… about 20 kids.

Several students commented positively about the differentiated mathematics instruction in the middle years. One student said, “You wouldn’t have to be doing things with kids that were at a lower level of maths and you would be able to learn the things that you needed to rather than keep going over the same sort of stuff that another group wouldn’t be at”.

In grade 10, many students at Sweeping Plains College accelerated into grade 11 level VCE General Mathematics. This was perceived to provide a good opportunity for advanced students, as well as facilitating more effective support for students finding mathematics difficult. Students continue to receive differentiated support through their senior years; however, this is more often through additional out-of-class assistance.

Valuing mathematics

The teachers also invested significant effort in encouraging students and their families to value mathematics and mathematics education. Regular mathematics columns in the school newsletter promoted mathematics activities and the achievement of students. Fortnightly mathematics awards were presented at school assemblies for effort and achievement. Students were supported to participate in an array of external mathematics competitions and activities. Every few years, Sweeping Plains College hosted a whole-school mathematics day. These activities were perceived to enhance the value placed on mathematics amongst students and parents.

The utility value of mathematics education was also emphasised. There was a focus on explaining how each aspect of mathematics is used in the real world. Adrian said, "I think as teachers, when we teach maths… we always try to use real-life situations for problem-solving" (teacher). Karen and Craig spoke about explicitly writing on the board why students are learning the mathematics that is the focus of that particular lesson. Various teachers spoke about adjusting their mathematics learning programmes to respond to student interest in topics such as taxation, finances, and farming, noting that this improved student engagement. The students felt this practice made the mathematics more relevant and easier to learn. One student said, "She'd relate it back to real life as well so it made it more relatable". Another comment was, "He just related it back to real life, which always makes things a lot easier to remember". In addition to exploring the real-world applications of mathematics, the staff also emphasised the utility value of studying mathematics for accessing further study and/or particular careers. Gerty offered her reflection on this pragmatic approach:

> Whatever you do you're going to need the maths, so there's got to be something that you have to, not necessarily enjoy, but at least persevere with… the fact that most of our kids do VCE maths, … the majority of them can see that maths is going to be involved in their job, some sort of maths. (teacher)

Subjects outside the mathematics programme were understood to further highlight the value of mathematics. Paul spoke about the role of mathematics in the Vocational Education and Training (VET) programme, "You've got to include numeracy everywhere… Numeracy is paramount. So it's imperative that the students, especially in engineering, have numeracy competency" (technologies leader).

Teacher capacity

The school invests in building the capacity of its mathematics teachers through a range of mechanisms. The mathematics staff regularly meet as a numeracy professional learning community (PLC) where they engage in targeted professional learning activities to meet school needs. Sometimes the PLC explores mathematics content, such as word problems and numeracy fluency. At other times, they consider the mathematics learning needs of particular students. Karen illustrated this, "This is the student I've got and this is their background and this is what I'm struggling with… What I want is an idea about what I can do, and things like that" (numeracy leader). The numeracy PLC also strategically pursue external professional development to help meet the needs of their students, for example having multiple staff trained in a mathematics intervention programme in response to concerns about the numeracy fluency of their middle school students. Teachers are also well supported to pursue their own professional learning interests. Kevin said, "We encourage our staff to undertake a lot of PD, particularly senior teachers, maths teachers, et cetera" (principal).

Careers education

Sweeping Plains College's careers education programme was also understood to contribute to the school's high mathematics performance by building student engagement and participation in mathematics. The school runs an extensive careers programme beginning in grade 7. Both staff and students spoke about this programme contributing to the student's understanding of mathematics pathways and careers. Kevin explained, "That really, I think, supports students when they're making choices for subjects entering into VCE, there's great knowledge there and recommendation regarding the need for your maths subjects for example, depending on what their career choices might be" (principal). Gerty commented that this programme led students to understand the importance of mathematics in their pathways, "By Grade 10 … the majority of them can see that maths is going to be involved in their job, do some sort of maths, and [many] do at least one science, 'cause they realise that will help" (teacher). Parallel to this programme, staff promoted STEM careers to the wider school community, particularly in mathematics. Karen said, "As a maths KLA [Key Learning Area group] we get sent careers in maths stuff and it's got examples of how people are using mathematics in their careers so I just publish those on the parent bulletin" (numeracy leader).

