



## LESSON STUDY RESEARCH REPORT

# A study into how children can effectively use models and images to help understand place value

St Aloysius' Catholic Infant School Lesson Study Group

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### Abstract

**Background:** The setting is an urban infant school in an area of higher-than average deprivation. The overall focus of the school's lesson study pilot was to look into ways of developing models and images to effectively develop our Year 2 children's basic understanding of place value.

**Aims:** The main aim of the study was to improve pupils' understanding of how to use Dienes' apparatus to partition 2-digit and 3-digit numbers, and to use this understanding to aid in their learning and understanding of addition and subtraction strategies.

**Methods:** A lesson study approach was used to teach pupils how to use Dienes' apparatus to partition 2-digit and 3-digit numbers. Close observation of case pupils informed changes in approach in lessons 2 and 3 of the sequence. Specifically, the role and purpose of Dienes' apparatus was made very explicit and their use was modelled by the teacher and in whole-class activities.

**Findings:** The lesson study helped teachers understand the importance of pacing and matching work to students' current understanding. Teachers had assumed too much about children's understanding and had focused on the visual and concrete elements of the Dienes' apparatus instead of the abstract thinking behind the structure of the blocks. Once the children were more secure in their use of Dienes' apparatus, this aided their understanding of partitioning 2-digit and 3-digit numbers, which will impact future learning and aid in addition and subtraction.

**Implications:** Future teaching will focus on allowing sufficient time for concept development, explaining resources, and tracking individual progress. Outcomes will be shared with other staff and lesson study will be used to improve teaching across the curriculum.

**Keywords:** lesson study; primary education; mathematics; place value; Dienes' apparatus

## Context

St Aloysius Infant School is a two form entry Catholic Infant school with nursery provision and a capacity for 210 pupils. The school is situated between Euston and King's Cross railway stations in Somers Town. We have 41% FSM and our RASIE Online shows a 0.47 deprivation indicator which is higher than the national average of 0.24. We aim to ensure that teaching and learning is accessible for a range of different learning styles and is challenging, enjoyable, stimulating and purposeful.

St Aloysius' Lesson Study group:

- ET -Year 2 class teacher and Mathematics Subject Leader
- LC -Year 2 class teacher with experience of teaching and learning in KS2

## Aims of the Lesson Study, Classes and Case Students

From our analysis of mathematics data from last year's Year 2 cohort, one concept that stopped many children from achieving a secure Level 2 was their ability to use and apply place value to support their calculations and understanding of number. We wanted to improve the way pupils learn place value through developing our use of models and images.

### Research and materials we consulted and decided to use:

In terms of the Lesson study approach, we have used materials published by Pete Dudley on [www.lessonstudy.co.uk](http://www.lessonstudy.co.uk) to record observations/ideas during each lesson and the follow up activities – structured peer conversations and pupil interviews. We also consulted a document called 'Lesson Study: Enhancing Mathematics Teaching and Learning' by David Burghes and Derek Robinson.

### The Year2 case study children:

- Pupil A – A new learner to our school, joining at Year 2. Baseline assessments suggested she could achieve Level 2B child by the end of Year 2 but there was indications that her progress might stall if she was not given clear guidance on how to improve.
- Pupil B – Assessed as working at Level 1A at the end of Year 1. He regularly says he doesn't enjoy learning because he doesn't understand much of the mathematics he is taught.
- Pupil C – Also assessed as working at Level 1A at the end of Year 1 but to date has struggled to apply his prior learning and make links to and between ideas and concepts he is taught in Year 2.

## First research lesson (RL1)

We planned to use Dienes' blocks to teach pupils what each digit represents in a 2-digit number. The main approach we used was to model place value using the Dienes' blocks to represent the tens and units in a 2 digit number. This formed the whole-class teaching sessions.

We planned the lesson together. The class teacher taught the lesson and the Maths Coordinator observed the three identified pupils.

