

Realising potential in mathematics for all

for ages 3 to 18

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Securing number properties with the use of Cuisenaire rods



Realising potential in mathematics for all

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The views expressed in this journal are not necessarily those of The Mathematical Association. The inclusion of any advertisements in this journal does not imply any endorsement by The Mathematical Association. The articles in this edition are arranged into three broad sections: reflective pieces, reports from the Maths Hubs and longer, more academic writing.

Editors' page 2 Reflective pieces: Difficulties within the options of SEN maths courses 3 and subsequent reporting of progress Mark Pepper shares his thoughts on the maths courses that are available for lower attaining students. If you are looking for ideas for KS 4 then this piece will be of real interest to you. Thinking about SEND 5 Peter Dennett and Donna Tones reflect together upon the impacts that attending a SEND Maths course have had upon their classroom practice. 7 How do we engage lower ability students in Maths? Rachael Parkhouse (Priory School, Portsmouth) takes the time to collect her thoughts about how attendance at a year-long SEND programme has enabled her provide the best possible provision for the pupils in her charge. 9

Developing vocabulary in maths at the Hear and Now 9 conference Bachael Lethbridge who has recently written for Equals about the

Rachael Lethbridge, who has recently written for *Equals* about the impact of a lesson called 'Finding the Frog', shares her thoughts upon a recent presentation she gave on developing vocabulary in maths at the recent Hear and Now conference.

Online maths resources for low ability learners gives students the opportunity for success

Jayne Warburton (of Mathletics fame) outlines some strategies to bear in mind when teaching low ability pupils.

Maths Hubs:

Each maths hub has appointed a SEND work group lead and we are pleased to be able to include two articles that highlight the work they are engaged in during this academic year.

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Louise Needham, at the New Bridge Group, has written a piece on Securing number properties with Cuisenaire rods. By the look of her article great fun has been had by all involved.

SEND and Mathematics Work Group reflections

Linda Lavagna-Slater shares her hopes for the work she is doing with three Hubs in the North West to explore the classroom manifestations of the 'Big Idea's' of mastery.

Academic paper:

Specially designed algebra instruction

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Tricia Srickland has submitted an academic piece for response. In Teaching Systems of Equations to Students with Disabilities in a Co-taught Mathematics Classroom she reports on a small-scale study that highlights the impact of co-teaching and the inclusion of specific instructional practices can have upon the development of algebraic understanding.



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Editors' Page

This edition of *Equals* serves to reflect the trend we have been experiencing in terms of our physical growth and involvement from an increasing number of contributors. All of the pieces in this edition have come in since January and so the Spring 2019 edition of *Equals* is quite eclectic but it does serve to highlight the range of interests that *Equals* seeks to serve. If you have any lesson ideas or thoughts on supporting low attaining pupils then please get in touch as we would love to hear from you and share your ideas. The contents section will give you a sense of the range and variety *Equals* is able to share and promote. *Equals* is primarily a network for supporting teachers and I view the sharing of experiences and practice as key to this.

Looking forward I am pleased to announce that both of our awards: The Harry Hewitt Memorial Prize and the Ray Gibbons Memorial Award have created quite a bit of interest and the winners will be announced in the Summer edition. Both winners will be interviewed in depth in celebration of their achievements. June 29th sees two of the editorial board (Pete Jarrett and Alan Edmiston) presenting at the Supporting Low Attaining Students, a morning conference organised by the London branch of the MA. See <u>londonmaths.org.uk</u> for further details and to book. We view this event as a continuation of SEND Saturday, a similar session that ran very successfully in June 2018 at the Institute of Education. In the last edition I mentioned a resource to support the lowest ability pupils (those who are often taught in nurture groups in Year 7 and 8) that I have been developing. A version of this was recently developed and trialed in several schools in the Tees Valley as part of a SSIF (Strategic School Improvement Fund) project funded by the Department for Education. The project was run from Carmel College, Darlington, and if you would like a copy of this resource please contact: ssifmaths@carmel.org.uk for further details. including costs. The pack includes 14 activities that can be used as topic starters but their primary use is for gaining insights into how your pupils view the world. Once we can see the world through their eyes we can plan more effectively to support their future learning.

As always if you have any comments on the pieces included in this edition please let us know them.

Mark Pepper shares his thoughts on the maths courses that are available for lower attaining students. If you are looking for ideas for KS 4 then this piece will be of real interest to you.

students in their mid-teens were

publicly shown to have achieved the

same level as the average 7 year old

Two longstanding difficulties within the provision of maths for lower attaining students have consisted of selecting an appropriate course of study and, upon the eventual conclusion

of the course, providing advice to the student on her/his next progression in their study of maths.

The courses that have been available for lower attaining students in the relatively recent past have been unsatisfactory. From 1965-1987 students that were deemed to have little realistic chance of obtaining a GCE were placed on a Certificate of Education (CSE) course. There was widespread criticism of this policy as it was effectively used as a 2-tier system and the CSE was not considered to represent a meaningful qualification. After the abolition of the CSE the Certificate of Achievement (COA) was introduced. One of the benefits of this

course in its original form was that it exclusively consisted of course work. Thus the stress of taking an exam was

removed whilst the students could demonstrate their achievements through the completion of coursework. In 2000 hugely detrimental changes were made to the COA. Firstly it became a mandatory requirement that the National Curriculum Level of Level 2 should be included on the certificate. Hence students in their mid-teens were publicly shown to have achieved the same level as the

> average 7 year old. In my experience this acted as a major disincentive for many students to become engaged with

the work with the consequence that some students then lacked motivation to study and in some cases this led to disruptive behaviour. Additionally exams were introduced and this generated great anxiety for some of the students.

The Entry Level system

The current qualification for lower achieving students consists of Entry Levels 1, 2 and 3 and Pre-Entry Levels for those students deemed not

The questions in the exam papers are so predictable that that there is a temptation for teachers to teach to the test to be ready for Entry 1. The Entry Level system is unsatisfactory and in urgent need of an overhaul. The difficulties

can be summarised as follows:

There is far too wide a gulf between Entry 3 and either GCSE or Level 1 of vocational courses.

