



SUPPORTING LEARNERS WITH SEND IN MATHEMATICS

A practical guide for schools



**“I LOVED THE WHOLE PROJECT
AND IT WILL HELP ME TO REALLY
TUNE IN TO MY SEND PUPILS AS
INDIVIDUALS AND NOT AS A GROUP
AND ENABLE ME TO FIND INDIVIDUAL
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(I AM NOW) BEING BRAVER WITH MY
CHOICES, AND AM NOT AFRAID TO
TAKE A CHANCE.”**

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1 INTRODUCTION

This booklet explains the findings of a research project funded by The Laurel Trust, involving nine schools - five mainstream primary and four special - during 2019-20. The research project explored strategies to better meet the learning needs of pupils with Special Educational Needs or Disabilities (SEND) in mathematics.

This booklet shares information about the rationale for, design and outcomes of the project. It then offers teachers and school leaders a set of practical ideas and advice for supporting pupils with SEND in mathematics in their own classrooms.

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2 THE RESEARCH PROJECT

The Lesson Study for Struggling Learners programme was an action-led research project led by the Communitas Education Trust in collaboration with the London South Teaching School Alliance. All participating schools sit within an area of urban deprivation, with high numbers of Pupil Premium pupils, and have observed increasing numbers of pupils with a diagnosis of SEND over recent years, in a context of shrinking school budgets. This has limited schools' abilities to access external expertise and school staff deployed to support pupils with SEND. The project therefore aimed to better support teachers to engage with recent evidence about supporting pupils with SEND and reduce the developing gap between mainstream and special schools.

Within Southwark, there was a 31% gap in maths attainment for pupils with SEND at the end of Key Stage 1 in 2019, and an even wider 49% gap at the end of Key Stage 2. This project sought to tackle this gap by supporting a group of mainstream and special schools to improve learning for pupils with SEND through a research approach to professional development: Japanese lesson study. In this process, teachers collaboratively plan and teach a series of lessons, discussing the learning they will then take into their own classrooms and the changes to practice they plan to implement.

The central research question was "Will enabling special and mainstream teachers to conduct joint lesson study make a difference to":

- **The confidence, knowledge, skills and practice of mainstream teachers in relation to teaching pupils with SEND mathematics?**
- **The enjoyment, engagement and learning of pupils with SEND in mathematics lessons mainstream classrooms?**
- **Whole school approaches to teaching and learning for pupils with SEND in mathematics in participating schools?**

Key aims of the project included:

- **To improve learning and wellbeing for pupils with SEND in mathematics lessons.**
- **To improve teachers' knowledge and understanding of what works for pupils with SEND in mathematics.**
- **To positively affect whole school policy and practice in relation to pupils with SEND in mathematics for five participating schools.**
- **To develop teachers' understanding of lesson study as a research tool in participating schools so that they use the approach to carry out their own research in the future.**
- **To develop a bank of effective strategies for teaching pupils with SEND in mathematics that can be shared across a wider group of schools.**

The intention of this project was not to implement a single approach to teaching mathematics, but to support teachers to identify a range of research-informed strategies, and to design, implement and measure the impact of any changes to practice that met the very specific needs of individual pupils with SEND in their classrooms. In this way, each teacher would be given the tools to construct and test a personalised intervention to meet the needs of their own pupils with SEND.

This project involved three teachers from each of five mainstream schools working alongside teachers from four local special schools to explore whether joint special-mainstream lesson study groups can improve the mathematics learning experience and outcomes for pupils with SEND in mainstream classrooms. The intention was that the project would offer learning for both special and mainstream teachers.



Participants began by observing learning in another participating school. They then identified focus pupils with SEND in their own mainstream classrooms, decided what difference they would like to make to these pupils' learning and then planned to try new strategies. In addition, each teacher group was provided with a range of research literature to study that focused on what is known about better meeting the needs of pupils with SEND in mathematics and was provided with a range of practical advice from the special school teacher in their group. In this way, the project hoped that the combination of research and practical expertise would combine to provide new solutions for pupils with SEND.

Each teacher group consisted of four teachers, with at least one being from a special school. Each group also contained one Lesson Study Lead Teacher who understood the approach and could lead the group effectively.

The project activities then consisted of:

- Lead Teachers meeting with a lesson study expert to plan first two sessions for teachers and to develop a detailed understanding of the project timeline (October 2019).
- A face-to-face session to introduce lesson study and the project, including timeline and data collection details.

- All participating teachers visiting their partner schools to observe practice, so mainstream colleagues observing in special schools, and special colleagues observing in mainstream schools.
- A face-to-face session to explore the literature on what works for pupils with SEND in mathematics and to review focus pupil case study baseline data. A focused research question was also agreed by each teacher group.
- Two planning sessions and two research lessons and post-lesson discussions were planned to take place for each lesson study group (January to April 2020). Unfortunately, for two schools, only one research lesson took place as the project was interrupted by school closures due to COVID. After each research lesson, teachers would be asked to commit to making at least one change to classroom practice.
- A face-to-face session to review learning from school-based lesson studies and to explore how best to implement this in their own practice and that of the school. Plans were also made to collaborate for mutual learning in the future. This became an online session due to COVID restrictions. Impact data was gathered (June).

This study had planned to incorporate the following methods of data collection:

- **A teacher baseline-impact audit to measure confidence in strategies to meet the needs of pupils with SEND in mathematics lessons (quantitative).**
- **A pupil case study from each participating teacher, capturing evidence of the impact of the project on engagement and enjoyment (Leuven Scale observation – see Appendix 1) and learning (work samples and assessment data) (qualitative and quantitative). Whilst baseline data was gathered, it was not possible to gather pupil impact data due to COVID school closures.**
- **Teacher evaluations of the impact of the project on their knowledge, understanding and skills in relation to better meeting the needs of pupils with SEND in maths lessons (qualitative).**
- **A senior leader survey to explore the degree of whole school impact on teaching and learning (qualitative). This did not take place as plans to disseminate findings to colleagues were cancelled due to school closures.**

3 FINDINGS

Confidence in teaching pupils with SEND prior to the intervention

Chart 1 below demonstrates that, at baseline, teachers were most confident in terms of adjusting their teaching during maths lessons when they recognise that pupils with SEND need extra help (67%, 12 of 18 teachers, were very or somewhat confident) and being able to manage extra adults in maths lessons so that the needs of pupils with SEND can be better met (61%, 11 of 18 teachers, were very or somewhat confident).

Teachers were least confident about planning sequences of learning that will enable good progression in maths for D pupils (33%, 6 of 18 teachers, were very or somewhat confident) and knowing what the next steps should be for pupils with SEND who routinely find maths challenging (33%).

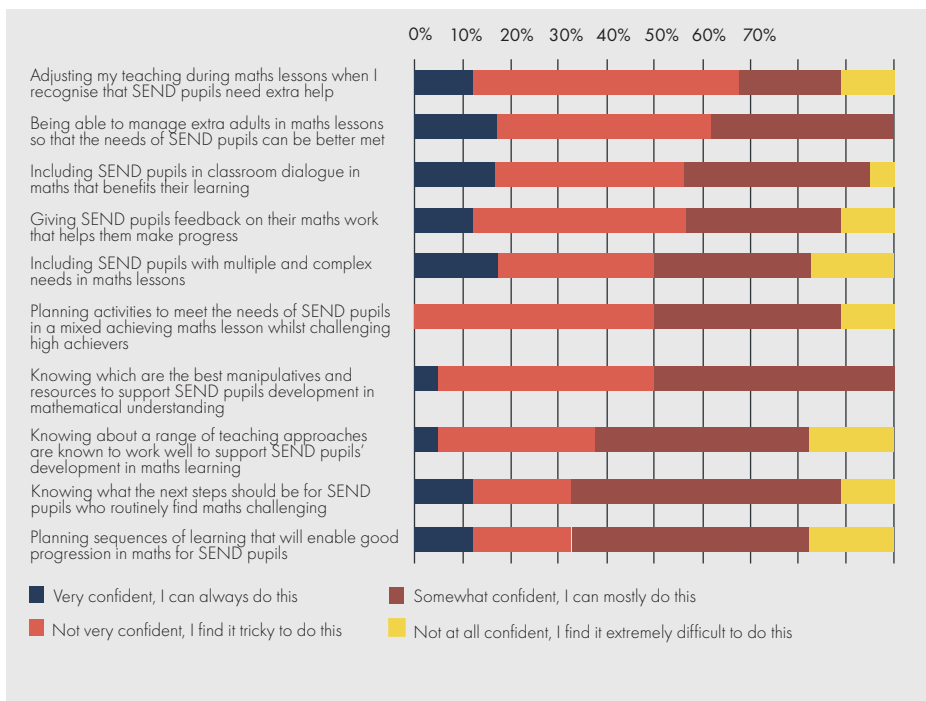
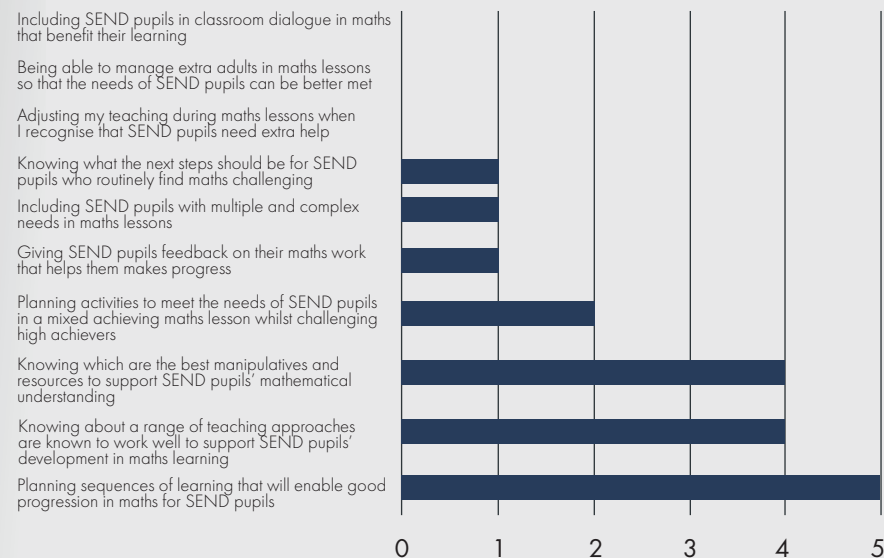