Practice architectures contributing to Sweeping Plains College's mathematics success

A range of interrelated factors appear to have facilitated the practices described in the previous section. These included the school's rural location, small size, and strong relationships; the strong learning culture; the local school network; timetabling arrangements; and staffing. These enabling themes are unpacked in this section and illustrated with excerpts from interviews and teacher comments from the anonymous survey.

Rural location, small size, and strong relationships

While Sweeping Plains College's small size and rural location were acknowledged to be restrictive in some instances, these same factors, along with strong relationships, were seen to facilitate practices contributing to the school's mathematics success. Teachers described how farming and other local industries highlight the utility value of mathematics for students. Some teachers also suggested Sweeping Plains College's isolation and decreasing local employment opportunities were a potential motivator for students to do well in mathematics subjects in order to seek study and employment elsewhere. Both teachers and students felt that the small size of the school and classes, particularly in VCE, made understanding and responding to each student's learning needs and maintaining appropriate expectations more achievable. The existence of strong relationships across the community was believed to further enhance the effectiveness of the support provided to students. Adrian explained, "You'll be seeing teachers down the street all the time, you'll be perhaps involved in the sporting clubs with them… that does help a little bit with the understanding and the trust and the support" (teacher). One student reflected:

> I think they [teachers] know where you're at and they know what you need help on, and they're willing to follow up… I think in rural areas, they're a bit more personal. Because we’re seeing our teachers all the time and not just in school but outside school, like in sporting bodies and other clubs outside of school, so you’ve got a bit more of a personal relationship with them than just that work sort of relationship.

At the same time, teachers acknowledged that small class sizes brought challenges, limiting class discussions and activities, diversity of peer support, and student perception of their relative achievement in STEM. Adrian expressed concern that Sweeping Plains College’s students’ limited exposure to other students resulted in them becoming complacent, saying, “So sometimes they just get in a little bit of a bubble and just roll along” (teacher).

The small size and rural location were also seen to facilitate support between staff members and independence. Gerty noted, “If we have questions, [we] can get together ‘cause there’s only a handful of us anyway” (teacher). Adrian said, “From my experience in the country, up here, so much distance from town to town… you’ve got to rely on each other, to get where you want to… That’s what the school does really, really well, I think” (teacher).

Strong learning culture

The school’s strong and established learning culture was also believed to enable the practices which led to its mathematics success. Sweeping Plains College adopted a set of five pedagogical principles that are featured in its policies and public documents. One pedagogical principle was, “Relationships are the key foundation to developing effective engagement with all members of the community. Interpersonal relationships and collaboration will be fostered within the school community” (college profile document). Another was, “High expectations are held for and by the learning community and all members within it” (college profile document). Several participants reflected that this culture had contributed to the STEM education practices and success of the school. Kevin said, “I think staff and the school [sic] has high expectations of themselves and that we’re going to get good results and kids sort of know that they’re expected to do well” (principal). In the survey on factors facilitating the school’s STEM success, one teacher reflected, “The community values education and will support any initiatives put forward by the school. They take interest in the success of our students”.

Local school network

Sweeping Plains College was part of a long-standing collaborative network with six other local schools seen to enable some of the practices associated with the school’s mathematics success. The most obvious manifestation of this collaboration was the Technical Trade Centre, where the seven cluster schools share VET training facilities and courses that emphasise the utility value of mathematics. The network of schools also shared a staff member, who was not based at Sweeping Plains College but who coordinated the school’s careers education. Finally, the network helped to build teacher capacity at Sweeping Plains

College through informal networking of staff who were teaching the same subjects, and through sharing formal professional learning opportunities.