The questions in the exam papers are so predictable that that there is a temptation for teachers to teach to the test and provide a maths diet of repetitive exercises within a narrow range of skills whilst neglecting a problem solving approach that encourages the development of logical reasoning.

The dilemma for the teacher

In the instances in which the student secures E3 with ease then, of course, the student can be entered

for Level 1 as a routine matter. Difficulties arise, however, in instances in which the student marginally achieves E3.

The unwelcome consequence of this is that the student would have a significantly reduced self-image.

There would then be a very high probability that the student would be unable to cope with the far greater demands of a L1 course. Under the present system the only options for the teacher are to recommend progression to L1 or to candidly tell the student that it is highly unlikely that they will attain L1. Of course the latter option is not viable due to the negative connotations of such advice. Hence invariably the student would be recommended to apply for a L1 course. In such cases there is a high probability that the student would struggle with the work, become disillusioned and fail to gain L1.The unwelcome consequence of this is that the student would have a significantly reduced self-image. it is appropriate for a student to be placed on a L1 course.

Difficulties presented by the requirement for the teacher to provide a predicted grade within GCSE courses

The mandatory requirement to provide a predicted grade for forthcoming GCSE exams can have serious implications regarding the motivation of some lower achieving students. A few years ago I

> taught maths to a bottom set of students. There was quite a wide range of ability within the group. For most of the group I

was obliged to predict a low grade. With reference to one of the students, whom I will call Mary, I predicted an F grade. For the most able member of the group, whom I will call Chris, I predicted a C grade. I noted shortly afterwards that both Mary and Chris were not engaging with the work that they had been set. I asked each of them about this and these were their responses:

Mary: "You think I am rubbish at maths and so I am rubbish and there is no point in me doing the work."

Chris: "I am going to get a C. You told me I would so I don't need to do any more work."

In my own experience I have encountered colleges of further education in which through scepticism

"You think I am rubbish at maths and so I am rubbish and there is no point in me doing the work."

of Entry Level qualifications they have used their own assessment procedures to determine whether It is hardly surprising that when a student is told by their teacher that they will not achieve highly then

the motivation of that student will be diminished. If the teacher was not forced to give a predicted grade then encouragement could be given right up until the exam with the possibility that some improvement would take place.

The provision of advice for future study by the teacher

It is essential for teachers to take great care when giving advice to students and their family representatives regarding progression to an appropriate course of study after gaining an E3 qualification. On the one hand there is a need to be positive and encourage feelings of confidence by the student. On the other hand it would be damaging to make unrealistic and unfulfillable predictions. I have heard unrealistic advice from some teachers in which they describe obtaining E3 as representing "the first rung on the ladder" towards the future acquisition of advanced qualifications with a progression to Level 1, followed by L2 with the opportunity to then study L3! This state of affairs can be avoided if the teacher confines any predictions to the immediate next step after securing E3. Positive encouragement can then be given for the forthcoming course of study with a gentle reminder that success cannot be guaranteed.

Mark Pepper

Thinking about SEND

Peter Dennett and Donna Tones reflect together upon the impacts that attending a SEND Maths course have had upon their classroom practice.

Two colleagues, Donna Tones and Peter Dennett, have been taking part in a trial to develop some of the resources that have been shared in *Equals* over the last few years; the measurement activity involving *Broken Rulers* and *Find the Frog* are two you may remember. Further details of the resource pack will be shared in the Summer edition of *Equals* but at this stage the insights afforded by this process and the impact upon those involved are worth sharing.

They were part of a group supported by the Solent Maths Hub and were able to spend three days

focusing upon the development and refining of resources suitable for use with children in special schools or the least able in Key Stages 2 and 3.

I don't know about you but it looks to me as if their classrooms will be far nicer places for SEND The quotes below were taken directly for the evaluations written by Donna and Peter. I feel it is important to write about teacher voice as what

is being said reflects the thinking both have been doing as they seek to provide the best possible climate for learning. I don't know about you but it

Fanals



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looks to me as if their classrooms will be far nicer places for SEND as a consequence of the time they have taken to reflect upon the needs of such a key group of pupils.

the sessions and were able to transfer these skills

"This time has made me think about what

opportunities I can be providing my SEN children

with, in particular the EHCP children as they often

struggle to explain their thinking. I have found the

time to reflect upon the progression of skills and

about the questions that can be asked to challenge

"Being able to observe some of these activities in

schools was extremely beneficial to see how they

"My children have been motivated to complete the activities and have enjoyed being challenged to explain their thinking and to move onto linked activities. Thev were pleased with what they

had accomplished during

back into class."

their thinking."

"The resource pack has enabled me to gain invaluable insights into how children think which has then impacted on future planning for that child."

tasks and how it helped them to understand an aspect of maths they would have otherwise struggled with. Colleagues commented on an increased level of enthusiasm and confidence in Maths.

It was clear that these

tasks enabled them to feel confident that they did understand mathematical concepts and were able to apply them."

can they can be adapted. I like the way they use

'everyday' materials/objects which children who

"My pupils all fedback about how they enjoyed the

find maths hard find non-threatening."

"The resources have enabled me to be more creative with my teaching. Found planning lessons around these resources, in this instance, more beneficial than resourcing a planned lesson. I can use them as a diagnostic tool to assess a learners' mathematical thinking before tackling a specific topic/area."

If you would like to contact either Donna or Peter then please get in touch and we will pass on their email addresses.

Colleagues commented on an confidence in Maths.

Please get in touch to share your thoughts on a CPD activity that caused

you to stop and think and change your practice as a consequence. What was it that made the difference and how did your pupils react?

Peter Dennett and Donna Tones

increased level of enthusiasm and

"The resource pack has enabled me to gain

can be adapted to provide

appropriate challenge."

invaluable insights into how children think which has then impacted on future planning for that child."

"The activities cover a range of mathematical skills and throughout the course we have discussed how the activities could progress even further and how

How do we engage lower ability students in Maths?

Rachael Parkhouse (Priory School, Portsmouth) takes the time to collect her thoughts about how attendance at a year-long SEND programme has enabled her provide the best possible provision for the pupils in her charge.

