Charles Sturt University

COVID-19 pandemic's disruption of primary school Mathematics and Science education: Challenges & Successes

Summary Report

A project of the STEM Education Research Group

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Project summary

COVID-19 disrupted the education of an estimated 1.6 billion children world-wide. School closures required the adoption of unfamiliar 'at-home learning' practices to continue children's education. These practices are particularly challenging for mathematics and science education as primary teachers often have relatively low confidence and abilities in these disciplines, and children's parents typically find them difficult. This leaves primary students' mathematics and science learning at risk of being impacted, as negative experiences in primary school have long term impacts on students' engagement and achievements. Though the COVID-19 disruption threatened primary mathematics and science education, it also prompted teachers and parents to trial innovative practices that may have long term benefits.

This project aimed to understand how at-home learning of mathematics and science was facilitated, and to identify new practices believed to be effective. Two separate moderated Facebook groups were used to support teachers and parents of primary school children to share and reflect upon their experiences of at-home mathematics and science learning, as well as to collect data about these experiences. Researchers regularly posted polls and comments in these Facebook groups to prompt comments from and exchanges between the participants. Participants posted comments, images, and videos that all contributed data to this study. In addition, in-depth narrative interviews were conducted with parents and teachers selected from these Facebook groups about their experiences of at-home mathematics and science education. These interviews were structured to empower participants to tell their stories, rather than respond to a set of potentially restrictive questions. Consequently, the themes that emerged were those that were most important to the participating teachers and parents.

This report captures the preliminary findings of this study, with further analysis underway. These findings are significant for mathematics and science education under pandemic-type conditions, as well as for post-pandemic educational practice. They provide an understanding of the common challenges and successes associated with at-home mathematics and science education, including rare insights associated with primary school use of learning technologies, and home-school partnerships to enhance learning. The findings of this study inform five recommendations for future practice:

1. Continue to nurture the increased parental engagement in mathematics education;
2. Capitalise on, and enhance, the new skills of students and teachers with digital learning tools;
3. Explore options to nurture collaborative learning online;
4. Address deficits in primary school science education; and
5. Support access to digital learning technologies and internet for all students.

Further, these finding indicate areas warranting further investigation, including the long term impact of the at-home learning experience on: parental engagement in mathematics education; primary school teacher practices, particularly those using digital learning tools; and student engagement and achievement in mathematics and science.

Introduction

The COVID-19 disruption of education

As part of the response to the COVID-19 pandemic, at least 188 countries shut down their schools, disrupting the education of approximately 1.6 billion children and young people (OECD, 2020). For children internationally these closures have resulted in interrupted learning, social isolation, increased school drop-outs, and, for children dependent on school meals programs, poorer nutrition (UNSECO, 2020). Parents have been burdened with facilitating the learning of their children, often resulting in wage loss as parents stay home to care for and support their children. Finally, teachers have experienced stress and uncertainty, coping with a rapid transition to at-home schooling for unknown periods with minimal notice and preparation.

In Australia, versions of at-home learning were employed beginning in April and continuing for many children through to June (e.g. NSW Department of Education, 2020; Victorian Department of Education, 2020). Students in all states other than Victoria returned to school as normal in July. In Victoria, due to COVID-19 infections in Melbourne, only students in rural and regional areas returned to school in July, along with Year 11 & 12 students in metropolitan Melbourne (Victorian Department of Education, 2020). However, as infections grew, by early August all schools in Victoria, other than regional specialist schools, had returned to at-home learning. At-home learning continued for regional Victorian students until October, with students in metropolitan Melbourne returning to normal school learning later still, in November.

Internationally, schools and school systems facilitated at-home learning in various ways, using a mix of online, television, radio, and paper-based resources, with families expected to support their children's education at home (Gouedard et al., 2020). External assessments were postponed or cancelled. Some school systems reduced the learning areas that needed to be covered during at-home learning. Efforts to facilitate at-home learning in the U.S. varied, with schools using phone contact, email, and internet (Walters, 2020). In Ireland, texts and emails home were most common, half of households received resources from school, and a quarter of parents reported that their children participated in virtual classes (Doyle, 2020). In Australia teachers facilitated at-home learning using a mix of video conferencing tools for synchronous lessons, pre-recorded videos they made themselves or sourced elsewhere, interactive games and tasks, digital learning platforms, and tasks designed to be completed using the home environment (Ziebell et al., 2020). Facilitating at-home learning was challenging, with the vast majority of teachers reporting they worked additional hours during this time, and that device and internet access were key challenges (Ziebell et al., 2020).