Timetabling arrangements

The timetabling and programming of Sweeping Plains College's mathematics curriculum may have been a further practice architecture enabling the mathematics education practices at the school. The curriculum was delivered conventionally through classes in the separate disciplines of mathematics, science, and technology, similar to in most Australian schools (Marginson et al. 2013). However, mathematics classes were allocated more time than the national average, while science classes were allocated much less. In the primary school, students studied 280 h of numeracy, and 47 h of science, each year, compared to an average of 202 h and 57 h respectively for Australian grade 4s (Thomson et al. 2017b). Students from grades 7 to 9 studied 287 h of mathematics, and 93 h of science, whereas the average Australian grade 8 student studies 139 h and 126 h per year respectively (Thomson et al. 2017b).

In VCE, the school delivered all the VCE mathematics classes, despite its small size. This breadth of senior offerings had been normalised, with one student saying, "I think here they just offer it if there's interest in that subject". These offerings were achieved by timetabling Further Mathematics as a grade 11 and 12 composite class. Grade 11 Foundation Mathematics and grade 11 Mathematical Methods were offered in a combined class delivered by the one teacher, an unlikely pairing of the most basic VCE mathematics subject with an advanced VCE mathematics subject. Grade 12 Mathematical Methods was offered as a normal non-composite class at the school; however, grade 12 Specialist Mathematics was provided via distance education.

Timetable arrangements also provided opportunities for team teaching in mathematics, from grades 4–6 and again in grades 9 and 10. Further, the flow of numeracy expertise between the primary and secondary schools was enhanced by some mathematics teachers teaching in both areas. Interestingly, no participants referred to these time allocations or timetabling arrangements when discussing the mathematics success of the school.

Staffing

Sweeping Plains College benefitted from a strong team of STEM teachers. When discussing the STEM teachers at Sweeping Plains College, Kevin commented, "there's some strong passionate teachers in those areas… we're fortunate in that regard" (principal). This was true of the mathematics teachers. Describing her mathematics teachers, one student said, "They were just very well educated themselves and just really good at explaining to other students what they were trying to get". Karen felt the passion of the mathematics staff was particularly important, stating, "You've got to have people on the ground that are passionate and can share their passion with the kids I think" (numeracy coordinator). The mathematics teachers were also well connected to the school and the local community. Adrian had spent his career teaching in rural schools in the district. Karen was a long-term staff member and also strongly involved in local sporting clubs. Sweeping Plains College had faced some staff turnover in

STEM—Grace and Chris were new recruits to the school. Participants also noted the difficulties associated with recruiting appropriately qualified mathematics teachers; however, the school strongly supported the mathematics teachers they had, in building their skills. One teacher commented in their survey "When asked for … the opportunity to advance teacher knowledge the administration has always provided time", and Gerty noted that accessing professional learning at Sweeping Plains College was much easier than at her previous school.

Discussion and conclusion

Sweeping Plains College was a school that had sustained high enrolment proportions and achievement levels in senior mathematics subjects, despite its rural location. A conceptual framework drawing on aspects of Appreciative Inquiry and the theory of Practice Architectures was used to identify and analyse the factors associated with the school's mathematics success. This analysis produced five key practices related to mathematics education: high expectations with support, differentiated instruction, valuing mathematics, building teacher capacity, and careers education. Further, the analysis identified five practice architecture themes key to enabling these practices: rural location, small size, and strong relationships; strong learning culture; local school network; timetabling arrangements; and staffing.