Every day I turn up to work looking forward to imparting my enthusiasm and knowledge in maths and to take my part in shaping the young lives in front of me. Then my Year 7 bottom set enter the and in their own direction. The lessons provide a practical scenario, which introduces a specific mathematical concept that allows mathematical thinking and discussion. For example, we enter a

room. I am faced with a sea of unenthusiastic faces who simply don't want to be there. I cajole and manipulate then into

undertaking my well planned lesson and I think it's all gone well - until the following day when I realise that little if anything has been retained at all. And so began a quest within my department to help improve the learning outcomes for these lower ability students in the knowledge that they will never be level 7 students, but maybe just maybe, we can enthuse them to become life-long learners of maths.

I am faced with a sea of unenthusiastic faces who simply don't want to be there. "Giant's" kingdom and measure items with the giant's feet and elves feet to aid our understanding of ordering decimals. In

other words, the students gain a hook, a prompt to retain their knowledge. In the subsequent lessons simply reminding the class of "Giant's" allows them to access the skill of ordering decimals. Therefore, the learning becomes "sticky", it sticks to what they know. We have found that the CAME resources provide material that is relevant to the students and consequently support this retention and recall process.

Our journey began a year ago when I attendeda course run by mylocal maths hub on"Engaging lower abilitystudents". Here I wasintroduced to the CAME(Cognitive Acceleration

in Mathematics Education) materials which allow students to explore maths at their own pace

encourage them to explain their thoughts to their peers; at no point do you lead, correct or provide answers

Whilst exploring the CAME scenario they are
given, the students must
orate their findings. As a
teacher you probe their
thinking by planning key
questions and encourage
them to explain their

thoughts to their peers; at no point do you lead, correct or provide answers. In fact there is no

anal

correct answer, only consensus as the students coerce their peers into their way of thinking. For a teacher, the insight into the student's way of thinking is invaluable. It

highlights the root of any misconceptions they may have and the path that is needed to remedy these.

For a teacher, the insight into the student's way of thinking is invaluable.

students. So for example, when subtracting in maths the word "exchange" is crucial when changing a ten into

inconsistencies with the language used, but we are

ironing these out as a team. We have acknowledged

the critical nature of the language we use with the

units as this word connects to the more traditional

maths with the physical activities they have been

performing. A teacher using the word "borrow"

instead of "exchange" confused one class. The

consistency of the oracy of key language is an

We are still on this journey and are aware that

there is no quick fix. We can see changes in

our students: they are more confident, they are

engaged, their enjoyment of maths is palpable,

and behavioural statistics within these lowest sets

essential part in the series of lessons.

I am personally always surprised at those students who excel in these lessons. It also highlights why my "star" students fail to retain. For students, not only does the lesson provide the hook, the thinking and orating of their thoughts helps to deepen their understanding of a topic and iron out any misunderstandings.

The CAME lessons only happen once or twice a half term and they are supported with a mastery syllabus. The syllabus has been adapted to focus on the crucial skills alone in a developmental sequence.

We have planned to start each series of lessons with the CAME resource which then directs the path through that section of learning. This is

reactive to the student responses. Students have the time to master these skills in a practical context (for example using Dienes for subtraction without recording the outcomes) before I then reintroduce the standard written methods and show how these connect to their physical methods.

All staff within the department have had training on how to deliver these lessons and all have trialled various lessons with our low ability groups. There have been hiccups along the way such as

and we do have many lightbulb moments which generates the immense satisfaction that makes our job so worthwhile are vastly improved. The students often comment that "this is my favourite lesson, I used to hate maths", "ah I get it, that makes sense now",

and we do have many lightbulb moments which generates the immense satisfaction that makes our job so worthwhile. We are yet to see how effective this programme will be in the long term in terms of results, however, I am confident to say that our new intake now look forward to their maths lessons and we are definitely on the right track to setting them up as lifelong learners who believe they can succeed in and understand maths.

Rachael Parkhouse

Developing vocabulary in maths at the Hear and Now conference

Rachael Lethbridge, who has recently written for *Equals* about the impact of a lesson called 'Finding the Frog', shares her thoughts upon a recent presentation she gave on developing vocabulary in maths at the recent Hear and Now conference.

This may be controversial, but I would propose that Maths teachers get an easier ride when it comes to 'teaching English'! With no paragraphs to mark and spelling only being required to 'convey intent', whole school literacy marking policies often have little impact on our work. However, Mathematics has the most subject specific language, if you consider science subjects separately. Many words have different meanings in different contexts e.g. scale, mean, pi and irregular plurals e.g. die/dice, index numbers/indices. For many students, all these words and their word forms need to be taught explicitly. It is highly unlikely that this language is used at home or amongst friends, and even if it were, a child with additional needs is unlikely to pick it up incidentally.

I work at Mary Hare, a school for deaf children in Newbury, Berkshire. It takes pupils aged 5-19 across both primary and secondary sites. Taking both day and boarding pupils, it is the largest school for the deaf in the UK. It follows an oral/ aural philosophy supporting pupils to achieve their full communicative potential. Back in October, the school hosted a training conference for professionals working in deaf education – Hear & Now. The day included presentations from staff on emotional literacy, conversations, stretch and challenge, conducting small scale research and developing vocabulary in Maths. The attendees came from a broad area of deaf education including teachers of the deaf and speech therapists working in resource bases, mainstream and specialist settings.



Myself and the head of department led the presentation on developing vocabulary in

Mathematics. We shared ideas and resources for displays, lessons and schemes of work. Since starting at Mary Hare over two years ago I have made many changes to my practice. My initial response to vocabulary was to make access to language as visual as possible through displays, maths note books and word mats. I'm always on the lookout for an interesting approach to a lesson

My initial response to vocabulary was to make access to language as visual as possible

that will promote communication and vocabulary. 'Finding the Frog' – found previously in MA *Equals* - was just such a lesson. I was pleased to be able to share these resources with the delegates at the conference. Another interesting approach was film making, inspired by the Maths Miniatures competition run by Maths World UK. Students had to plan, write, practice, present and edit their film, they also chose to add subtitles as they wanted their films to be as accessible as possible. This gave them opportunities to repeat key vocabulary in different formats.