CHART 1: knowledge and experience of teaching pupils with SEND before the project

CHART 2: preferred project focus at baseline



When asked which skill they would pick to develop during the project, teachers' responses mirrored the skills they felt least confident about (see chart 2 above). For example, they had been most keen to develop skills in respect to planning sequences of learning that will enable good progression in maths for pupils with SEND (5 of 18 teachers). Teachers reflected that this would lead to better progression and understanding for pupils with SEND and that their time would be used more efficiently. Teachers also commonly cited knowing about a range of teaching approaches known to work well to support pupils with SEND's development in maths learning (4 of 18 teachers) as a preferred area of focus, reflecting that this would stop them using the same methods over again, allow pupils greater independence in their work and reduce the need for TAs to focus on just pupils with SEND.

Participants were asked what else they would like to gain from the project. In open response, the most common themes were around the need for a bank of resources and strategies recommending 'what works' with pupils with SEND, making pupils with SEND into more independent learners and more ways to improve SEND communication and socialisation.

Confidence in teaching pupils with SEND following the intervention

There were 17 valid responses to the end-point survey. The following data compares their baseline responses to their end-point responses.

Chart 3 below demonstrates that the largest impact can be seen in respect to teachers confidence Planning sequences of learning that will enable good progression in maths for pupils with SEND (increasing from 5 feeling very or somewhat confident at baseline to 16 at the end-point) and Knowing about a range of teaching approaches are known to work well to support pupils with SEND's development in maths learning (increasing from 6 feeling very or somewhat confident at baseline to 16 at the end-point). These were also the most popular areas for development at baseline suggesting that the project has adequately reflected the needs of the participants.

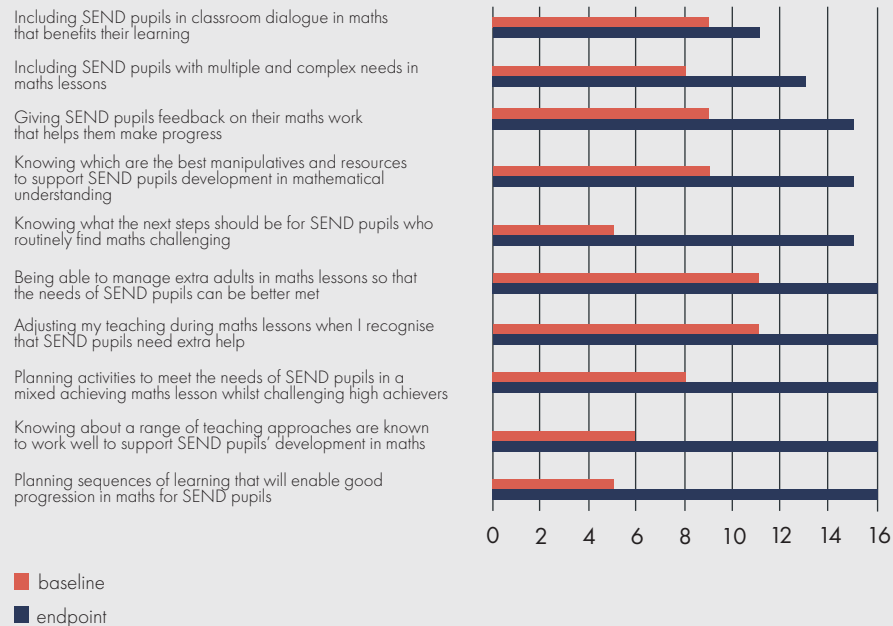


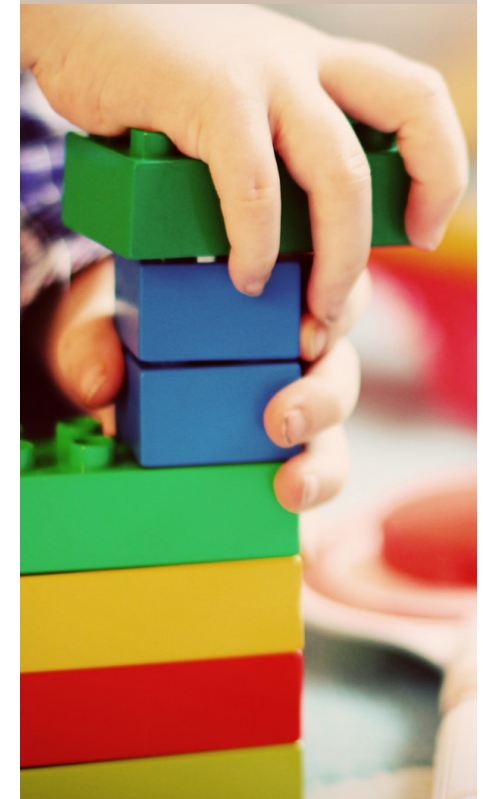
CHART 3: Teachers reporting they are very or somewhat confident

When asked, in open response, to reflect on how the project had impacted upon them, teachers said that they were now able to plan for a broader range of pupils and be more inclusive (8 participants), would be better able to adapt resources for pupils with SEND (5) and plan a sequence of lessons (4), focus more on desired outcomes for pupils with SEND in their planning (2) and had a better idea of why pupils with SEND disengage (2). Specific ideas that resonated with teachers included using multi-sensory approaches, ensuring resources are accessible, and splitting learning into manageable chunks. Some reflected that they expected to see more confident pupils and pupils with SEND that make more progress as a result. One participant said:

"I have a wider understanding of the different practical and visual ways I can help ALL pupils to grasp trickier, abstract concepts. I've also realised that I need to spend longer on these, allowing the children in my class to fully master the practical and visual concepts, before asking them to tackle them abstractly. This helped not just my children with SEN but all children in my class. I found a mastery of practical and visual learning of concepts actually allowed my pupils working at GD to extend and apply their learning to even trickier challenges. I will ensure I [find] ways to implement this in all topics now, from subtraction right through to time."

Additionally, participants cited the following as beneficial aspects of the programme:

- Access to academic reading.
- A deeper understanding of the mastery approach and how it can benefit pupils with SEND.
- The importance of planning for the resources used.
- Watching peers structure lessons.
- Giving children time and resources to figure out how to solve a problem themselves, before showing them the correct method.



Programme evaluation

There were 18 responses to the end of project evaluation survey. Chart 4 below shows that, on the whole, where participants had been able to complete project tasks before lockdown, the majority found each element to be very or quite useful.