This case study provides an illustration of a school that used the strengths of its rural context to overcome the issues commonly associated with rural mathematics education to achieve mathematics success. While the small size of rural schools has been seen to produce difficulties in maintaining expectations and setting appropriate benchmarks in mathematics (Pegg and Panizzon 2011), at Sweeping Plains College, the small size was seen as key to setting and helping students meet expectations. The school demonstrated how the typically small size and strong relationships of a rural school can be harnessed to build expectations and aspirations in mathematics. Small numbers of students made it easier for the mathematics staff to know and track the learning needs and interests of all learners. They could tailor learning to appeal to the interests of their students, often by setting mathematics learning in local contexts, as recommended by the CESE (2013). Further, they could set goals that were challenging yet achievable for each student, and provide the support required to help students reach them. The strong relationships that existed between students and teachers in this rural community created conditions within which mathematics teachers were motivated to provide such support, and students felt confident to seek out and accept it. This is rare empirical evidence for Hardre's (2011) assertion that the strong relationships of rural communities can facilitate effective mathematics education.

Difficulties associated with maintaining mathematics pathways are commonly encountered by rural schools (Lyons et al. 2006; Weldon 2016). Sweeping Plains College was not exempt from these challenges; however, the school employed a range of measures to minimise and overcome these challenges. Differentiated instruction and timetable structures allowed for ease of acceleration in mathematics. Alongside high value placed on, and the high expectations established in mathematics, this ensured there were good numbers of students interested in, and prepared to, study senior mathematics. These mechanisms secured sufficient student demand for all senior mathematics subjects, with Further Mathematics and Mathematical Methods offered as composite classes and Specialist Mathematics offered via distance education. Being able to offer all these mathematics subjects, despite the known issues associated with composite classes and distance education (McPhan et al. 2008), was an important contributor to maintaining the school's high expectations and aspirations in mathematics.

Concomitant with building student demand for mathematics is the challenge of building a strong mathematics team to staff these subjects. The school acknowledged difficulties experienced in recruiting mathematics teachers, as commonly occurs in rural schools (Handal et al. 2013); however, these difficulties had not severely impacted Sweeping Plains College. This may be due in part to having two long-term, strong, and highly experienced mathematics teachers on staff. It may also be due to the leadership's strong support of the professional development of the mathematics teachers at the school, and the school's numeracy PLC's approach to professional learning, which included many of the elements of effective mathematics professional learning described by Watson et al. (2012). Professional learning in mathematics at Sweeping Plains College focussed on the school's students' learning needs, as identified by the teachers who know them, and drew on external expertise as required. The mathematics teachers at Sweeping Plains College were regarded as strong educators by the school community, and they were seen by their students as strongly supportive, counter to Hardre's (2011) findings regarding rural mathematics teachers.

There were factors potentially contributing to Sweeping Plains College's mathematics success that have limited support in the literature. Participants placed significant emphasis on the value of differentiated instruction in mathematics; however, research into the impact of this practice is limited and offers inconclusive findings (Anthony et al. 2019). The form of differentiated instruction adopted by Sweeping Plains College is similar to that described by Prast et al. (2015), with its cycle of identifying individual learning needs, setting personalised goals, providing differentiated instruction and practice, and assessing the progress and process. There is limited evidence that such a model improves student achievement, dependent on its implementation (Prast et al. 2018). In fact, the use of differentiation in general has only a small to medium effect on average student achievement, and in some circumstances a negative effect on the performance of low-ability students (Deunk et al. 2018). Given the conviction of participants in this study that differentiated instruction had contributed to Sweeping Plains College's mathematics success, while the published literature in this area is inconclusive, further research into practices similar to those at the school seems worthy of further investigation. Another potential factor contributing to the school's mathematics success was that Sweeping Plains College students spend many more hours studying mathematics than the national average (Thomson et al. 2017b). As there is only limited literature exploring the association between instructional time and achievement in mathematics in Australia, with a 2004 study suggesting there is no association (Baker et al. 2004), this is another area worthy of further exploration.

A limitation of this study is that the entire cohort whose performance was the basis for choosing Sweeping Plains College for study was only 25 students. Although unlikely, it is possible that Sweeping Plains College's "mathematics success" was due to student rather than school-based factors. However, even if this was the case, the identified practices provide a valuable illustration of how the mathematics engagement and achievement of this cohort were developed and maintained.