In the department, a significant change we made was the addition of vocabulary tests. A selection of ten words are included at the start of each topic test. The words are

chosen to cover varying degrees of mathematical difficulty. Most of the words can be found within the test itself. We

chose a format that was easy to mark and gave the students the best chance of success. There is a clue with a one word answer, like you would find in a simple crossword. The first letter of the word is could put them off the actual maths, so we encouraged the students to complete it at the end. This also meant they would have 'warmed

up' their brains to the topic which should improve their recall. Since the conference, I have shared the vocabulary tests with our own speech therapy department, including a complete set of answers. They will work on these words in their therapy sessions, outside of maths lessons. Increasing students' exposure to new vocabulary is vital for making it stick. The professionals were particularly interested in the vocabulary tests. I've often heard teaching assistants and primary teachers talk of their own feelings of inadequacy or insecurity in maths. Likewise, in deaf education, speech therapists or resource base leaders might not be maths specialists. I think the vocabulary tests were popular because they offered something concrete to work on.

Increasing students' exposure to new vocabulary is vital for making it stick. The next Hear and Now Conference will be held on 13th November at Mary Hare School. To book a place at the conference,

please visit www.maryhare.org.uk/events

Rachael Lethbridge

Online maths resources for low ability learners gives students the opportunity for success

Jayne Warburton (of Mathletics fame) outlines some strategies to bear in mind when teaching low ability pupils.



Jayne Warburton, CEO EMEA, 3P Learning

Jayne Warburton, former Assistant Head Teacher and CEO EMEA, <u>3P Learning</u>, providers of curriculum-aligned educational resources <u>Mathletics</u> and <u>Mathseeds</u> discusses best practice for teaching maths to extreme low ability pupils and strategies that teachers can employ within the classroom...

I have worked in education for over 30 years, and as a former teacher and a passionate advocate of maths learning, I want to ensure that all pupils – regardless of their innate ability – learn vital maths skills and develop a love of lifelong learning. The following strategies for teachers will make teaching maths to low ability learners much less intimidating!

How can Mathletics and Multiverse be used to teach extreme low ability pupils maths?

Mathletics – 3P's multi-award winning curriculummapped, adaptive learning solution for KS1-3 - enables teachers to assign any level of the curriculum course to pupils, without them being aware of the level to which they have been assigned. Therefore, the pupils are neither labelled and nor develop a negative perception of themselves as maths learners; instead the teaching is targeted at their zone of proximal development.



Mathletics

In the modules section of <u>Multiverse</u> - 3P's new and highly immersive game designed to increase fluency in multiplication fact and recall - pupils can choose a shorter, basic game to play and select on which tables they would like to focus. This gives lower ability or less confident pupils the opportunity to take control of their own learning, choosing a level which allows them to succeed and become more confident in their maths skills.





Multiverse

What do teachers need to keep in mind when teaching low ability pupils, as opposed to average or high ability pupils?

Teachers need to be aware that pupils often have strengths and weaknesses across different topics: Mathletics enables teachers to create bespoke courses. As an example, a child who is weak at numbers but strong with shapes could have a course created for them with number topics selected from a lower curriculum, and shapes from a higher curriculum. At 3P Learning, we also provide Mathseeds – a digital maths resource, created specifically for the needs of early maths learners from Reception to Year 2 - as an additional course option for schools who work with younger or low ability pupils. For those who require learning divided into small bite-size activities and respond well to visual and auditory content, this program is often very effective. By providing both Mathletics and Mathseeds, 3P Learning supports teachers in selecting the appropriate resource for all learners.



Mathseeds

What strategies can we put in place to make approaching maths less intimidating for low ability pupils?

I would recommend that teachers:

- Ensure that pupils are using the appropriate course to support their progress and drive learning outcomes
- Use the breadth of the resource for example, the <u>printable resources</u> may suit some pupils better than the online resource
- Celebrate participation and effort rather than
 focusing solely on achievement

Please recommend two maths activities for teachers who are educating low ability pupils

- Maths models and images (particularly in the area of Mathletics known as Rainforest Maths) supports low ability learners as they move from concrete to visual representations before progressing to abstract concepts.
- <u>Times Table Toons</u> and Maths Mental videos provide further resources which support pupils with a wide variety of learning styles

What are some fundamental and core maths skills that extreme low ability pupils need to learn?

Place Value is the core maths skill which underpins all number work. Without a secure understanding of place value, pupils will struggle to gain the fundamental maths skills required for school and life. <u>Play Paws</u> - a game by Mathletics that builds essential skills and capabilities in place value, number sense, addition and subtraction - uses the maths manipulatives of Ten Plates and Tens Rods and unit cubes to help develop a deeper understanding of Place Value.

How can you foster a love of lifelong learning in pupils who struggle with academics, particularly maths?

It is often difficult for teachers to motivate low ability pupils, particularly in a subject such as mathematics which can be perceived as intimidating. Gamification is a great way to overcome this obstacle. In the past gamification has been associated with gimmicks; designed to engage but not necessarily embed knowledge. However, there is no reason why gamification shouldn't both motivate and embed learning.

When gamification is well integrated into the learning environment it should:

- Capture learners' attention
- Challenge them
- Engage and motivate them
- Help them learn

Gamification is present in many aspects of life outside the classroom, such as targets on a fitness app or holiday reading challenges. It builds a sense of achievement which can vastly improve outcomes if harnessed correctly within the classroom.

Mathletics and Mathseeds make learning fun with the use of elements such as avatars, gold bars and certificates. When teachers make lessons relevant and engaging it helps pupils develop a love of learning.

Pupils also need to feel that they can succeed, so the pitch and pace of the learning they are presented with is very important. Online learning, with programs like Mathletics and Mathseeds, gives pupil the ability to control the pace of their learning, while the immediate feedback helps to build confidence and motivates them to keep moving forward and tackle new learning tasks.