With no modern precedent, it is uncertain what impact the COVID-19 pandemic's disruption of education will have (Gouedard et al., 2020). Where the disruption results in reduced instructional time, this could result in reduced student achievement, as instructional time has been shown to impact student achievement in PISA testing (Lavy, 2015). The prolonged absence from school could lead to the attrition of academic skills, with student skills known to decrease during their absence from school across the long summer school holidays, with the skill decrease greater in mathematics than reading (Reimers & Schleicher, 2020). Early studies of the impact of the pandemic on education suggest some negative impacts. An Australian study reported that 53% of primary school teachers felt that the standard of work produced through at-home learning was poorer than that produced through at-school learning (though some did note that students with significant parent support produced higher quality work) (Ziebell et al., 2020). Australian parents of children with disabilities reported decreased curriculum, behavioural and social support from schools during at-home learning (Dickson et al., 2020).

It is anticipated the COVID-19's disruption of schooling will exacerbate inequalities in education (Doyle, 2020). Prior to the pandemic, children from low socioeconomic status (SES) households were known to underachieve in schooling compared to children from more affluent backgrounds, including in mathematics (Murphy, 2019) and science (Murphy, 2018). The stress and time required to manage financial challenges can mean that parents in poorer families have less capacity to invest in their children's education, while more wealthy families can provide their children with more stimulating learning materials and experiences (Doyle, 2020). The COVID-19 pandemic has worsened the conditions contributing to educational inequity. Lock-downs and measures to mitigate the pandemic have resulting in increased unemployment, disproportionally

impacting those in lower-income industries (Uren, 2020). Many low paid workers who have retained their jobs are unable to work from home (e.g. retail, supply-chain, transport, and health-care workers), so are more likely to miss work when schools and childcare close, further increasing financial stress (UNESCO, 2020). Further, at-home learning has introduced additional factors that threaten to increase inequity. Low SES households may not have the desk space or digital technology to effectively support at-home learning (Doyle, 2020). Parents with lower educational backgrounds may not have the confidence, or literacy and numeracy skills required, to facilitate their children's engagement in schoolwork.

Early studies suggest that the impact of the COVID-19 pandemic on education is indeed inequitable. A study considering the use and availability of educational resources during at-home schooling in Ireland showed that parents from higher education backgrounds reported accessing a greater diversity of resources than those from lower education backgrounds, particularly online resources (Doyle 2020). Australian teachers reported a range of equity concerns about at-home learning, including those associated with resource and digital technology access, and parent support (Ziebell et al., 2020).

Despite the challenges and anticipated negative impacts of COVID-19 pandemic's disruption of schooling, there are also suggestions that the disruption may yield innovative practices leading to long term changes to education (Broom 2020). Some argue that pandemic induced at-home learning has provided the opportunity to expand and advance the use of digital learning technologies (Rospigliosi, 2020). Early indicators from research suggest that this has been the case, with Australian teachers noting that at-home learning has positively impacted students' digital technology skills, and expressing increased interest in the future use of flipped learning and more generally improved use of digital technologies across the curriculum (Ziebell et al., 2020). Beyond the use of learning technologies, at-home learning may have resulted in other positive changes. Teachers feel that at-home learning has resulted in improvements in students' independence, organisation, and resilience (Ziebell et al., 2020). Teachers also reported a strengthening of school-home partnerships, with improved communication and support from parents (Ziebell et al., 2020).