Sweeping Plains College is a case of a rural school where an array of mathematics practices appear to have contributed to very-high, sustained senior mathematics performance. Rather than the school's success being attributable to one or two innovative programmes, these practices were part of a school-wide approach that valued and delivered high-quality mathematics education for all students. Mathematics education, like all school practices, is comprised of a complex array of situated activities, and the cultural, material, and social structures that shape them (Kemmis 2008), which are likely to be unique to each school community. Given this, this case study does not describe a generalisable approach to be adopted by other schools. Rather, it provides transferable insights into how the school-wide implementation of a range of mathematics education practices may be used to foster increased participation and achievement in senior mathematics education. While the practices used by Sweeping Plains College may not be novel, their collective and whole-school implementation leading to senior mathematics education excellence is not well represented in the literature. Further, this study provides rare evidence as to how a rural school can overcome the constraints associated with their small size, isolation, and socioeconomic disadvantage, and capitalise on their rural context, in order to succeed in mathematics education. Further investigation into the mathematics practices of other successful rural schools and comparison with those of less successful rural schools could deepen this understanding, offering more guidance to rural school practitioners and policy makers hoping to close the mathematics performance gap between metropolitan and rural schools.

Acknowledgements The author would like to acknowledge the support of the Victorian Department of Education and Training, along with his supervisors, A/Prof Lena Danaia and A/Prof Amy MacDonald, in completing this research.

Author's contribution The paper and the research described within are the sole work of the author. Elements of this paper have been previously published in MERGA conference proceedings:

Murphy (2019b). Practices contributing to Mathematics success in a low socioeconomic rural Victorian school. In G. Hine, S. Blackley, & A. Cooke (Eds.) *Education Research: Impacting Practice, Proceedings of the 42nd annual conference of the Mathematics Education Research Group of Australasia Mathematics* [Conference Proceedings]. (pp. 516–523). MERGA.

Funding This research was supported by an Australian Government Research Training Program (RTP) Scholarship.

Data availability Not applicable

Compliance with ethical standards

Conflict of interest Not applicable

Code availability Analysis used NVivo and thematic codes identified in the paper.

References

Anthony, G., Hunter, J., & Hunter, R. (2019). *Working towards equity in mathematics education: is differentiation the answer?* Mathematics Education Research: Impacting Practice (Proceedings of the 42nd annual conference of the Mathematics Education Research Group of Australasia), Perth.

Anderson, R., & Chang, B. (2011). Mathematics course-taking in rural high schools. *Journal of Research in Rural Education, 26*(1), 1–10 http://sites.psu.edu/jrre/wp-content/uploads/sites/6347/2014/02/26-1.pdf.

Australian Curriculum Assessment and Reporting Authority. (2015). What does the ICSEA value mean?. https://docs.acara.edu.au/resources/20160418_ACARA_ICSEA.pdf

Australian Curriculum Assessment and Reporting Authority. (2017). NAPLAN achievement in reading, writing, language conventions and numeracy: national report for 2017. ACARA. https://www.nap.edu.au/docs/default-source/default-document-library/naplan-national-report-2017_final_04dec2017.pdf?sfvrsn=0

Australian Curriculum Assessment and Reporting Authority. (2019). My School. https://www.myschool.edu.au/

Australian Industry Group. (2015). Progressing STEM skills in Australia. Australian Industry Group. http://cdn.aigroup.com.au/Reports/2015/14571_STEM_Skills_Report_Final_-.pdf

Avery, L. M., & Kassam, K.-A. (2011). Phronesis: children's local rural knowledge of science and engineering. *Journal of Research in Rural Education (Online), 26*(2), 1.

Baker, D., Fabrega, R., Galindo, C., & Mishook, J. (2004). Instructional time and national achievement: cross-national evidence. *PROSPECTS, 34*(3), 311–334. https://doi.org/10.1007/s11125-004-5310-1.