For further information on Mathletics, please visit <u>https://uk.mathletics.com/</u>

For further information on 3P Learning, please visit <u>http://www.3plearning.com/</u>

Jayne Warburton

Securing number properties with the use of Cuisenaire rods

Louise Needham, at the New Bridge Group, has written a piece on Securing number properties with Cuisenaire rods. By the look of her article great fun has been had by all involved.

This academic year I have had the pleasure of working with some very enthusiastic teaching assistants on the Maths Hub NW2 subject enhancement project. The project is being run over six two-hour sessions. During the last session, we looked at the suitability of Cuisenaire rods for ks1 and ks2 children for number.



We started the lesson by just playing with the Cuisenaire rods. The Teaching assistants did exactly what the children would do in class, sandwiches were created and staircases. There were some fantastic discussions on why staircases are a great visual tool for creating mathematical discussions around the number system, particularly how it increases. Children that have not been taught more/ less than are already ordering rods by size.



Mathematical talk around one more/less can be introduced.

14

Books & Stories

We started to look at activities for young children and linked this in with other areas of the curriculum. Cuisenaire rods are a great resource to bring creativity into maths. One idea shared with the Teaching Assistants was to use the rods whilst telling a story.

The three little pigs

For example, if telling the story of the three little pigs, the children could then create houses for the pigs using the rods. Example mathematical questions could be:

- What is the same between yours and your partner's houses?
- What is different between yours and your partner's houses?
- Which house is the biggest?
- Why is it the biggest?

Further activities could be trying to knock the houses down by blowing them or with marbles ("whose house stayed up the longest? Etc.)







Goldilocks and the three bears

Choose rods to represent the characters. Again asking questions to link mathematical reasonings to the chosen rods.

- What is the same between yours and your partner's rods?
- What is different between yours and your partner's rods?
- Which character is the longest? Why?
- Why is it the smallest? Why?







Staircases

The next activity that we looked at as a group was the importance of making staircases. Staircases are a great way of identifying smallest to biggest, one more and one less and teen numbers. To find out more, here is the link to an excellent blog that discusses the importance of staircasing:

https://www.arithmophobianomore.com/ staircases-and-cuisenaire/

What's the same?













What happens if we add another staircase in a different orientation?

Sandwiches

During the first stages of playing with Cuisenaire rods, children might make sandwiches. These are a fantastic way to introduce the concept of equals; stemming from this, discussions can take place with regards to 'the same as', addition, subtraction and finding the difference. Examples of these are below.

Addition



https://www.helpingwithmath.com/printables/ worksheets/addition-subtraction/10a6-additionsubtraction07.htm

Finding the Difference

https://www.helpingwithmath.com/printables/ worksheets/addition-subtraction/10a6-additionsubtraction08.htm

It is essential that children are encouraged to play with the rods initially; they will make their own mathematical discoveries. Once children are confident in playing with the rods and their properties, harder mathematical concepts can be introduced. For example, prime numbers, multiples, square numbers and prime numbers.



Trains

Trains are a simple way of introducing concepts of addition and subtraction. The equals sign can be explored further and early concepts of algebra. Children as young as 6 can write simple algebra before using number, they will write equations to show the lengths of the trains. Once numbers are introduced they can look at number bonds and writing their own stem sentences.

Activities https://nrich.maths.org/4349 https://nrich.maths.org/4331

Blogs

http://nyccami.org/making-trains-from-cuisenairerods/

Bar Models

Cuisenaire rods are an excellent resource to use when solving bar model problems. Examples of this are below.

Further bar model questions can be found: <u>https://</u> www.tes.com/teaching-resource/barvember-problems-of-the-day-11764693



Multiplication

Making multiplication floors allows children to see that e.g. $6 \times 4 = 4 \times 6$ floors can be stacked to show that they are equivalent.







Multiplication as repeated addition can be shown by creating long trains.

Multiplication of fractions

Here is a fantastic blog post on multiplication of fractions:

http://www.homeofbob.com/math/numVluOp/ frcDecPrNmvlu/multiplicationFractions.html

Cuisenaire rods are an amazing resource for all ages. The internet has a wealth of ideas for the use of this resource. For older children they can be used to prove Pythagoras' theorem, exploring geometric sequences, area and perimeter.

I have no doubt there will be a box in every school, however often they are at the back of a cupboard collecting cobwebs! Let us get using this amazing resource again within maths lessons, dust off the cobwebs and get children exploring concepts in mathematics with this excellent resource.

Louise Needham

SEND and Mathematics Work Group reflections

Linda Lavagna-Slater shares her hopes for the work she is doing with three Hubs in the North West to explore the classroom manifestations of the 'Big Ideas' of mastery.

SEND and mathematics has been a passion of mine for the past fifteen years. As a National Adviser for Every Child Counts, I was involved in researching, developing and writing programmes to support pupils who find mathematics difficult. Working closely with teachers from a wide range of context as a independent consultant I have learnt that once mathematically) and how these can support pupils with SEND to develop a deeper knowledge of counting, which will lead to greater confidence in the classroom.

The workgroup is structures over a period of 3 months with a combination of face to face meetings

a child is excited and engaged in mathematics there is no limit to their progress.

these can support pupils with SEND to develop a deeper knowledge of counting, which will lead to greater confidence in the classroom - which is where the most learning will take place! Each participant will be asked to select three case pupils to track

and in school gap tasks

I am very excited about

the opportunity to be a work group lead for Developing Working Partnerships for SEND and Mathematics Project run through the North West Three Maths Hub based in St Helens. The participants on the work group are from both main stream and special school settings and vary in their roles from Maths Leads, SENDCOs, specialised SEND teachers and class teachers. throughout the project to enable them to measure the impact that trialled activities/resources have had on their learning.

We will be exploring how a Diagnostic Interview with selected case pupils will enable the teacher to find out what the learner CAN DO and explore how the learner makes sense of counting (oral,

As many schools are engaging in Teaching for Mastery - my hope is that this project will allow teachers the opportunity

to reflect on the 'Big Ideas' of Mastery put forward by the NCETM (Coherence, Representation and structure, Variation, Fluency and Thinking

Knowing what a learner knows will enable the teacher to build on and extend what the learner can already do object, group counting and subitizing) and how s/he has constructed mathematical meaning. Knowing what a learner knows will enable the

teacher to build on and extend what the learner can already do, rather than focusing on what they cannot do. Diagnostic assessment (which I refer

anal

to as Diagnostic Interview as the term Diagnostic Assessment is being used by many publishers as a fixed set of questions given to pupils) is a technique that has been developed through several Every Child Counts programmes over the past ten years.