The COVID-19 disruption of primary mathematics and science education

While there has been some research into the impact of the COVID-19 pandemic on education generally, there has been little published on its impact on mathematics and science education specifically. There is reason to believe the pandemic may have particularly and negatively impacted these subject areas. Many parents are not confident in supporting their children in these disciplines (Buckley, 2013) and parent attitudes and modelling influence student outcomes in mathematics and science (Cheng, et al., 2017). Further, primary teachers are known to have relatively low confidence and ability in teaching mathematics and science (Appleton, 2007; Murphy, Neil & Beggs, 2007; Watson, 2001), a situation potentially exacerbated by the use of an unfamiliar mode of teaching. Teacher confidence is known to impact student engagement and learning (Klassen & Tze, 2014). Primary school experiences of mathematics and science can impact students' continued engagement and achievement in these subjects (Goodrum et al., 2012, McPhan et al., 2008). Many students already suffer anxiety and low confidence in these subjects (Buckley, 2013; Sorvo et al., 2017), often induced by poor experiences in primary school and continuing throughout their schooling (Larkin & Jorgensen, 2016; Wegner, Strehlke, & Weber, 2014). Given that primary students already tend to find mathematics and science learning challenging, and the low efficacy of teachers and parents to support them, COVID-19 conditions could have negatively impacted student learning in these disciplines.

Despite these possible negative impacts, there is potential that the crisis will reveal innovative practices currently under-researched or under-utilised in primary mathematics and science education. This research reveals new findings about the contributions of school-home partnerships to student engagement and achievement in mathematics and science. The findings also offer new insights into the use of the digital technologies that have been widely employed to facilitate at-home mathematics and science learning, technologies that up until recently have had slow uptake in schools, particularly primary schools (Howard & Mzejko, 2015).

This research project

This research explored the disruption of mathematics and science education through the perspectives of primary school teachers and parents. It offered teachers and parents the opportunity to reflect and learn from their experiences through the development of two separate Communities of Practice (CoP) (Wegner, 2010), allowing them to share their challenges and successes in at-home mathematics and science education via two separate Facebook groups. These Facebook groups were a source of data for identifying and describing practices felt to be effective during the pandemic. Teachers and parents from the Facebook groups were also recruited to be interviewed via video conferencing, phone, or email, providing them opportunities to tell their stories of at-home primary mathematics and science education in greater depth.

This research describes the challenges faced by teachers and parents during the pandemic induced at-home learning. It provides perspectives of how these challenges were managed well, and how they could have been managed better. It shares parent and teacher perspectives of how the pandemic's disruption impacted the learning and engagement of primary school students in mathematics and science. It also reveals innovative instructional approaches to primary school mathematics and science education employed during at-home learning that could inform education practices post COVID-19.

Research design and analysis

This research aimed to:

- explore and make explicit the mathematics and science learning and teaching approaches used, and the manner in which students learned from these experiences, during at-home learning under COVID-19 conditions;
- Facilitate collaborative reflection and learning between teachers, and also between parents, strategies believed to be critical during the pandemic (Reimers & Schleicher, 2020);
- identify and disseminate successful science and maths education practices as a way to support teachers, parents and students during the pandemic, the recovery, and beyond; and
- inform and improve the future use of at-home learning, digital technology, and home-school partnerships in primary mathematics and science education.

Research Questions

There were three overarching research questions guiding this research:

1. How was at-home mathematics and science learning facilitated?
2. What were the experiences of students, teachers, and parents involved in these learning programs and the perceived impacts on students' learning in maths and science?
3. How did these align with effective pedagogies represented in the literature?

Phase 1 Facebook groups

Design

This project established two separate social-media based groups, one amongst primary teachers of mathematics and science, and one amongst parents supporting their children's learning of mathematics and science at home. Facebook was selected as the platform to help drive this research because of its ability to support rapid recruitment of participants, and its potential to allow users to create a strong sense of belonging to a community via participating in a group (Buelo et al., 2016; Kosinski, 2014). These groups in Facebook were intended to be environments for the participants to freely and safely share information and expertise with peers and researchers (Yildrim, 2019).

Recruitment

Digital snowball sampling was used to recruit both teacher and parent participants from Australia (Bhutta, 2012). 32 members were recruited to the teachers' group, and 43 members were recruited to the parents' group.