Barley, Z., & Beesley, A. (2007). Rural school success: what can we learn? *Journal of Research in Rural Education, 22*(1), 1–16 http://cep.org.au/files/2010/11/Rural-School-Success-What-can-we-learn.pdf.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology [Article]. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

Centre for Education Statistics and Evaluation. (2013). Rural and remote education: literature review. New South Wales Department of Education and Communities. https://www.cese.nsw.gov.au/component/k2/item/42-rural-and-remote-education-literature-review

Clark, L., Majumdar, S., Bhattacharjee, J., & Hanks, A. C. (2015). Creating an atmosphere for STEM literacy in the rural south through student-collected weather data. *Journal of Geoscience Education, 63*(2), 105–115. https://doi.org/10.5408/13-066.1.

Committee on STEM Education. (2018). Charting a course for success: America's strategy for STEM education. National Science & Technology Council. https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf

Deunk, M. I., Smale-Jacobse, A. E., de Boer, H., Doolaard, S., & Bosker, R. J. (2018). Effective differentiation practices: a systematic review and meta-analysis of studies on the cognitive effects of differentiation practices in primary education. *Educational Research Review, 24*, 31–54.

Echazarra, A. & Radinger, T. (2019). Learning in rural schools: insights from PISA, TALIS and the literature. OECD Education Working Paper. Organisation for Economic Co-operation and Development. http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=EDU/WKP(2019)4&docLanguage=En

Education Council. (2018). Optimising STEM industry-school partnerships: inspiring Australia's next generation. Education Council. http://www.educationcouncil.edu.au/site/DefaultSite/filesystem/documents/Reports%20and%20publications/Publications/Optimising%20STEM%20Industry-School%20Partnerships%20-%20Final%20Report.pdf

Elle, F., & Meissel, K. (2011). Working collaboratively to improve the learning and teaching of mathematics in a rural New Zealand community. *Mathematics Education Research Journal, 23*(2), 169–187. https://doi.org/10.1007/s13394-011-0010-7.

Gideon, L., & Moskos, P. (2012). Interviewing. In L. Gideon (Ed.), *Handbook of survey methodology for the social sciences* (pp. 108–118). Springer.

Goddard, Y., Goddard, R., Bailes, L., & Nichols, R. (2019). From school leadership to differentiated instruction: a pathway to student learning in schools. *The Elementary School Journal, 120*(2), 197–219.

Goos, M., Dole, S., & Geiger, V. (2011). Improving numeracy education in rural schools: a professional development approach. *Mathematics Education Research Journal, 23*(2), 129–148.

Goos, M., & Kaya, S. (2020). Understanding and promoting students' mathematical thinking: a review of research published in ESM. *Educational Studies in Mathematics, 103*(1), 7–25 https://doi-org.ezproxy.csu.edu.au/10.1007/s10649-019-09921-7.

Graham, S., & Provost, L. (2012). Mathematics achievement gaps between suburban students and their rural and urban peers increase over time. *Carsey Institute Issue Brief, 52*, 1–8 https://files.eric.ed.gov/fulltext/ED535962.pdf.