During the Diagnostic Interview the role of the teacher is to observe and listen to the learner, reinforcing what they know while probing to assess his/her understanding and confidence in counting.

avoids teaching any new skills or concepts and stays with what the child already knows...' (Dunn et al, 2010. p226). By looking out for sound

'The teacher deliberately

These skills can then be transferred to another area of mathematics, disseminated to colleagues and support learners who find mathematics difficult of early number is most likely to be successful when it is closely attuned to children's current levels of knowledge and is strongly informed by a very clear understanding

competences that can be built on and for any specific barriers that hold back the pupil's learning the teacher avoids planning a teaching sequence from preconceived ideas.

Most importantly, the Diagnostic Interview is a time to build the learner's confidence by enabling the learner to engage in mathematics that they are familiar with, ensuring success but also allowing the learner to become aware of what they know so that they can build on this knowledge and understanding.



of where children's learning will next progress to'.

Sticky notes can be used during the Diagnostic

Interview to reinforce the learner's skills, knowledge

As a workgroup we will identify the small steps that need to be mastered to build on the case pupil's

current skills, knowledge and understanding of

counting. Therefore, enabling the child to engage

in mathematics that they can do and build on new

learning. Wright (2008 p203) states that 'Teaching

and understanding.

Understanding Mathematics for Young Children (Haylock & Cockburn 2017) will form the core text for the workgroup as it focuses on the mathematical ideas that underpin what is taught and how children can be helped to construct understanding of those ideas themselves. A key model from the book that we will explore is understanding as making connections – 'a mathematical concept can be thought of as a network of connections between symbols, language, concrete experiences and pictures' (Haylock et al 2017 p30)

I believe that keeping a tight focus on one specific area of mathematics (in this case counting) will enable the teachers to trial ideas, reflect on the impact and refine their teaching methods/ resources to meet the needs of the case pupils. These skills can then be transferred to another area

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of mathematics, disseminated to colleagues and support learners who find mathematics difficult. For example, developing number sense cards which use a variety of representations and structures for numbers 1 to 10 will be the starting point of how they can be developed further. By doing this my hope is that the teachers become resourceful as opposed to gathering resources which have a limited use.



All participants have their own expertise and experience to bring to the workgroup which will ensure rich discussions, reflective practice and collaboration.

Linda Lavagna-Slater

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Specially designed algebra instruction

Tricia Srickland has submitted an academic piece for response. In Teaching Systems of Equations to Students with Disabilities in a Co-taught Mathematics Classroom she reports on a small-scale study that highlights the impact of co-teaching and the inclusion of specific instructional practices can have upon the development of algebraic understanding. Teaching Systems of Equations to Students with Disabilities in a Co-taught Mathematics Classroom Tricia K. Strickland, Ph.D.

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Abstract

Secondary students with disabilities are expected to achieve within the high school mathematics curriculum to the same level as their non-disabled peers, although an achievement gap exists. Co-teaching may be a viable practice for improving the mathematics outcomes for students with disabilities as this practice provides students with access to a mathematics educator and a special educator. This article demonstrates how co-teachers may implement specially designed instruction to teach students how to solve systems of equations. Examples of embedding specially designed instruction into the six common approaches to co-teaching are provided. Specific instructional practices include the use of explicit instruction, strategy instruction, cue cards, graphic organizers, and the concrete-representational-abstract integration strategy.

Keywords: co-teaching, algebra, mathematics, specially designed instruction

Co-teaching is a service delivery method for providing specialized instruction (e.g., special education and related services) to students with disabilities (Friend & Cook, 2017). For the purpose of this article, a co-taught classroom is taught by a general educator and a special educator, who provide joint instruction to meet the educational needs of a diverse group of students. Co-teaching is a desired approach to teaching mathematics to secondary students with disabilities as it provides them with an opportunity to remain in the general education classroom, gaining access to a curricular content specialist (e.g., the mathematics teacher) and receiving individualized instruction from a special education teacher. Including specially designed instruction in the co-taught secondary mathematics classroom may lead to greater academic outcomes for students with disabilities.

Co-teaching Models in a Secondary Mathematics Classroom

Friend and Cook (2017) describe six approaches to co-teaching, specifically, (a) one teach one observe; (b) one teach one assist; (c) station teaching; (d) parallel teaching; (e)alternative teaching; and (f) teaming. The following sections exemplify how co-teachers can incorporate research based special education instructional practices within each of the six approaches in a secondary classroom.

One Teach, One Observe

The one teach, one observe approach involves one teacher leading instruction while the other teacher collects observational data on an individual student, a group of students, or the entire class.

Although this approach does not provide specially designed instruction, it does provide the special

educator the opportunity to gather important data needed to monitor progress and plan for future supports. For example, as the mathematics education teacher (MET) instructs the whole class, the special education teacher (SET) may closely observe how a student uses concrete manipulatives to solve a system of equations to determine if the manipulatives are an appropriate support. This approach to co-teaching should be used sparingly to avoid the special educator being relegated to a subordinate role (Friend & Cook 2017).

One Teach, One Assist

The one teach, one assist model is a common approach to co-teaching in which one teacher leads instruction while the other teacher walks around the room assisting students as needed. This approach has been criticized as too often the special educator is placed in the subordinate role of an assistant rather than an equal teaching partner. This is a common situation in many co-taught secondary classrooms (Friend & Cook, 2017)

As one teach. one assist is commonly implemented. special educators must find opportunities implement evidence-based to interventions in this approach. Providing students with learning disabilities opportunities to verbalize their mathematics understanding and providing ongoing feedback are two instructional interventions that support their mathematics achievement (Gersten, et., al., 2009) and may be incorporated in the one teach, one assist approach. For example, the SET notices that a student has incorrectly solved a system of equations. She asks the student to tell her his thoughts as he solved the system. While the student is explaining the solution, the SET is able to assess what he knows about systems of equations as well as where he is making errors. Additionally, the SET is able to provide immediate feedback. The SET then asks the student to solve the next problem aloud. Again SET is able to provide feedback.