Data collection & analysis

Data was collected from the site for a 10 week period from June to September, capturing the end of term 2 and most of term 3 in Australia, providing participants the opportunity to share both during and after widespread school closures. Quantitative data was gathered through poll questions about how teachers and parents facilitate/d at-home mathematics and science learning. Qualitative data included participant posts (including text, images and video) about their experiences of facilitating science and mathematics at-home learning.. Emergent themes were identified through thematic analysis (Braun & Clarke, 2006) of the qualitative data.

Phase 2 Interviews

Design

Phase two involved conducting semi-structured narrative interviews (Kim, 2016) with teachers and parents participating in the Facebook groups to seek further insights into their experience of at-home mathematics and science education.

Recruitment

Participants in the Facebook groups were invited to participate in an interview. Seven parents and seven teachers gave their consent to be interviewed.

Data collection

The interviews took place over a 6-week period between from August to September 2020. Participants were given the opportunity to share their experiences and reflections how it suited them, however the researcher did have questions to support or guide this sharing if required. Two weeks after the conclusion of the interview they were transcribed and anonymised, before being added to the data corpus.

Analysis

For this preliminary analysis, the interview transcripts were also subjected to thematic analysis. Emergent themes were identified through iterative engagement with the data by two members of the research team. The remaining members reviewed these themes to establish intersubjectivity.

Key findings

Parents' Perceptions of At-home Mathematics and Science Education

Most parents in the study reported that there were daily mathematics activities to complete during the period of at-home learning. Parents reported that these activities were generally delivered asynchronously through online learning platforms, with teachers sometimes offering explanatory videos. Several parents said that their schools supplemented this online delivery with resource packs that were sent home at the beginning of the pandemic, often including a mathematics textbook or collection of worksheets.

Most parents, reported a significant focus on fluency activities, with parents in the Facebook group affirming this shared experience with comments like, "Same here. So much working memory spent on basic facts and times tables." Measurement was also a common focus of the tasks set for at-home learning. While some parents reported the use of resources from around the house "to make maths real", many parents believed that the mathematics activities set were predominantly work-sheet based.

Parents' perceptions of at-home science education were varied, however common to many was the belief that there were very few science learning experiences offered during lockdown. Where parents did identify science activities, several commented these were often associated with literacy tasks. Some parents did report engaging in hands-on science activities that utilised resources from home such as common kitchen ingredients or materials from the garden.

Challenges

LEVEL OF PARENTAL SUPPORT REQUIRED

Universally, the parents in this study reported that at-home learning required significant time and effort on their behalf to effectively support. In some cases, the parents in this study reported taking time off work, reducing the hours they worked, or otherwise altering their working arrangements, to support their children's at-home learning. The way parents engaged with their children's mathematics and science learning varied. Some parents described their role as monitoring (and at times enforcing) completion of the set tasks. Other parents supported their children to interpret set tasks, and to plan for their completion. Some parents even supplemented the activities provided by the teacher with activities their sourced themselves in response to their children's particular learning needs. However, no matter the mode of engagement, parents reported that supporting at-home learning was taxing and they expressed relief for various reasons when schools re-opened.

An associated issue was that several parents reported their children resisting the support they offered. This was potentially associated with the conflict between the role of parent and the role of teacher in-loco. One parent, an experienced teacher said, "I mean, I can be a teacher to a hundred other kids, but to my own kids, I'm a mum. They just don't take it in the same light."

PARENTAL UNDERSTANDING OF MATHEMATICS EDUCATION

Parents' personal understanding of contemporary mathematics education practices seemed to pose a problem in some cases. One parent explained this issue, "The teacher teaches in a certain way [that] we don't know…And then, you know, you end up confusing them [the child] even more". Other comments from parents suggest similar issues. One parent reported that her child questioned her authority to teach mathematics, where another avoided engaging in difficult mathematics problems with her child as her child "wasn't listening to me at all".