Halsey, J. (2018). Independent review into regional, rural and remote education—Final report. Commonwealth of Australia. https://docs.education.gov.au/system/files/doc/other/01218_independent_review_accessible.pdf
Handal, B., Watson, K., Petocz, P., & Maher, M. (2013). Retaining mathematics and science teachers in rural and remote schools. *Australian and International Journal of Rural Education, 23*(3), 14–30 http://www.spera.asn.au/school/publications/journals/15/57.
Hardre, P. (2011). Motivation for math in rural schools: student and teacher perspectives. *Mathematics Education Research Journal, 23*(2), 213–233.
Hardre, P. L., Sullivan, D. W., & Crowson, H. M. (2009). Student characteristics and motivation in rural high schools. *Journal of Research in Rural Education, 24*(16), 1–19.
Hibberts, M., Johnson, R. B., & Hudson, K. (2012). Common survey sampling techniques. In L. Gideon (Ed.), *Handbook of survey methodology for the social sciences*. Springer.
House of Common Science and Technology Committee. (2017). Industrial strategy: science and STEM skills. House of Commons. https://publications.parliament.uk/pa/cm201617/cmselect/cmsctech/991/991.pdf
Howley, C. B., Showalter, D., Klein, R. K., Sturgill, D. J., & Smith, M. A. (2013). Rural math talent, now and then. *Roeper Review, 35*(2), 102–114. https://doi.org/10.1080/02783193.2013.766963.
Ihrig, L. M., Lane, E., Mahatmya, D., & Assouline, S. G. (2018). STEM excellence and leadership program: increasing the level of STEM challenge and engagement for high-achieving students in economically disadvantaged rural communities. *Journal for the Education of the Gifted, 41*(1), 24–42. https://doi.org/10.1177/0162353217745158.
Jorgensen, R. (2016). Middle leadership: a key role of numeracy reform [Article]. *Australian Primary Mathematics Classroom, 21*(3), 32–37 http://ezproxy.csu.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=118245963&site=ehost-live.
Kemmis, S. (2008). Praxis and practice architectures in mathematics education Navigating currents and charting directions, (Proceedings of the 31st annual conference of the Mathematics Education Research Group of Australasia), Brisbane.
Kemmis, S., Wilkinson, J., Edwards-Groves, C., Hardy, I., Grootenboer, P., & Bristol, L. (2014). Praxis, practice and Practice Architectures. In S. Kemmis, J. Wilkinson, C. Edwards-Groves, I. Hardy, P. Grootenboer, & L. Bristol (Eds.), *Changing practices, changing education* (pp. 25–42). Springer.
Luschei, T., & Fagioli, L. (2016). A vanishing rural school advantage? Changing urban/rural student achievement differences in Latin America and the Caribbean. *Comparative Education Review, 60*(4), 703–745. https://doi.org/10.1086/688394.
Lyons, T., Cooksey, R., Panizzon, D., Parnell, A., & Pegg, J. (2006). Science, ICT and mathematics education in rural and regional Australia - The SiMERR National Survey. University of New England. https://simerr.une.edu.au/pages/projects/1nationalsurvey/Abridged%20report/Abridged_Full.pdf
Marginson, S., Tytler, R., Freeman, B., & Roberts, K. (2013). STEM: country comparisons. Report for the Australian council of learned academies. Australian Council of Learned Academies. http://dro.deakin.edu.au/eserv/DU:30059041/tytler-stemcountry-2013.pdf
McPhan, G., Morony, W., Pegg, J., Cooksey, R., & Lynch, T. (2008). Maths? Why not? DEEWR. http://www.gsu.uts.edu.au/academicboard/cabs/082/papers/082-item6-1.pdf
McPhan, G., & Tobias, S. (2011). MERJ special issue - editorial. *Mathematics Education Research Journal, 23*, 77–81.
Morgan, R., & Kirby, C. (2016). The UK STEM education landscape: a report for the Lloyd's register foundation from the royal academy of engineering education and skills committee. https://www.raeng.org.uk/publications/reports/uk-stem-education-landscape
Murphy, S. (2019a). School location and socioeconomic status and patterns of participation and achievement in senior secondary mathematics. *Mathematics Education Research Journal, 31*(3), 219–235.
Murphy (2019b). Practices contributing to Mathematics success in a low socioeconomic rural Victorian school. In G. Hine, S. Blackley, & A. Cooke (Eds.) Education Research: Impacting Practice, Proceedings of the 42nd annual conference of the Mathematics Education Research Group of Australasia Mathematics [Conference Proceedings]. (pp. 516–523). MERGA.
Murphy, S. (2020a). Achieving STEM education success against the odds. *Curriculum Perspectives, 40*(2), 241–246.
Murphy, S. (2020b). Science education success in a rural Australian school: Practices and arrangements contributing to high senior science enrolments and achievement in an isolated rural school. *Research in Science Education*. https://doi.org/10.1007/s11165-020-09947-5.
OECD. (2019). PISA 2018 Results. https://doi.org/10.1787/5f07c754-en.
Pegg, J., & Panizzon, D. (2011). Collaborative innovations with rural and regional secondary teachers: enhancing student learning in mathematics. *Mathematics Education Research Journal, 23*(2), 149–167.