Station Teaching

Station teaching typically involves dividing students into three groups, with each group rotating through stations. Each teacher leads one station, while the third station involves independent work (Friend & Cook, 2017). For example, the mathematics education teacher (MET) may lead a station on reviewing how to solve systems of equations using the elimination method, while the special education teacher (SET) leads a station reviewing the substitution method. The third station involves students completing an online activity, such as Illuminations interactive entitled Pick's Theorem as a System of Equations (https://illuminations. nctm.org/Games-Puzzles.aspx). Students rotate through each station so that they receive instruction from both teachers. Specially designed instruction may be incorporated within this approach. For example, the SET may provide students with cue cards, which are effective instructional adaptations for students with learning disabilities (Maccini, Strickland, Gagnon, & Malmgren, 2008). See Figure 1 for an example cue card for solving systems of equations. Additionally, technology, such as online interactives and virtual manipulatives, support mathematics achievement for students with learning disabilities (Maccini, et al., 2008). See Table 1 for a list of technology tools to support students with disabilities.

Substitution Method Steps	Example 3x - y = 4 -4x + 2y = 2
Step 1: Choose one equation and solve for one variable. Does an equation contain a term with the coefficient of 1 or -1? If yes, use this equation.	3x - y = 4 3x - y - 3x = 4 - 3x -y = 4 - 3x y = -4 + 3x
Step 2: Substitute the new equation for the found variable into the second equation Did I remember to distribute (multiply)? Did I remember to combine like terms on each side of the equation? Did I remember to keep the equation balanced? (what I do to one side of the equation, I need to do to the other side)	-4x + 2(-4 + 3x) = 2 -4x - 8 + 6x = 2 2x - 8 = 2 2x - 8 + 8 = 2 + 8 2x = 10 $\frac{2x}{2} = \frac{10}{2}$ x = 5
Step 3: Substitute the value of the variable in step 2 into either of the equations.	3(5) - y = 4 15 - y = 4 15 - y - 15 = 4 - 15 -y = -11 y = 11
Step 4: Check your solution by substituting the values into both of the original equations.	x = 5 y = 11 3x - y = 4 3(5) - 11 = 4 15 - 11 = 4 4 = 4

Figure 1. Sample cue card for solving systems of equations using the substitution method.

Technology Tools to Support Students with Disabilities

To×ol	Description
National Library of Virtual Manipulatives http://nlvm.usu.edu/en/nav/vlibrary.html	NLVM is a free library of web-based virtual manipulatives. There are virtual manipulatives for all grade levels and content domains (i.e., number operations, algebra, geometry, measurement, data analysis & probability).
Interactivate http://www.shodor.org/interactivate/	Interactivate is a free, online website with over 100 activities for learners to explore mathematics. It also includes example lesson for teachers.
GeoGebra <u>https://www.geogebra.org/</u>	GeoGebra is a free, online interactive tool with geometry and algebra applications. Classroom resources include activities, lesson, simulations, exercises, and games covering mathematics content from elementary to college levels.
Desmos https://www.desmos.com/	Desmos is a free, online interactive used to graph functions, plot data, evaluate equations, and explore transformations. They offer digital activities covering grades 6 – 12.

Recently, Friend (2018) has proposed a variation on the traditional station teaching approach. Students may be divided into ability groups (low, average, high) based on assessment data. It is important to remember that students with disabilities may fall into any of these groups and that groups should be reformed at the beginning of every unit. Friend (2018) then suggests that low performing students spend two rotations with the special educator, as high achieving students do not need the supports from the special educator. Table 2 provides an example of this approach.

Example Rotations for Station Teaching

	Mathematics Teacher	Special Education Teacher	Independent Work
Rotation 1	AS - Receives mathematics instruction on current topic	LAS - Reviews pre-requisite skills needed to engage in current math topic	HAS – Receives a task which requires them to apply knowledge to a novel situation
Rotation 2	LAS – Receives mathematics instruction on current topic	AS - Guided practice with supports	HAS – Receives a task which requires them to apply knowledge to a novel situation HAS – Continues to work on task
Rotation 3	HAS – Shares solutions to task	LAS – Guided practice with supports	AS – Completes independent work

- LAS = Low achieving students
- AS = Achieving students

HAS = High achieving students

Parallel Teaching

When using the parallel teaching approach, the class is divided into two equal groups. Each teacher works with one group of students. Unlike station teaching, groups do not rotate, but stay with the one teacher for the entire lesson. Teachers may teach identical lessons, or they may teach the

lesson using different techniques (Friend & Cook, 2017). However, in a co-taught classroom in which specially designed instruction is implemented, the special educator will teach using research-based special education practices. The following is an example of this approach to co-teaching.

The admission to the county fair is \$2 for children and \$5 for adults. On Tuesday, 2000 people came to the fair and \$5500 was collected. How many children and how many adults came to the fair on Tuesday?

STAR	Strategy
------	----------

STAR Steps	Answers		
 Search the word problem Read the problem carefully Ask yourself, "What facts do I know?" "What do I need to find out?" Write down facts 	I know: \$2 for children, \$5 for adults, 2000 total people, \$5500 total money I need to find out how many children and how many adults		
 Translate the words into two equations Choose variables Identify operations Write equations 	Let c = number of children Let a = number of adults Total number of people: $c + a = 2000$ Total money: $2c + 5a = 5500$		
 Answer the problem ■ Choose a strategy (elimination or substitution) ■ Follow the appropriate steps for chosen strategy 	Substitution c + a = 2000 c + a - a = 2000 - a c = 2000 - a	2(2000 - a) + 5a = 5500 $4000 - 2a + 5a = 5500$ $4000 + 3a = 5500$ $4000 + 3a - 4000 = 5500 - 4000$ $3a = 1500$ $a = 500$	c + a = 2000 c + 500 = 2000 c = 1500
 Review the solution Reread the problem Ask, "Does the answer make sense? Why?" Check answer 	 √ 500 adults plus 1500 children equal 2000 500 times \$5 equals \$2500 1500 times \$2 equals \$3000 \$2500 plus \$3000 equals \$5500 		

Figure 2. Completed STAR Strategy worksheet.