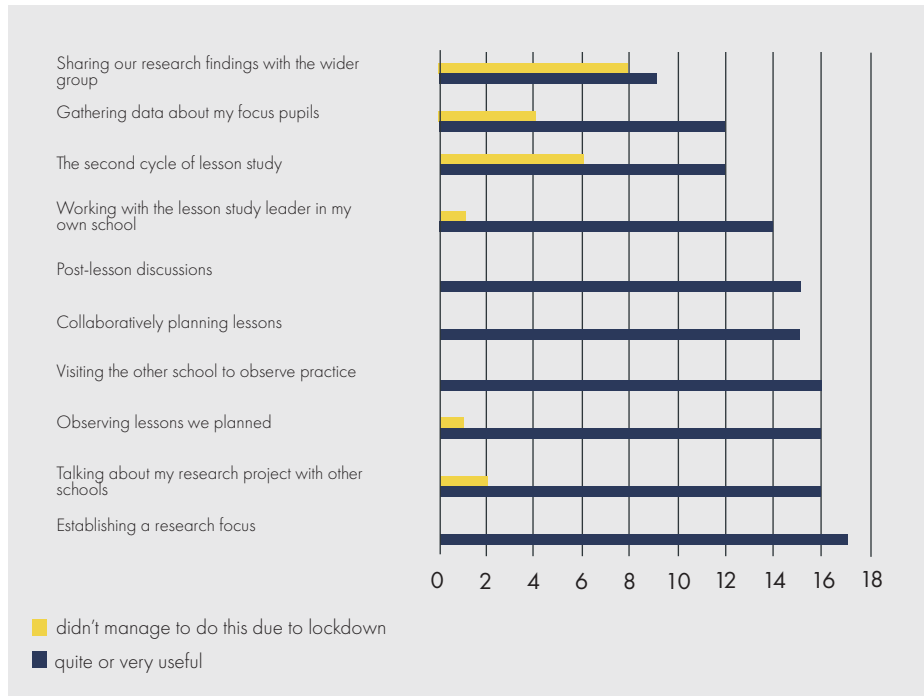


CHART 4: Number of teachers who found this project element to be quite or very useful

Sixteen of the 18 participants who took part said they would be quite or very likely to carry on using lesson study in their own school and 13 said it would have a strong or some effect on the other teachers in their school. Of those that had not been able to influence colleagues, lockdown was cited as the main reason.

When asked to comment on the project as a whole, examples of comments made included:

"I really enjoyed this project and hope to be able to see lesson study holding a more permanent place in education."

"This course has really helped to understand that thorough lesson planning is essential in order to be able to cater for SEND children. Lesson objectives, resources and adults must be planned for carefully. This has been a really great opportunity to share experiences with other teachers from different settings..."

"It's an excellent project, teachers found it helpful and above all takes the children's need into account."

"I loved it and would be thrilled to participate in future projects, I am really keen to further develop my practice!"

"I loved the whole project, and it will help me to really tune in to my SEND pupils as individuals and not as group."

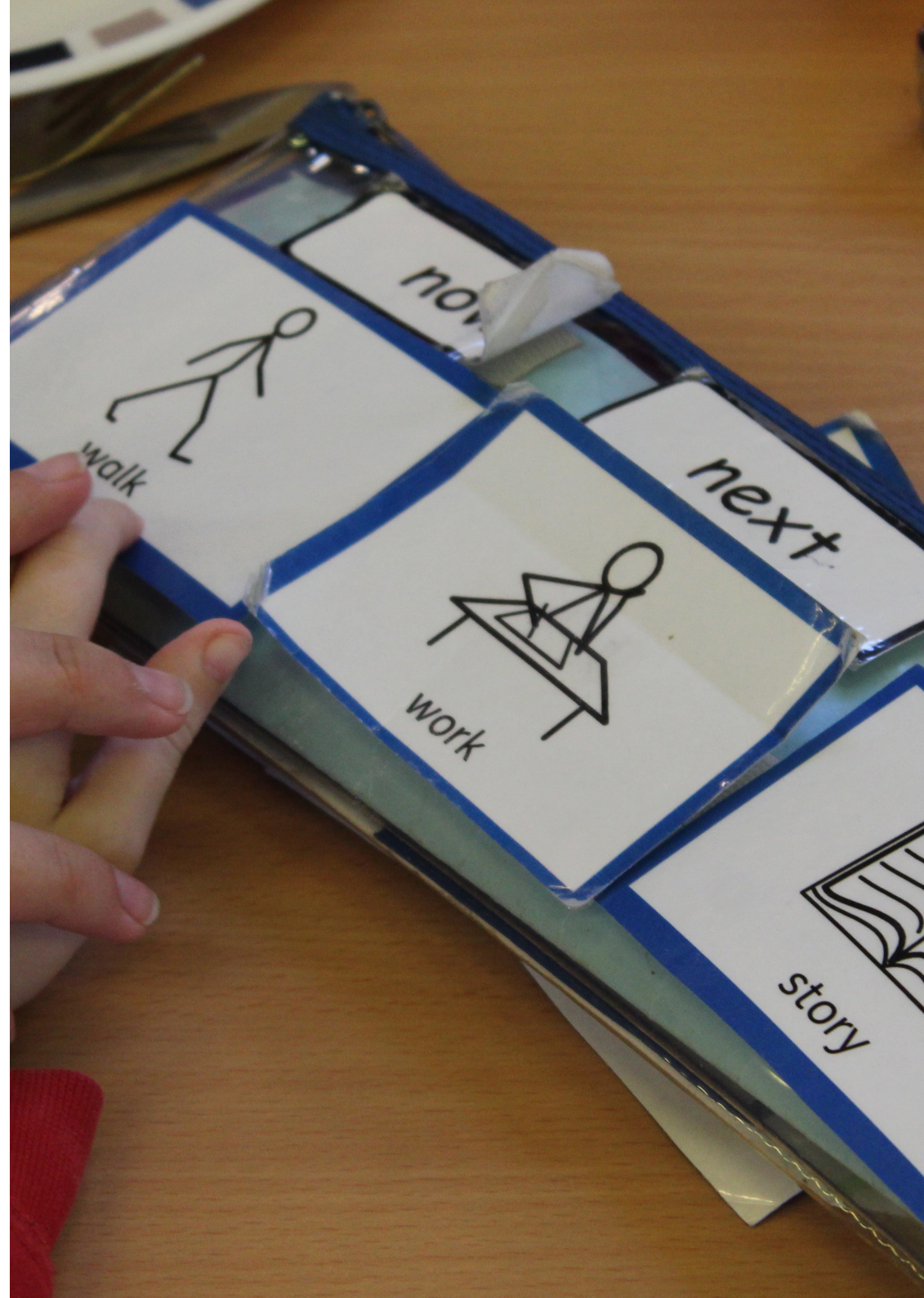
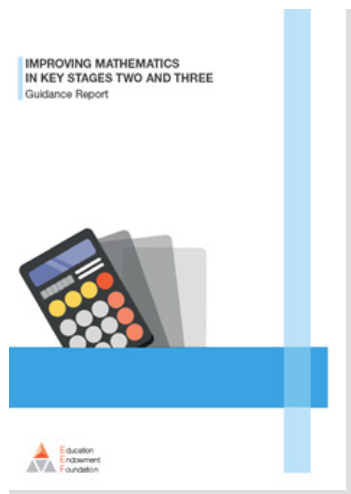
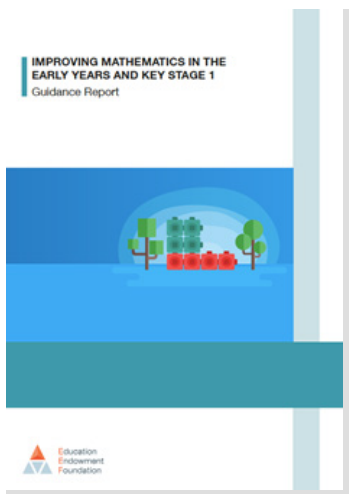
"Having read more widely around SEND has made me want to research more, find out more about the strategies we can put in place to better support the children."

"Working with my lesson study leader for me was the most useful part of this course. They were extremely knowledgeable and asked challenging questions which allowed me to deeply reflect on my practice outside of my school setting an expectations."



4 LINKS TO EEF GUIDANCE REPORTS

The findings in the following section of this booklet are drawn from the research outputs of the project and prioritised for inclusion by participating teachers. However, they do align with a number of the recommendations in the four EEF reports listed below, and we strongly recommend practitioners read these guidance reports alongside this booklet:



5 PRACTICAL GUIDANCE FOR TEACHERS

5.1 Think about each pupil as an individual

“As I now have a greater understanding of what is causing my pupils with SEND to disengage, I am able to prepare lessons which cater to a variety of needs. Pupils are showing higher levels of engagement and as a result making greater progress within the lessons.”