Prast, E. J., Van de Weijer-Bergsma, E., Kroesbergen, E. H., & Van Luit, J. E. H. (2015). Differentiation in primary school mathematics: expert recommendations and teacher self-assessment. *Frontline Learning Research, 3*(2), 90–116.

Prast, E. J., Van de Weijer-Bergsma, E., Kroesbergen, E. H., & Van Luit, J. E. H. (2018). Differentiated instruction in primary mathematics: effects of teacher professional development on student achievement. *Learning and Instruction, 54*, 22–34. https://doi.org/10.1016/j.learninstruc.2018.01.009.

Prince, G., & O'Connor, M. (2018). Crunching the numbers on out-of-field teaching in maths. Australian Mathematical Sciences Institute. https://schools.amsi.org.au/2019/01/14/crunching-the-numbers-out-of-feild-teaching/

Reed, J. (2007). Appreciative inquiry. Thousand Oaks. https://doi.org/10.4135/9781412983464.

Rönnerman, K., & Kemmis, S. (2016). Stirring doctoral candidates into academic practices: a doctoral course and its practice architectures. *Education Inquiry, 7*(2), 27558. https://doi.org/10.3402/edui.v7.27558.

Semke, C. A., & Sheridan, S. M. (2012). Family-school connections in rural educational settings: a systematic review of the empirical literature. *School Community Journal, 22*(1), 21–47 http://ezproxy.csu.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=77393015&site=ehost-live.

Smit, R., & Humpert, W. (2012). Differentiated instruction in small schools. *Teaching and Teacher Education, 28*(8), 1152–1162.

Thomson, S., De Bortoli, L., & Underwood, C. (2017a). PISA 2015: reporting Australia's results. Australian Council for Educational Research. https://research.acer.edu.au/ozpisa/22/

Thomson, S., Wernert, N., O'Grady, E., & Rodrigues, S. (2017b). TIMSS 2015: reporting Australia's results. Australian Council for Educational Research. https://research.acer.edu.au/timss_2015/2/

Tracy, S. J. (2010). Qualitative quality: eight "Big-Tent" criteria for excellent qualitative research. *Qualitative Inquiry, 16*(10), 837–851. https://doi.org/10.1177/1077800410383121.

Victorian Curriculum and Assessment Authority. (2020). VCE and VCAL administrative handbook. VCAA. https://www.vcaa.vic.edu.au/administration/vce-vcalhandbook/Pages/index.aspx.

Victorian Tertiary Admissions Centre. (2016). Prerequisites for 2018. VTAC. http://www.vtac.edu.au/files/pdf/publications/prerequisites-2018.pdf

Watson, J., Beswick, K., & Brown, N. (2012). *Educational research and professional learning in changing times*. Springer Verlag.

Watson, J., Wright, S., Hay, I., Beswick, K., Allen, J., & Cranston, N. (2016). Rural and regional students' perceptions of schooling and factors that influence their aspirations. *Australian and International Journal of Rural Education, 26*(2), 4.

Weldon, P. (2016). Out-of-field teaching in Australian seconday schools (Policy Insights), Issue. https://research.acer.edu.au/cgi/viewcontent.cgi?article=1005&context=policyinsights

Williams, J. H. (2005). Cross-national variations in rural mathematics achievement. *Journal of Research Education, 20*(5), 1–18.

Yin, R. K. (2014). *Case study research : design and methods* (5th ed.). SAGE Publications, Inc.