STUDENT ENGAGEMENT

Parents also commonly reported difficulties in maintaining their child's engagement in at-home learning. While at-home learning may have initially been positively received as a novelty, as it continued, student engagement in learning declined. A typical comment was: "My child initially enjoyed the online learning and being taught by mum. Overtime, the interest in online learning was wearing thin." Parents offered a range of contributors to this disengagement. In several cases, parents believed that the mathematics work set was "mundane" or covered material that their children were already familiar with. Parents also believed the difficulties in establishing teacher presence through online means significantly impacted student engagement. Several parents reported a perceived lack of assessment of, or feedback on, the mathematics tasks submitted, beyond acknowledgement of receipt, and that this was de-motivating. Finally, a lack of peer interaction was also believed to be demotivating, leaving their children "really bored" and "a lot more

emotional". Some parents believed there was minimal online class interaction focussed on mathematics or science, and suggested that increasing this would have been desirable.

DIGITAL TECHNOLOGY

Parent's experiences with technology to support at-home mathematics and science learning varied. Some parents encountered difficulties due to a lack of physical resources, with some parents reporting difficulties negotiating access to limited technology amongst family members. One parent managed to source an additional laptop from a grandparent. Another parent commented on the difficulties posed by not having a printer to produce hard-copies of mathematics resources sent home. The reliability of the internet impacted one rural family in the study, with parents having to limit their work-use during school time. Despite this, disruptions still occurred, resulting in loss of work and significant frustration. Some parents also encountered difficulties due to their own personal technological literacy. For one parent, she managed this by requesting hardcopies from the school and minimising her use of online resources. Another parent reported being frustrated by the size of images and videos being too small to see, potentially alluding to another digital literacy issue.

PERCEIVED LACK OF SCIENCE EDUCATION

Most parents reported that little science education occurred during the school closures. Where it did, they said that science activities occurred once a week. Few parents said they thought this was problematic with some justifying it as the result of an appropriate emphasis on maintaining literacy and numeracy skills during the closures.

Successes

IMPROVED ENGAGEMENT WITH CHILDREN'S MATHEMATICS LEARNING

Many of the participants noted that at-home learning allowed them to better engage with their children's mathematics learning. Prior to school shut-downs few parents described significant engagement with their children's mathematics learning, with one parent commenting ""I hadn't really ever done anything maths wise with him." During at-home learning, parents became better acquainted with their children's mathematics abilities. Several parents acted to address what they perceived to be deficits, particularly with regard to fluency, with the introduction of additional number facts tasks by parents being common amongst participants. One parent sought professional help for her child as a result of her experiences in at-home mathematics learning. This resulted in a diagnosis of a learning disability. The parent was able to employ expert assistance, resulting in significant gains in mathematics learning, something she felt would not have happened had school shut-downs not occurred.

ENHANCED PARENTAL ENGAGEMENT IN SCHOOLING

Relatedly, many parents reported improved engagement in schooling. Several parents said that they had an improved understanding of contemporary mathematics education, including how to use particular resources, as a result of their experiences in at-home learning. Some parents described liking the increased awareness about learning activities and their children's progress. One parent commented, "because of the closure, I've got a bit more control on what's going on…I know whatever is up, it's on Seesaw [learning management platform]." Several parents also actively contributed to the school's program during closures, with some organising social gatherings for their children and classmates, and another organising online science activities.

HOME AS A LEARNING SPACE

While at-home mathematics and science learning suffered from a lack of teacher and peer contact, several parents reported certain benefits that came from the home space. They described their children enjoying having an enhanced sense of autonomy. Several of the participants said their children would start the school day early, working hard to complete tasks in the hope of earning free time later in the day. One parent reported that her children enjoyed blending the freedom of home with the routine of school – the children would work on school tasks but were able to eat and take bathroom breaks whenever they liked. Other parents described the benefits of negotiating the sequence of tasks to be completed during the day, or even adjusting workload from day to day, to help manage their children's emotional state and academic engagement. Finally, despite the challenges, several parents expressed gratitude for being able to share the time at home with their children that the school closures afforded them.