- mindset and resilience
- confidence and anxiety
- literacy
- reasoning
- memory and speed of processing
- arithmetic and number sense (dyscalculia)

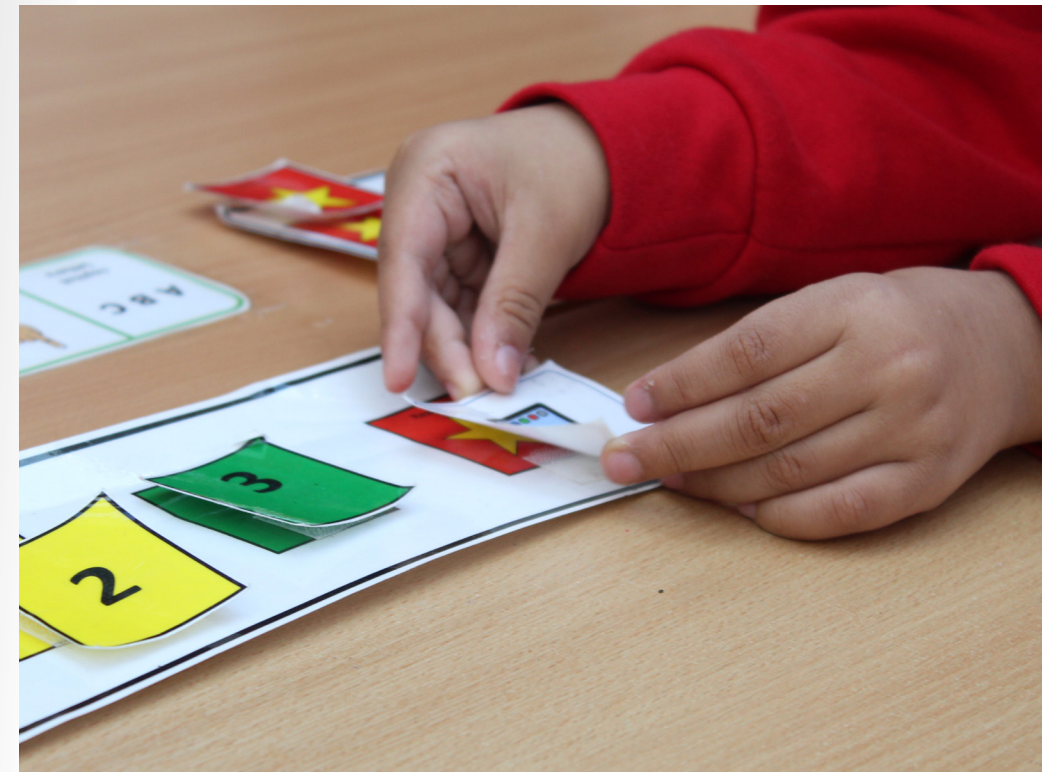
There is no one-size-fits-all description of pupils with SEND and we must bear this in mind when considering what might support their mathematical learning. Geary (2015), suggests that students struggling with a mathematical learning disability face challenges in either one or several areas:

- a delay in the development and poor fidelity of the system for representing approximate magnitudes;
- difficulty mapping numerals, number words, and rational numbers onto associated quantities;
- poor conceptual understanding of some arithmetic concepts;
- developmental delay in the learning of mathematical procedures;
- difficulty committing basic arithmetic facts to or retrieving them from long-term memory.

However, it is not only those students who can find it difficult to engage in lessons. Behan (2019) notes that whilst students may not face specific learning difficulties their maths learning can be impacted by other factors such as:

Therefore, for support strategies to work, they must be relevant to the specific child and meaningful enough for them to want to do it. When these things align then there is a greater chance of success.

Take the time to get to know your SEND children at the beginning of the year, as this will prove invaluable as the year progresses and will ensure that you are planning the best types of learning opportunities for them. Using the Leuven Scale (see Appendix 1) or a similar tool whilst observing is a great way to measure the different levels of engagement and wellbeing that individual pupils with SEND have with particular types of task. This will allow you to develop a detailed understanding of these pupils' enjoyment and engagement of mathematics learning and enable you to know how long they can focus for and the amount of work that they will be able to complete comfortably in one session, as well as to anticipate any challenges planned learning activities will throw up.



One teacher on the project identified that a particular learner needed regular breaks during the maths lesson. Knowing this enabled her to plan in such breaks, meaning the pupil could achieve more and also grow in confidence, and in his ability to persevere with tasks. The teacher began to ensure she provided him with exactly the appropriate amount of work for each session, using small chunks of learning each of which offered a firm building block in his learning and development.

5.2 Plan sequences of lesson carefully to gradually introduce concepts

“An organised and clear sequence of lesson plans reflects the small steps the children must take to achieve the main goal and learn the skill.”

North (2019) explains how deliberate and well thought-through lesson structure should be a key component of our attempts to reduce the decision-making overload that some pupils experience in lessons and that content sequencing is an important aspect of this. One teacher recounted an anecdote from a Shanghai maths leader, whose action research found that an inexperienced teacher who had taught perimeter before area produced significantly higher instances of correct responses from pupils calculating the area of complex shapes than a highly skilled and very experienced teacher who had begun with area before moving to perimeter. A well-planned and structured sequence of lessons will benefit all, and this is

By breaking down every stage of learning into the smallest of steps, not only is the burden on learners’ working memories reduced, but you also make sure all the necessary pre-skills are in place before introducing new content (Bird, 2017). The new information that pupils with SEND need to process is less and by focusing on one specific teaching point it is easier to assess what misconceptions might be impeding learning and to address these effectively.

Through planning research lessons, it became clear to teachers on the project that they needed to consider the coherence of the unit or block of learning within which the lesson sat. Teachers therefore began by identifying what prior knowledge it would be necessary for pupils with SEND to have in order to access this lesson, and how the lesson could build effectively on prior learning.

Many schools on the project followed a particular scheme of learning for maths or used textbooks and where these were high quality, they broke topics down into series of teaching points or small steps which could help focus individual lessons.

However, teachers found it was important to look at teaching sequences critically and to consider the specific needs of the pupils within their classes. Teaching with the textbook and not from the textbook means that planning resources were used as a starting point and teachers were not be afraid to deviate or make changes in the interest of their pupils. Teachers found it was often necessary to break a concept down into even smaller steps to ensure pupils with SEND comprehended fully.

Teachers on the project identified some planning pitfalls that were important when planning sequences of learning to meet the needs of pupils with SEND:

- **Making assumptions about what was taught previously:**

Content may have been taught, but has it been retained? Do pupils with SEND have the necessary prior knowledge to engage with the new learning? A quick assessment at the beginning of the unit of work can help check what has really been learnt.

- **Exploring connections across concepts before a single concept is fully understood:**

Whilst it is useful to emphasise that maths is a few big ideas applied in different ways rather than a seemingly endless series of facts and algorithms that need to be remembered, the most effective lessons for pupils with SEND looked in depth at only one idea, and did not follow tangents of thinking.

- **Not building in retrieval practice into lesson structure:**

The strongest sequences of learning for pupils with SEND considered lessons as ‘overlapping lily pads’, supporting pupils with SEND to recall the relevant learning from previous lessons before introducing new content.

- **Moving too quickly:**

It is easy to feel under pressure to move quickly through the curriculum to ensure coverage or to remove concrete resources or pictorial representations once abstract representations have been met. Both approaches may damage learning for pupils with SEND.



5.3 Break lessons into short chunks

“Moving forward, I will be splitting lessons into manageable chunks for my students and giving them a cold start to improve understanding of new concepts.”

Teachers on the project found that short bursts of learning were more successful for pupils with SEND. Shorter tasks with less to complete resulted in better learning outcomes. These pupils needed to have lots of short breaks, and this improved on-task concentration. For certain pupils with SEND, this meant doing a completely unrelated physical activity or non-mathematical task.

Teachers found that using timers helped give the breaktime a clear beginning and an end, avoiding situations in which pupils with SEND did not want to come back to the maths task.

Regular mini-plenaries helped break lessons up for pupils with SEND, tackling misconceptions quickly, and allowing time for specific teaching of skills. Catching mistakes in methods before they became embedded helped avoid bad habits forming, which were difficult to unlearn.



5.4 Plan talk carefully

As a teacher, being purposeful and precise with your language requires a high level of subject knowledge as well as careful planning. This can be a challenge as many UK teachers are not maths specialists; however, thankfully, there is an expanding range of high-quality resources available to support planning and preparation for lessons. Teachers on the project made careful use of planning schemes used in their schools, as well as other resources including the NCETM PD Materials, to identify key vocabulary. They then included this in both written plans and on the presentations that were to be delivered to the class to ensure teachers' and support staff's language was accurate and precise.