The SET and the MET decide to use parallel teaching to teach students to solve word problems involving systems of equations. The MET works with the group of students who have earned the highest score on a pre-assessment, using an inquiry-based approach to develop a strategy for solving the word problems. The SET works with students who earned the lower scores on the pre-assessment, many of which have identified learning disabilities, and supports their learning through the use of research-based instructional practices from the special education mathematics literature. Specifically, the SET implements explicit instruction with strategy instruction. Explicit instruction refers to a highly structured, teacher-directed method for presenting new information that incorporates key variables such as curriculum-based assessment, advanced organizer, teacher modeling, guided practice, independent practice, and review for maintenance. Strategy instruction includes the use of memory aids (i.e., mnemonics, cue cards) and graphic organizers (i.e., graphs and charts) that provide students with a strategic plan to solving problems. The use of a strategy involves a general approach to solving a wide range of problems (Gersten, et al., 2009) and has been found to be effective for students with LD in a wide range of educational settings, including general education classrooms and alternative settings (Maccini, et al., 2008).

The SET uses the STAR Strategy, which prompts students to Search the word problem, Translate the words into mathematic equations, Answer the problem, and Review the problem (Maccini, et. al., 2008). See Figure 2 for the completed STAR cue card for a word problem involving systems of equations. This STAR cue card has specific cues for solving systems of equations. The SET provides explicit instruction for each step of the STAR strategy.

Alternative Teaching

Alternative teaching involves one teacher working with a small group of students for the purpose of reteaching. enrichment, assessment, or preteaching, while most of the students remain with the other teacher and receive large group instruction (Friend & Cook, 2017). Alternative teaching provides the opportunity for students to receive individualized instruction from the special educator or the mathematics educator. For example, the MET may use alternative teaching to conduct diagnostic interviews with students as an assessment or to provide an enrichment task for high achieving students.

Will coefficients sum to zero?	x - 2y + 3z = 7	-2x + z = -3	-3x = -9
If yes, proceed to solve by	-3x+2y-2z=-10		x = 3
elimination.	2x - 2y + z = 4	-x-z=-6	
If no, transform equations into			
a form that coefficients will			
sum to zero.			
Check your work:	x - 2y + 3z = 7	-2x + z = -3	
$3-2\left(\frac{5}{2}\right)+3(3)=7$	3 - 2y + 3(3) = 7	-2(3) + z = -3	•
(2)	$-2y + 12 = 7 \checkmark$	-6 + z = -3	(x=3)
$-3(3) + 2\left(\frac{5}{2}\right) - 2(3) = -10$	-2y = -5	(z = 3)	\bigcirc
$2(3) - 2\binom{5}{-} + 3 = 4$	5		
2(3) - 2(2) + 3 - 4	$y - \overline{2}$		

Figure 3. Graphic organizer for solving systems of linear equations adapted from Ives (2007). Students begin in the left corner block and move clockwise through the graphic organizer.

Alternative teaching may also be used to provide specialized instruction to students with disabilities. For example, in an inclusive mathematics classroom, a group of five students with disabilities are struggling to generalize methods used to solve systems of equations in two variables to solving systems of equations in three variables. While the MET continues instruction with the class, the SET provides additional supports, in this case, a graphic organizer which has research to support its effectiveness for teaching students with learning disabilities to solve systems of equations in two and three variables (lves, 2007). The use of this graphic organizer emphasizes a nonverbal approach to teaching systems of linear equations that relies on visual-spatial cues rather than language skills (lves, 2007). See Figure 3 for a sample of this graphic organizer. Students are explicitly taught how to use the graphic organizer during the small group instruction in the alternative co-teaching. Thev then will use the graphic organizer to solve systems of equations in future lessons, which may include any approach to co-teaching.

Teaming

Teaming involves both teachers sharing the responsibility of teaching the entire group of students. Both teachers are fully engaged in the delivery of academic instruction and yet each teacher integrates their expertise throughout the instruction (Friend & Cook, 2017). Within teaming, instructional strategies that benefit all students may be modelled, such as the use of manipulatives.

The MET and the SET have decided to team teach a lesson on introducing students to the process of solving systems of equations. The MET understands the value of using manipulatives in the classroom when introducing a new mathematics topic. The SET shares with the MET a research-supported instructional strategy called Concrete-Representational-Abstract (CRA) instruction. CRA instruction involves students progressing through three phases of instruction. First, students solve math problems using concrete manipulatives. After they demonstrate mastery of the mathematics skill using concrete manipulatives, they then progress to the representational phase in which they solve similar problems using drawings of the manipulatives. After they demonstrate proficiency of the mathematics skill using drawings, students solve problems using abstract notation only (Strickland & Maccini, 2010). The MET and the SET decide to use manipulatives during their teaming lesson to introduce solving systems of equations. Specifically, the MET leads the class in a demonstration of solving systems of equations using manipulatives. The SET will ask the MET clarifying questions and will make explicit connections between the manipulatives / drawings and the abstract notation. See Figure 4 for an example of a system of equations solved with concrete manipulatives. In future classes, the SET will continue to provide CRA instruction to small groups of students with disabilities and/or students who need additional supports, via alternative or parallel teaching, while the other students transition to abstract notation only with the MET.

Set up for the system of equations x + y = 4 and x - y = 2.







Figure 4. Steps needed to solve the system of equation x + y = 4 and x - y = 2 using concrete manipulatives.

Ennals

Conclusion

Co-teaching is a viable practice for ensuring that students with disabilities are provided access to the secondary mathematics curriculum and receive instruction from a qualified MET. Additionally, the preceding classroom examples exemplify how a SET may incorporate specially designed instruction into a secondary mathematics classroom using any of the common co-teaching approaching. As more students with disabilities are included in the general education mathematics classroom, incorporating specially designed instruction is imperative to ensure that they are achieving within the mathematics curriculum.

Tricia Srickland

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