RECOGNITION OF TEACHER EFFORT

While parents did offer critique of at-home mathematics and science learning, as noted in the challenges section, a common theme across the data was parental recognition and appreciation of the effort put in by their children's teachers. Several parents commented on how well teachers prepared and adapted to support at-home learning. One comment was, "You know, the on-boarding, the innovation, everything was amazing through the whole time." Other parents expressed appreciation for how approachable and supportive their children's teachers were. Parents described receiving phone calls and other contact "checking in" on how they were going. They also said they were pleased with how responsive teachers were when they needed help or had questions.

Teachers' Perceptions of At-home Mathematics and Science Education

Teachers described variously delivering mathematics and science resources via email, online platforms, and, in some cases, in hard copy. They sourced or created videos that could be used to scaffold mathematics learning. They were cognisant of the different circumstances and stresses faced by their students and their families during the shut-downs as they planned and supported at-home learning. Some teachers spoke of providing activities that could be completed online or printed out and completed on paper. Others spoke about setting tasks that made use of resources easily accessible at home. A few teachers spoke about trying to include open ended mathematics tasks in the program they offered, though most teachers did not discuss this. Teachers sought to deliver a consistent, weekly program. One teacher described this as "A slow release of, I guess, strategies and format that parents could follow. Something that was predictable in nature." Common to this consistent program were daily numeracy tasks, many of which were worksheet based. Teachers also spoke about making efforts to differentiate the mathematics program to support a range of abilities. Further, several teachers suggested that they somewhat lowered expectations for completion of work or new learning to avoid causing undue stress. One teacher said, "We're trying not to push them as much as what we would in a classroom." Another commented, "I've decided to hold back…and just work on skills they already know. Just strengthen skills, rather than introduce new ones."

Many teachers described adjusting the mathematics programs so that the mathematics topics covered were easier for parents to support. Measurement was a common topic programmed for at-home learning. Teachers spoke about setting tasks that involved measuring objects around the house, measurement and fractions during cooking, and measuring time. Money and financial mathematics was another topic commonly included in the at-home learning program. Further, some teachers described attempting to align topics across the year levels so that families with more than one child did not have to address multiple different topics.

Teacher perceptions of the science program during the school shutdowns varied. Several teachers felt that the science programs suffered during at-home learning. One teacher commented, "I haven't done science as a major focus remotely." Other comments suggested that a lack of access to resources and the ability to engage hands-on with the students limited the type of science activities that could be set. Some teachers did, however, set science activities that made use of resources at home, and encouraged students to upload videos or photos of their work to share through the school's learning management system.

Challenges

AMOUNT OF PREPARATION REQUIRED

All teachers in this study described the increased workload involved in preparing for and supporting at-home learning. This was exacerbated by the fact that supporting at-home learning was not teachers' only focus as they were also required to support the learning of children of essential workers who continued to attend school. As discussed above, it was common for teachers, and whole schools, to rearrange their mathematics programs to best support at home learning. Some teachers discussed how the transition to at-home learning forced a change to their teaching approach. Sometimes the lack of access to classroom resources forced compromising preferred pedagogies. One teacher described the challenge in supporting students to persist with difficult mathematics tasks through at-home learning, resulting in a simplification of tasks set. Other teachers commented on the challenges of differentiating at-home mathematics learning. In the classroom, teachers noted they engage in significant spontaneous tailoring of learning experiences for individual students.

LEVEL OF PARENT SUPPORT REQUIRED

Most teachers noted that parents had varied capacity to support at-home learning and expressed concern about the impact this had on children's mathematics and science learning. Several teachers noted that supporting at-home learning was stressful for parents, particularly when they were juggling other commitments such as paid work, and caring for multiple children. Many teachers expressed concern about the poor progress of students with families unable to provide sufficient support. One teacher commented that nearly half of her class participated in very few of the online mathematics classes she offered, noting, "They are the ones who actually can't afford to go missing." Another teacher worried about the impact of at-home learning on students already having difficulties with mathematics, "Some of the children with learning difficulties, they do very little at home, and I worry that the gap is growing." There were other concerns expressed where parents were able to support their children's at-home learning. Some teachers worried that some children may have been receiving undue assistance, noting a sharp increase in achievement for a few students. Other teachers worried that her students' parents had difficulties providing effective support as they were unfamiliar with contemporary mathematics education methods.