Teachers found that consistent lesson structures helped pupils with SEND understand what was being asked of them during each part of the lesson, and there were also particular approaches which helped ensure that task instructions did not overwhelm the working memory of pupils with SEND:

- *repeating instructions;*
- *delivering instructions one at a time;*
- *presenting instructions alongside a visual checklist;*
- *keeping vocabulary as simple as possible.*

Focusing on one concept at a time also helped reduce the possibility of overwhelming pupils with SEND with language, and especially with too many new words. The connected nature of mathematics is one of its most interesting aspects and seeing pupils make these connections can be exciting and rewarding, but teachers found that diverging from the focus of the lesson ran the risk of introducing additional language that could confuse or overwhelm pupils with SEND.

Kelly's research (Kelly, 2020) helped one school to reflect on how the instructions they gave during lessons not only challenged children to think about their new mathematical learning, but also to consider what they were being asked to do. "Learning new things involves shifting gears as the activity changes. That takes flexible thinking skills," (Kelly, 2020) something many pupils with SEND find challenging.

Teachers also found that it was not enough to make pupils with SEND aware of the relevant language - it was also important that they were given opportunities to use and apply this language through guided practice. Teachers should use language alongside practical demonstrations to explain the choices being made, and then support pupils with SEND to do the same with increasing independence. For example, when teaching addition with regrouping you might explain, "Now I have 12 ones, I know 12 is greater than 10 so I will need to regroup. 10 ones are equal to 1 ten so 12 is equal to 1 ten and 2 ones..." and then later in the lesson, support pupils with SEND to articulate their thinking when working on problems with a partner using a stem sentences such as,

**[] ones + [] ones is equal to [],
I know that [] is greater/less than
10 so this means I will/will not need
to regroup.**

This means that not only do pupils with SEND embed new vocabulary by using it in context, but they also have the key learning reinforced through listening to explanations from their peers. Regular plenaries as well as summarising learning at the end of each lesson in one or two short sentences gives pupils with SEND further opportunities to listen to peer explanations.

Mathematical concepts are mastered as pupils work together, using their shared experiences and language to develop a consensus of understanding as a class, with teacher support to guide discussions and clarify misconceptions as necessary.



Here are some pitfalls to avoid when thinking about your use of language and talk in maths lessons:

- **Not having consistency of language between all staff.** Consistency is key as it avoids pupils' working memories being unduly taxed by introducing additional vocabulary, or having two words for the same thing: e.g., "the big number" and "minuend" for the first number in a subtraction equation. Briefing other adults in advance of the lesson and making key language clear both in planning and during the lesson (through stem sentences for instance) are some of the strategies that can support staff to work coherently together.
- **If conversations during group and partner work are left unchecked, it is possible for misconceptions to develop with pupils using and applying vocabulary incorrectly.** Adults in the class should correct these when they hear them and use regular plenaries to ensure pupils with SEND hear key language being used correctly by adults and their peers.
- **It is important not to value the precise use of language to the extent that pupils with SEND are reluctant to share misconceptions or partly formed ideas.** When pupils perceive their classroom as "mistakes unfriendly", the effort they put into their work has been shown to decrease (Steuer et al., 2013). By valuing mistakes as a valuable tool for learning, up-leveling pupils' responses and mirroring them back to them or allowing other pupils to "build on" other responses, it is possible to avoid this danger.



5.5 Ensure teaching assistants focus on learning and not task completion

“(From now on), I will make sure support from additional adults is planned to scaffold pupils’ learning, allowing them increasingly to work independently.”

Additional adults are a valuable classroom resource and can often greatly impact the learning of the children in class. However, Giangreco (2010) found that well intended teaching assistants (TAs) can inadvertently promote behaviours such as over-dependence, non-engagement with the teacher and interference with peer interactions, especially when working with pupils with SEND.

Similarly, Blatchford, Russell and Webster’s (2012) important study into teaching assistants and other school staff and analysed the impact of teaching staff on learning, behaviour and academic progress; the project found that increased time with aTA had a negative impact on progress for pupils with SEND, one of the reasons being that the focus of these additional adults can sometimes shift to task completion. The project found that it was the way in which TAs were deployed and their focuses and values that made the biggest impact. When focussed on the process of learning rather than the outcome, pupils with SEND can make good progress with the support of a TA.



When planning lessons, it is important to think about the role of the TA and how they can best support learning, as well as communicating this clearly to them. This will ensure that the TA is aware of how best to support the teacher and the pupils with SEND in order to impact the learning rather than detract from it.

- Ensure the TA is aware of their role and the specific learning objectives for the pupils with whom they are working. The objectives for pupils with additional needs may be slightly different to the other pupils in the class. For example, in a lesson on addition, the main objective for some pupils may be to accurately determine and count out the correct number of resources, or to use one to one correspondence. In this instance, if the TA is not aware of these goals then they may focus on supporting the pupils with SEND in adding together two groups when they are not yet able to understand how to first make those groups at all. By ensuring good communication of specific goals and objectives, we can ensure that the TA understands what pupils with SEND are expected to achieve and therefore ensure that they can achieve that with independence.
- Ensure that the TAs are empowered and involved in both the planning and delivery of the lesson as well as helping support the culture of the classroom. Teachers on this project found that when TAs understood the teacher’s main priorities and did not feel pressured to produce a page of beautifully presented, heavily supported work, they were more likely to focus on the process of learning. Involving TAs in the planning process and communicating well empowers them to either ask for additional support from the teacher if something is not going well in a lesson, or to further explore something when misconceptions arise, therefore supporting pupils’ understanding rather than pushing on to get the work finished.
- Provide question stems or discussion points in order to enable open questioning and a focus on learning processes. Providing TAs with some open question stems can increase confidence and allow them to ensure they are supporting the thinking processes of the pupils with SEND with whom they are working, rather than supporting task completion. Radford, Blatchford & Webster (2011) found that while teachers ‘open up’ discussions with open questions, TAs are more likely to ‘close down’ the talk, which can result in less developed understanding from pupils with SEND.
- Allow TAs to continue their professional development by sharing higher order thinking and questioning skills as well as developing mathematical understanding through training. Blatchford, Russell and Webster (2012) highlighted the importance of TAs continually developing their professional skill and understanding. Radford, Blatchford & Webster (2011) suggest that part of this can come from teachers sharing these skills and questioning techniques with TAs in order to develop interactions and ensure they are opening up discussions. Alongside this, helping TAs develop confidence in mathematical concepts and subject matter will allow them to focus more on the process of learning because they will have the knowledge to talk around the subject and explore different methods, rather than understanding solely what has been taught in that lesson, which could lead to a tendency to just complete the task.

“I have learnt that additional adults must be very clear about the expectations for the lesson and must be given plans that are clear and easy to follow.”

It is important to maintain a strong and open relationship between the teacher and any additional adults in the classroom. There are some pitfalls that should be avoided when ensuring that TAs are focussed on the learning rather than task completion:

- **It is important to strike a balance between the shift away from task completion and ensuring high expectations for all children. Ensuring that TAs are clear that although you may not be expecting a page of completed work for every child, you all need to have high expectations and ensure that every child is challenged in their individual ways.**
- **Ensure that all evidence or observations are meaningful. If you are not recording learning in traditional methods such as work in books, you may choose to task the TAs with providing evidence such as photographs or observations. It is important to ensure that TAs have a really clear understanding of who and what that ‘evidence’ is for. Ensure that TAs understand what they need to show with any photographs or observations in order to ensure that it truly reflects the context in which the children were learning and what each individual was able to achieve independently.**

5.6 Use a ‘cold start’

“I now know how important it is to give children time and resources to figure out how to solve a problem themselves, before showing them the correct method. This way they have their own experience to relate to the teaching of the method.”

Teachers on the project found that ‘cold starts’ were particularly beneficial to pupils’ learning in mathematics. ‘Cold starts’ allow pupils to try a previously taught or new skill before any teacher input. According to Goddard (2019), if learners are encouraged to recall what they have learned and have a go before the teacher shows them, even if what they try is wrong, their memory will be enhanced as a result. For example, teachers in one research lesson noticed that when pupils with SEND were reminded about mistakes made in a previous lesson on adding fractions together, they were able to self-correct independently. The experience of remembering their own mistakes and avoiding a repeat was more powerful than a teacher modelling a perfect example.

Pupils with low self-esteem or confidence may struggle with the experience of making mistakes. Teachers felt the ‘cold start’ approach encouraged pupils with SEND to adopt a growth mindset in relation to their mistakes. Firstly, pupils with SEND were able to see how their previous mistakes directly informed current success. Secondly, if the teacher asked a few pupils to share different misconceptions, a healthy mistake-making environment could be normalised. This kind of reflection and self-regulation can also be linked to metacognition (Barnett, Cleary, 2015) which has been shown to improve outcomes for pupils.