STUDENT ENGAGEMENT

Teachers observed that engagement in at-home learning varied from student to student. "We definitely had a mixed bag of learners with some students embracing this mode of learning and others completely disengaged," was a typical comment. Teachers also noted that student engagement waned as the school shut-downs continued. One teacher said, "I think towards the end when there is just that bit of fatigue and it became less engaging…It did become mundane for everyone." Some teachers attributed this disengagement to the limited array of teaching strategies that could be employed during at-home learning, for example, "Resources and activities that we would normally plan in a classroom and exposure to different opportunities of learning is very restricted in remote learning context." Further, teachers felt the lack of social connection, and opportunities to learn collaboratively, also significantly impacted student engagement. Several teachers also noted challenges with maintaining their own motivation. One teacher said, "Motivation is getting harder for me as a teacher and particularly because you know you're not seeing the engagement with the kids."

FEEDBACK

One teacher spoke about the tension between providing meaningful feedback to students, while meeting student and/or parental expectations. They said that often families would upload a large amount of "quite surface activities". However, from their perspective it was more important to give in-depth feedback on fewer, more significant work pieces.

DIGITAL TECHNOLOGY

Teachers reported there were various issues associated with digital technologies. Several schools made limited or no use of learning management systems prior to the shut-downs, requiring them to quickly adopt platforms and attempt to support many in the school community who were unfamiliar with these tools. Some teachers also reported that department regulations associated with cyber safety limited the type and mode of technology use during the closures, further restricting the teaching strategies that could be employed. Finally, some teachers noted difficulties associated with student's not having access to appropriate, or appropriately functioning, technology.

SCIENCE EDUCATION

Many teachers commented that science was not a strong focus during the school shut-downs, "Unfortunately, it took a bit of a back seat." Where science learning experiences were offered they were sometimes described as optional and relatively unstructured, with one teacher commenting, "There wasn't much engagement from the kids."

Successes

PROFESSIONAL LEARNING

While preparing for and supporting at-home learning required increased time and effort, many teachers reflected positively on what they had learned through the experience. Many teachers described developing their skills in clearly communicating learning intentions, differentiating learning activities, and scaffolding work tasks, as the school closures progressed. Several teachers also acknowledged the increased professional learning materials made available online by the various education departments.

USE OF DIGITAL TECHNOLOGY

Several teachers reported increased confidence in the use of online learning platforms, video conferencing software, and other digital learning tools. One teacher said that they saw long term benefits from this experience, suggesting they will use technology more in the future, particularly as part of a “flipped learning” approach. Another teacher reported their school was planning to institute one afternoon a week were the school would offer after-hours support to students and families online, in order to maintain the skills and independence developed through at-home learning.

COMMUNICATION WITH PARENTS

Some teachers believed the school shut-downs precipitated enhanced communication with parents. One teacher spoke about the positive impact of their work “upskilling” parents in contemporary teaching strategies, such as the use of learning intentions. Some teachers also actively sought feedback from parents about their experiences of at-home learning, and used this information to inform future practice. Some teachers reported structuring parent communication into their weekly routine, for example, “We had weekly ‘parent pit-stops’ where we would either call or video conference with parents and discuss their child’s learning.” Several teachers commented that parents appreciated the increased transparency, for example “Parents really enjoyed being able to see what their children were doing. Knowing really how they were going, and interacting in a different way with their learning.”

INCREASED STUDENT INDEPENDENCE

Several teachers reported that at-home learning had resulted in some of their students becoming more independent learners. Teachers said that their students had become “more independent” and “self-motivated”, and they had an increased “ability to follow instructions and ask clarifying questions”. Teachers did, however, note that not all students experienced this improvement.

VALUING SCHOOL

Finally, many teachers felt that the at-home learning experience resulted in many students having an increased appreciation for school and the learning environment it affords. Teachers observed that upon returning to school students seemed grateful for opportunities to collaborate and to engage in “meaningful work in the classroom”. Other teachers felt students were more receptive and respectful towards their classmate.

Recommendations for Practice and Future Research

This preliminary analysis of findings suggest some recommendations for practice, as well as indicating future analysis of the data corpus for this project, and future directions for further research.