The strategy was also found to be useful at the point of teaching a skill for the first time as it provided valuable assessment for learning which could inform the sequence of learning moving forward.



5.7 Make careful use of manipulatives and concrete resources

“Through practical lessons involving the whole class, my children with SEN began topics on a ‘high’ feeling - involved, enjoying and understanding the first lessons in the sequence far more independently than usual. This increased their confidence, and they were more engaged with ‘trickier’ lessons involving abstract concepts later on in the sequence.”

A meta-analysis comparing the use of ‘hands on’, practical resources with abstract mathematical teaching found that manipulatives had a positive impact on learning (Carbonneay, Marley & Selig 2013). The same study found a greater impact on retention than problem solving, suggesting that while concrete resources and manipulatives are greatly beneficial, the way in which they are used informs their impact. This is supported by a study by Moscardini (2009) who found that practical resources are often used as either a ‘tool’ or a ‘crutch’ by both teachers and pupils.

When studying one- and two-digit subtraction problems with learners with moderate learning difficulties, he found that concrete resources can sometimes be used simply to teach procedures. In these cases, it was found that long term understanding was not improved. However, when the concrete resources were used flexibly, as a “tool” to help further understanding rather than a “crutch” to complete a process, long term impacts on knowledge and understanding were much greater. In these instances, pupils were more likely to generalise and apply what they had learnt across contexts.

As well as this, manipulatives may provide some pupils with SEND with a confidence boost needed in order to persevere with challenging problems. Carr, Seiner, Kyser and Biddlecomb (2008) found that pupils who had less reported confidence in mathematics were more likely to persevere in their use of manipulatives. This may then lead to improved achievement and wellbeing which might allow these children to build their mathematical understanding in the long term.

Teachers on the project found that giving pupils opportunities to hold and physically move resources allowed them to see mathematical structures and removed the need to visualise or hold information in the mind before they were ready to do so. Alongside this, using concrete resources within a context, for example using cut out characters to support addition or multiplication for younger pupils, not only engaged pupils with SEND, but made the maths real and meaningful. Overall, teachers reported that use of such concrete resources increased pupils’ independence and reduced over reliance on adult support.

“(From now on), I will ensure resources are accessible, e.g. within reach and labelled clearly, to encourage independent use”



Teachers on the project found they were able to plan to use of manipulatives and concrete resources for many different mathematical concepts and lessons. They found the use of manipulatives were most successful for pupils with SEND when:

1 The rationale for the use of manipulatives and concrete resources had been carefully thought through in planning:

During lesson planning, ensuring that teachers were clear which resources they wanted to use and why, helped support learning progression for pupils with SEND during the lesson. Removing any resources that might confuse or over-complicate activities ensured that the pupils could stay focused on the maths that they were learning. Thinking about what the children needed to know and how resources could genuinely support understanding of a concept or a process, allowed teachers to ensure that every resource they used was for a reason and would impact learning.

2 Processes and resources were modelled explicitly at every stage:

Having the resources available was not enough. Teachers needed to ensure that pupils with SEND were explicitly taught how and when to use them within the context of the lesson. Modelling the use of the manipulatives for each individual task allowed pupils to understand the processes and procedures involved, enabling them to focus on the mathematical concepts being taught.

3 Individual pupils, classrooms and available resources were kept in mind:

Remaining realistic about what was possible for pupils with SEND in our classrooms allowed teachers to ensure that they were not overwhelming pupils with new structures and routines too quickly. Allowing all pupils to have concrete resources on the carpet during a teaching input may seem unrealistic at first. This will require the teaching of structures and routines in order for pupils to understand the use of the resources as well as the practicalities of getting them out and putting them away, what to do with them when they're not being used and how to share them effectively with partners. Teachers needed to bear in mind what was available in order to plan realistically. If a teacher did not have 15 cubes available for every pupil, they would need to consider alternative resources.

4 Visuals were used to support the use of the manipulatives and concrete resources:

The use of visual reminders, such as checklists, allowed pupils with SEND to be as independent as possible when using resources. Removing the need to remember the steps involved in each procedure meant that pupils could work on tasks with minimal adult input.

An example of a pupil checklist made using Communication In Print software

Steps to success				
	? 1 Question 1	? 2 Question 2	? 3 Question 3	? 4 Question 4
 Read the statement and then read it again				
 Identify the denominator and choose the grid that matches				
 Share the amount into the fraction grid				
 Check that each part of the fraction is the same value				
 Count how many are in one part of your fraction grid.				
 Is it the same as the statement?				
 Yes? Its true! No? Its false				

“(I have learnt not to be) afraid to try and use new manipulatives as well as allowing the children just to have a play with the manipulatives before getting stuck into the activity.”

Teachers on the project identified several pitfalls in terms of using concrete resources, including:

- Having too many resources used in different ways in one lesson can be overwhelming. Teachers found that planning a different resource for each task led to confusion and cluttered workspaces. This in turn detracted from the learning that had been planned. To avoid this, make sure that each resource has a very specific and clear use and that pupils with SEND are really aware of how to use them to achieve the desired lesson outcomes.
- Not all manipulatives and resources are self-explanatory. Although allowing pupils to decide how to use manipulatives may provide some extra challenge for the higher achievers, for pupils with SEND it is important to explicitly teach how to effectively use each resource with modelling at every step. Ambiguity in terms of how best to use the resources may detract from learning and lead to poor learning behaviours.
- Pupils with SEND need time to explore and play with some resources. Pupils may be excited by the introduction of new resources, especially if they are linked to their own personal interests. This could lead to distraction and resources being used for play activities instead of the task at hand. Allowing pupils with SEND some time to explore and play with the resources outside of the time allocated for the task can mean they use the resources more effectively during the maths lesson. We found that allocating specific time for talking about the characters or building towers from the blocks allowed pupils with SEND to understand when playing time had finished, and therefore meant on-task time was more efficient.
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“I have learnt that it is extremely important to plan carefully for the resources used. I have learnt that often less is more, as I always had too many resources, and this created confusion.”


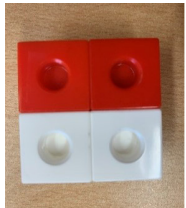
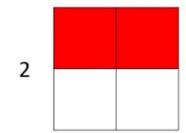
- Not accounting for set-up and tidy-up time can leave the lesson feeling rushed. Some resources will take a while to organise, especially if there are lots of them needed for each individual student. If this is not planned for, it can take up valuable lesson time and leave the teaching staff and children feeling rushed. To avoid this, make sure resources are prepared into packs before the lesson wherever possible or ask the children to help organise them. Plan time at the end of the lesson for tidying up. We found incorporating this time into the lesson and using it as a plenary worked well. For example, counting as you put the resources away or explaining a different key term to a partner that you have learnt as you put away each resource.
- Pupils with SEND may become over-reliant on a specific resource. Although resources are fantastic at helping to build mathematical structures and understanding, it is important to gradually reduce their use and move towards a pictorial representation. This will allow pupils with SEND to generalise the skills they have learnt and apply their learning in different contexts when the specific resource you have used may not be available.



5.8 Display multiple representations to support conceptual understanding

Bruner identified three stages of cognitive representation and showed that all learning occurs through these stages, beginning with direct manipulation of objects and ending with children being able to work in the abstract, for example using formal written methods. For learners who are also facing challenges due to their underdeveloped executive functioning it is even more important that they are supported to move through these stages at an appropriate pace:

What this means in practice, is that it is difficult for all pupils and especially those facing additional challenges to think in the abstract if they have not had sufficient access to and interaction with concrete manipulatives and pictorial representations that expose the mathematical structure being taught. When introducing a new concept, teachers should use the CPA (concrete, pictorial, abstract) approach either within a lesson or across a series of lessons as appropriate.

			$2^2 = 2 \times 2 = 4$
<p style="text-align: center;">Enactive</p>	<p style="text-align: center;">Iconic</p>	<p style="text-align: center;">Iconic</p>	<p style="text-align: center;">Symbolic</p>

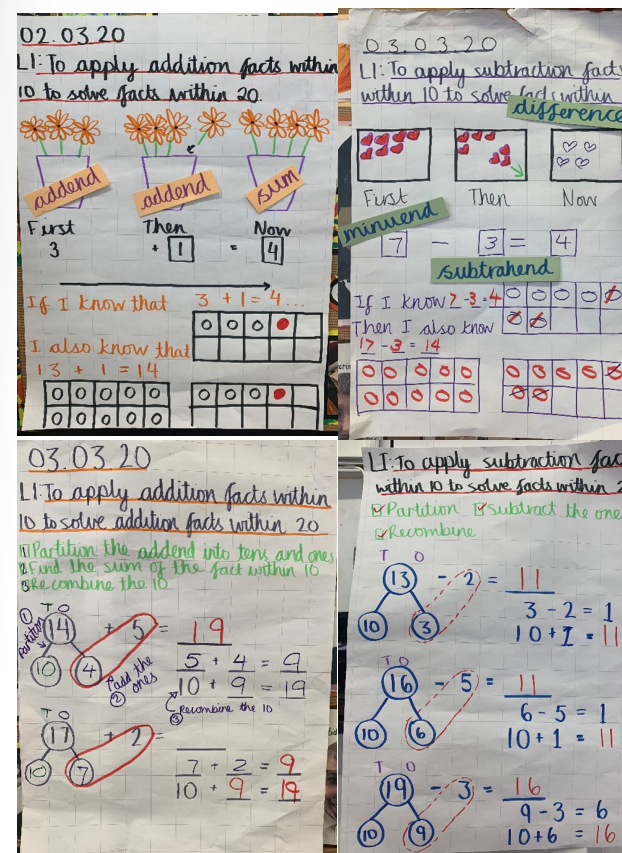
Kelly (2020) explains that when pupils are working on complex maths problems, they can get lost in the problem due to their inability to hold on to information necessary to complete the problem. Some pupils with SEND will therefore require iconic or enactive prompts to support this recall. Learners with dyscalculia, for example, may have very little ability to conjure up an accurate mental number line in their heads.

Teachers on the project noticed that some pupils with SEND found it difficult to follow the teacher's voice, and using modelled examples that were structured in a clear and logical way for example by using annotations, notes or colours could support pupils to make sense of the explanation independently later in the lesson (e.g. while attempting practice questions or following a lapse in concentration).

For many pupils with SEND, memorisation of symbolic procedures is challenging, and they will continue to rely on visual models to support their working memory and cognitive flexibility when many of their peers will be comfortable working in the abstract (e.g. when using formal written methods). It is therefore useful to have a record of visual models for pupils to refer back to. This could either be in books or on display in the classroom.

- In books – In KS2, children may be able to copy examples from the board but for some children, including those in KS1, a printed example that can be stuck into books is likely to be necessary.
- On display – visual models used or produced during lessons can be moved to a working wall or display for children to refer back to during future learning. In some cases, it may be useful to have a washing line with models showing the progression in learning over a series of lessons.

Some examples of classroom displays for use in future learning



"I now have a wider understanding of the different practical and visual ways I can help ALL pupils to grasp trickier, abstract concepts. I've also realised that I need to spend longer on these, allowing the children in my class to fully master the practical and visual concepts, before asking them to tackle them abstractly. This helped not just my children with SEN but all children in my class. I found a mastery of practical and visual learning of concepts actually allowed my pupils working at (higher levels) to extend and apply their learning to even trickier challenges. I will ensure I find ways to implement this in all topics now, from subtraction right through to time."

It is important to use a range of representations to explain concepts to pupils who have difficulties with learning, as they likely see and learn in different ways to their peers. (Gibbons, 2018, p.4). The NCETM provide Professional Development materials with a range of representations mapped to the national curriculum that can be used to support learners.

It can be distracting for pupils with SEND if tables become cluttered, so it is better to have representations recorded in books or on boards rather than as an additional table resource. Older pupils (e.g. years 4, 5 and 6) may be able to copy off the board but younger pupils (e.g. years 1, 2 and 3) will likely need to stick in notes (e.g. a screen grab) supplied by the teacher.

Many pupils are not accustomed to their books being a resource that they can use to support their learning, likely seeing them instead as a record for their teacher, so building a culture where pupils refer back will take time and prompting. It is essential to build this prompting into lessons and to persevere in order to see the benefits. For some pupils with SEND, a personalised, 'What to do if I get stuck' crib sheet may support them to look back over previous work or to use the displays around them. This could be placed inside the cover of a books for easy reference.

If lessons are not sequenced thoughtfully, then referring back won't be useful, as previous working walls will not show learning that can be built upon, and pupils with SEND may need to look back a long way in their books to find the relevant information.

Different learners will move through the concrete, pictorial, abstract process at different paces and it is important not to move them on before they are ready. For pupils with SEND, visual representations may need to be complemented by access to concrete resources for longer periods of time.

5.9 Pupil explanations as a learning strategy

"Students must engage in discourse that is connected to their thinking about the math with which they are engaged and that supports deeper understanding." (Buffington, Knight and Tierny-Fife, 2017, p.1)

Research shows that explaining or 'teaching' a concept to a peer consolidates understanding (Cohen, Kulik and Kulik, 1982). When vocabulary is taught in context and children have the opportunity to rehearse its use, the language is more likely to be used by pupils in the future. Scarcella (1990) and Schleppegrell (2012) found that pupils need support in the learning and use of this academic language and that when given the opportunity to practice their new vocabulary they are able to build their understanding. Feldman and Kinsella (2005) found that 'prepared participation,' which gives pupils time to collect their thoughts, can help improve the development of understanding through talk. Both Feldman and Kinsella (2005) and Buffington, Knight and Tierny-Fife (2017) recommend speaking frames and sentence stems to support pupils with SEND.

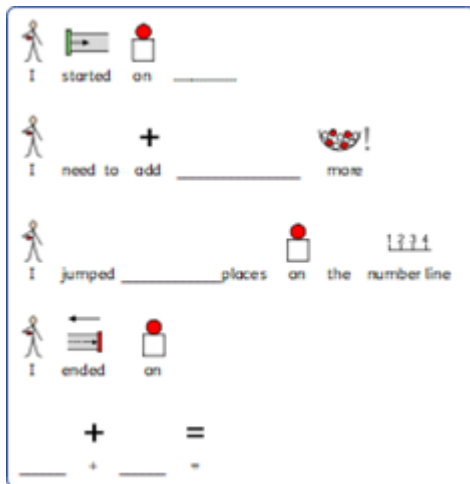
Teachers on the research project found that empowering pupils with SEND to explain their thinking in full sentences with the use of sentence stems and mathematical vocabulary enhanced their understanding and led to a deeper conceptual understanding.

"(I have learnt that) encouraging SEND pupils to answer in full sentences can solidify understanding."

Some of the most successful strategies were:

- Provide pupils with SEND with terminology that will help them to explain concepts and ideas. For example, giving a name to the different parts of an addition equation allowed pupils to fully explain the process, which consolidated their understanding.
- Provide speaking frames to support pupils with SEND to formulate full sentences. Giving a structure supports pupils to explain their ideas and allows them to focus on the mathematical understanding, as well as to explain what they have not understood.
- Differentiate speaking frames. Use visuals such as symbols or cloze passages to support pupils with SEND in explaining their thinking in full sentences.
- Have high expectations for full sentences every time. Providing a speaking frame also reminds pupils of the expectation of full sentences. When pupils with SEND become familiar with using speaking frames, they will begin to formulate their full sentences independently.

- Encourage all adults in the classroom to model full sentences both when speaking to the pupils and to each other. Have the additional adult model full sentences at the start of a class discussion in order to set expectations for how pupils should answer.
- Have generic and specific speaking frames available in every maths lesson. You may have some generic speaking frames which can be used in every lesson and displayed on the walls. These might include sentence stems such as "First I...", "To find my answer I...", and "I can prove it by...". These can be used during whole class discussions including when pupils are working at the front of the class or demonstrating on the whiteboard.
- You may then have specific speaking frames that support pupils with SEND to explain how they solved a particular problem or completed a particular task. This may look more like this:



Example of speaking frame developed using Communication In Print software.

Be mindful that pupils with English as an additional language may face extra barriers to full sentence explanations. In these instances, maintain high expectations and ensure that you are differentiating any speaking aids in order to fully support every pupil. Teachers also found that pupils with SEND needed to have fully understood any new language before being asked to use it in full sentences. Teachers also found it was important to make sure TAs were prepared for the language that would be used in every lesson and confident to use it accurately.

Printed speaking frames on tables did sometimes provide a distraction to pupils with SEND during whole class discussions. Some teachers resolved this by using generic speaking frames stuck to the tables or secured to walls that are near pupils' tables. Sharing speaking frames was difficult for some pupils with SEND with sight or social needs, so consider individual speaking frames in this case.