Recommendations for Practice

We have drawn five key recommendations from this study with the potential to positively impact schooling both during school-closures and in the post-pandemic era:

1. Continue to nurture parental engagement in mathematics education

Many parents reported feeling empowered by the improved understanding of their children's mathematics knowledge and skills, and the understanding of contemporary mathematics education practices, that their experience of at-home learning gave them. Parental engagement in their children's mathematics learning is known to have the potential to positively impact student achievement and engagement in mathematics (Emerson et al., 2012). It seems that at-home learning has given many parents the skills and confidence to better engage in their children's mathematics education. It is important that teachers continue to nurture the development of parental skills and confidence in mathematics education through communication, information sharing, and invitations to maintain involvement, in order to build effective parental engagement.

2. Capitalise on, and enhance, new skills with digital learning tools

Teachers reported that they, and their students, developed new skills in using digital learning tools during at-home learning. Some teachers and parents indicated that while some uses of digital technology were effective, some were less so. Teachers should critically evaluate the use of digital learning tools during school shutdowns to identify strategies that enhanced student learning and seek ways to incorporate these into their ongoing practice. Schools and departments should continue the enhanced levels of resourcing and professional learning seen during the school closures, to support this work.

3. Explore options to nurture collaborative learning online

Teachers should also further explore the potential for digital technologies to facilitate social interaction and collaborative learning, as this was widely believed to be missing during at-home learning.

4. Address deficits in science education

In many cases, at-home learning made visible the minimal role science education plays in primary school learning programs. In light of national and jurisdictional STEM education initiatives, it seems important that this deficit be addressed. School leaders should re-evaluate the place and importance of science education in their programs and teachers should be supported to strengthen their science education practice.

5. Support access to digital learning technologies and internet

At-home learning also made visible issues inequitable access to digital learning technologies that impacts schooling. In some cases this was associated with families not having the resources to provide learning tools for their students, or with school supplied equipment being old and inadequate for the task of supporting remote learning. In other cases, this was associated with poor internet access in some geographical areas. Governments need to provide financial and policy support to address both these issues.

Future research

This report contains the findings of a preliminary analysis of data from this project. The data collected offers further opportunities for analysis. Currently under-review are two papers:

- A study of parental engagement in at-home mathematics learning arguing that the parents in this study fell into one of three categories: monitors (parents who supported at home learning by overseeing the completion of tasks); facilitators (parents who worked with their children to complete

the set tasks); and enhancers (parents who supplemented set tasks in response to their children's learning needs).
- An investigation of the use of digital technology to support mathematics and science learning that compares the rhetoric associated with digital technologies and remote learning during the pandemic to the lived reality of teachers and parents.

The research team is discussing a range of other investigations using the data including:

- An investigation of teachers experiences facilitating at-home mathematics and science education.
- A strengths-based analysis of teachers' approaches to supporting at-home mathematics and science education.
- An analysis of motivational factors impacting perceived student engagement in at-home mathematics and science education.
- An investigation of the extent and type of primary science activities implemented during the school closures.

This preliminary analysis also points to the need for future research projects, including:

- An investigation of the impact of the at-home learning experience on student achievement and engagement in science and mathematics. Science and Mathematics are both disciplines with relatively poor participation and achievement in the later years of schooling in Australia (Office of the Chief Scientist, 2017). It will be important to know how this period of at-home learning has impacted long-term achievement and engagement, and to explore any factors contributing to variance in this impact.
- A study of the impact of the at-home learning experience on teachers' mathematics and science education practices. The school closures forced primary school teachers to trial and experiment with a range of unfamiliar activities and modes of delivery. It will be important to investigate which, if any, of these become integrated into teachers' professional practices post-pandemic.
- A longitudinal study of parental engagement in mathematics education.
- A study of the experiences of families from lower socioeconomic backgrounds. Most parents participating in this study had a Bachelor degree or higher, with only three parents not having this level of education. It is reasonable to expect that the experience of at-home learning of parents not captured in this study have much to contribute to our understanding of the impact of school closures on the mathematics and science education of our students.

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