5.10 Build confidence and remove scaffolds gradually

Teachers on the project observed that pupils with SEND needed to be offered a series of similar tasks over an extended period of time in order to really develop an understanding of the concept being taught. This corresponds with what we know to be true of all learners: 'Nobody ever excels at anything without lots of practice and that starts with the way we conduct our lessons' (Sherrington, 2019 p. 39). Sherrington (2019) highlights a range of relevant instructional procedure identified by Rosenshine (2012), including:

- Providing a high level of practice.
- Guiding students as they begin to practice.
- Preparing students for independent practice.
- Monitoring students when they begin

Teachers on the project implemented this principal of gradually removing scaffolding to support pupils with SEND to move through different stages of practice, in order to achieve sufficient depth of understanding and allow them to engage with their work independently.

The most effective teaching sequences involved pupils with SEND first joining the whole class teaching of new skill or concept with the teacher modelling or explaining the mathematics, through guided practice, with the teacher asking questions, checking understanding, and using worked examples to 'make sure that they are developing strong schema early on' (Sherrington, 2019 p. 39). Pupils then explored similar problems as a pair or a group with the teacher or TA ensuring they achieved strong understanding: 'Practice must be guided so that the chance of forming misconceptions is minimised' (Sherrington, 2019 p. 39).

Paired work helped reduce anxiety levels and uncertainty for pupils with SEND on the project and provided opportunities to quiz or question their peer. This ensured pupils were able to achieve a high success rate, which Rosenshine (2012) identifies as a necessary prerequisite before pupils are ready to have a go on their own. Following the advice of Rosenshine (2012), when pupils progressed to this independent practice it was important that tasks remained largely the same as during guided practice and paired and group work in order to allow pupils with SEND to be sustain a high success rate and continue to build their confidence as another layer of support was removed.

“(From now on), I will plan mixed-achievement grouping or pairing to support learning.”

This process was fluid and led by the pupils with SEND themselves: some did not progress past paired learning in the first session on the topic. Where success rates were too low, it was necessary to, “re-teach, re-explain, re-model; to return to more secure ground and build back up again, perhaps trying different approaches” (Sherrington, 2019 p. 42). The next time that they were offered the task, sometimes the next day, teachers began by offering them an opportunity to work again with a partner, before letting them progress to working alone. Pushing pupils with SEND too fast and too far was observed to be detrimental to learning and often had a long-term effect on their willingness to engage with other new and unfamiliar tasks.

5.11 Formal recording isn't always needed

Evans (2002) discussed the importance of talk in maths to develop understanding and relate problems to real life contexts. Dowker (2004) also suggested that observing working processes can lead to diagnosis and intervention planning, thus proving a useful tool when working for pupils with additional needs.

The teachers in this study found that there was value in encouraging oracy opportunities and facilitating meaningful discussion around the learning, even when this meant pupils with SEND had much less time to record written answers or complete worksheets. The teachers observed that some pupils with SEND were more confident when discussing their answers, using the visual supports provided or showing their answers using the concrete manipulatives and that for some, there was little value added from the time spent on the formal recording of answers. It was found that when pupils with SEND were free to discuss what they had done, or were planning to do next, the teachers and teaching assistants could gain a full understanding of what they had truly understood.

Teachers also explored alternative methods for recording answers: recording videos, or demonstrating understanding through drawing pictures, both allowed the pupils to feel successful and show their understanding. A comment in the pupils' book alongside a picture or QR code linking to a recorded video was enough evidence of what the pupil had understood or taken from the lesson. These “tools of access” (Dowker 2004 p.16) allowed pupils with SEND to show what they had understood in a developmentally appropriate way.

5.12 Build confidence and remove scaffolds gradually

A significant number of different, but often similar, mathematical strategies are required by children in primary education. Choosing the correct strategy can be difficult in itself, but remembering the smaller steps involved can also be a challenge. Teachers on the research project found that when they viewed workbooks not just as a record of learning, but as a valuable support tool for future learning, this helped pupils with SEND to develop independence.

One of the research groups considered the effectiveness of two different workbook styles in relation to rounding, when the teacher was revisiting the skill around three weeks after the initial teaching moment. In a classroom where books are used solely as a record of past learning, teachers discussed how pupils would look back on their previous learning and see a list of answers such as, ‘256 rounded to the nearest 100 = 300’. Perhaps some children would be able to infer the context of this answer and to remember the strategies they used, but where learning is less secure, or pupils have particular difficulties with memory, teachers felt they would not. Unless the specific smaller steps were displayed clearly somewhere in the learning environment, the child might feel like they were starting from scratch, as they did three weeks previously.

In a classroom where books are used as an effective support tool, however, looking back at previous work reminds pupils with SEND of the learning journey and supports recall of skills. If the writing in the workbook is carefully planned, it can be organised to remind pupils of key concepts and misconceptions. In line with North's (2019) recommendation, teachers on the project began to plan the use of double page spreads to enhance this strategy further. Teachers found that there was a period of transition if this strategy was new to pupils, and that clear and explicit expectations for presentation and sharing some good examples helped them learn how best to record understanding so that it provided a better support for future learning.

Teachers found that presenting learning in this structured way was particularly helpful for pupils with SEND, but also was a valuable source of assessment for learning. When looking at books, teachers could see at what specific point a certain skill might have been misunderstood and to then pinpoint this area for more support. Additionally, the workbooks often offered teachers some worthwhile feedback on which parts of the lesson were effective and which were less so.

6 CONCLUSION

This project enabled special and mainstream teachers to work and learn together productively about successful strategies for pupils with SEND in mainstream mathematics classrooms. Some of these strategies align closely with what we know about teaching SEND pupils more generally, such as considering each child's individual need, ensuring TA support is carefully planned, and ensuring teacher and pupil talk is carefully structured to support learning.

Others offer strategies which are specific to mathematics teaching and learning, such as using manipulatives in a carefully planned way, displaying multiple conceptual representations, and using pupil notebooks as tools for future learning.

One limitation of the project was that teachers were unable to gather a full set of impact data due to COVID -related restrictions. However, all strategies tested and recommended by teachers on the project are backed up with extensive research evidence from other sources, and they should therefore provide a useful toolkit for schools looking to improve their support for pupils with SEND in mathematics.



7 APPENDICES

THE LEUVEN SCALE

Developed by Ferre Laevers (1999), the Leuven Scales help you to understand how focused and comfortable children. Laevers believed that high levels of well-being and involvement were prerequisites for learning. Both well-being and involvement are scored from one to five, with five being the highest level and one the lowest. Leuven Scale assessments can be used to observe children who are concerning, in terms of learning progress or, as on this project, to measure wellbeing and involvement before and after a significant change to practice, like the move from formal to play-based learning in Year 1.

THE LEUVEN SCALE FOR INVOLVEMENT

Level	Involvement	Signal
1	Extremely low	Activity is simple, repetitive and passive. The child seems absent and displays no energy. They may stare into space or look around to see what others are doing.
2	Low	Frequently interrupted activity. The child will be engaged in the activity for some of the time they are observed, but there will be moments of non-activity when they will stare into space, or be distracted by what is going on around.
3	Moderate	Mainly continuous activity. The child is busy with the activity but at a fairly routine level and there are few signs of real involvement. They make some progress with what they are doing but don't show much energy and concentration and can be easily distracted.
4	High	Continuous activity with intense moments. The child's activity has intense moments and at all times they seem involved. They are not easily distracted.
5	Extremely high	The child shows continuous and intense activity revealing the greatest involvement. They are concentrated, creative, energetic and persistent throughout nearly all the observed period.

THE LEUVEN SCALE FOR WELL-BEING

Level	Well-being	Signal
1	Extremely low	The child clearly shows signs of discomfort such as crying or screaming. They may look dejected, sad, frightened or angry. The child does not respond to the environment, avoids contact and is withdrawn. The child may behave aggressively, hurting him/herself or others.
2	Low	The posture, facial expression and actions indicate that the child does not feel at ease. However, the signals are less explicit than under level 1 or the sense of discomfort is not expressed the whole time.
3	Moderate	The child has a neutral posture. Facial expression and posture show little or no emotion. There are no signs indicating sadness or pleasure, comfort or discomfort.
4	High	The child shows obvious signs of satisfaction (as listed under level 5). However, these signals are not constantly present with the same intensity.
5	Extremely high	The child looks happy and cheerful, smiles, cries out with pleasure. They may be lively and full of energy. Actions can be spontaneous and expressive. The child may talk to him/herself, play with sounds, hum, sing. The child appears relaxed and does not show any signs of stress or tension. He /she is open and accessible to the environment. The child expresses self-confidence and self-assurance.

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