### Post lesson discussion:

The first thing that immediately struck us when observing the three target pupils during the carpet session, was that none of them were putting hands up to offer ideas or share their understanding with others. A short time-bonded assessment to check each time a question was asked whether any of the target children offered any response, indicated that not one of them had put up their hand. This suggested complete disengagement in the lesson. When working at the set activity in their groups:

- **Pupil A:** When given a number to partition, she used a mixture of rods and unit cubes when she represented 2-digit numbers as an image. This suggested she didn't understand the value and the difference in the value of each piece of the resource. She continued to count out how many units were in a rod of 10 which suggested she didn't recognise the value of the rod.
- **Pupil B:** Very reluctant to have a go on his own and was holding back, waiting for the teacher to work with him and give further guidance – highlighting a low confidence in his own ability to have a go at the tasks.
- **Pupil C:** She could use unit cubes to represent the units in a 2-digit number. However, like Pupil A she thought that she could use the 10s rods for units as well. This indicated that she too didn't fully grasp the value of the rods and cubes.
- **Whole-class learning:** Overall there was evidence that most children were able to use Dienes' blocks to represent and record the value of 2- digit numbers. The more able learners were able to apply this knowledge and solve a challenge involving the creating of their own 2-digit numbers.

The main issue for teaching was that the value of the basic blocks was not made sufficiently explicit to the children. This was especially so for the group containing the case pupils. We had both made the assumption that the children would recognise that units were represented by the cubes and the rods were in groups of 10 so would represent 10s. We had focused on the visual and concrete elements of the resource instead of the abstract thinking behind the structure of the blocks. When we interviewed the case study pupils we learned:

- **Pupil A:** Stated that using “the cubes” was the aspect of teaching that worked best for her. She also said that she enjoyed “writing down the numbers”. This suggested that she thought the resource was helping her to understand the numbers that she had written down.
- **Pupil B:** Said that he didn't enjoy the lesson because “I wasn't good at it”. He said he learnt “nothing” but did say the best part of the teaching was “when the teacher wrote it on the board”. This suggests a confidence issue as the work in his exercise books showed otherwise.
- **Pupil C:** Talked about enjoying “splitting up numbers” and said that she learnt how to “split up numbers properly”. This suggests she was beginning to understand the general principal of partitioning a number into tens and units and could recognise the place value of the digits.

In the Post Research Lesson Discussion, our view was that Pupil A was happy to use the Dienes resources to represent 2-digit numbers but didn't fully understand the values of rod and cubes that were essential parts in the resource. Pupil B needed additional adult support to build up his confidence in using the resources successfully. Pupil C needed to understand that the rods represented '10' and to use this knowledge to help count out different multiples of the 10s. We decided that in the cases of Pupils A and C, these issues could be addressed in the next lesson's direct teaching.

Our next research lesson would focus on ensuring that we explicitly taught the value of each part of the Dienes' resource to ensure that children could use them efficiently to represent the value of each digit as represented in a 2-digit number.

## Second research lesson (RL2)

We still wanted children to understand the structure and relative values of the rods and cubes in the Dienes' equipment and use these to represent 2-digit numbers. This time we explicitly modelled how the Dienes' blocks could be used to represent a 2-digit number. We explored the value of each piece of equipment and introduced an ICT game in the plenary when children were to apply their knowledge of the value of the Dienes' blocks values in a light and engaging way.

We planned the lesson together. The class teacher taught the lesson and the Mathematics Coordinator observed the three identified pupils

We noted that in general pupils had a much better understanding of how the rods and cubes could be used to represent a 2-digit number. The class teacher wrote 2-digit numbers on the board and modelled how these can be partitioned using the Dienes' apparatus. She talked through the idea of unit cubes being 1s and the 10 units become a rod of 10. She invited a range of children to come up to the front during the carpet session and to use the Dienes' equipment to represent given numbers.

- **Pupil A:** Was still unsure how to use the Dienes' blocks correctly. She made 11 using 2 rods of 20. When we discussed with her whether this was correct or not, Pupil A understood that "10 and 10 makes 20" and recognised her mistake and then put one rod back and took a unit cube instead. Further representations were made successfully with Pupil A counting out unit cubes to represent units in a 2-digit number and then counting out the right amount of 10s rods for the tens in a 2-digit number.
- **Pupil B:** Absent from the lesson. It raised the issue of how we might follow up the work with an absent case study pupil.
- **Pupil C:** Pupil C understood that units were represented using the Dienes' unit cubes. Initially she struggled to count in 10s when using the rods. However, this was because she still didn't equate a rod as being 'worth' 10 units. We followed this up in a short session after the pupil interview during which we talked about a rod being worth 10 and counting in 10s whilst moving the rods one at a time.

- **Whole-class learning:** Children had consolidated their learning of place value through the use of the Dienes' blocks. However, the class teacher put a line down the middle of a 2-digit number to show how it was being split into T and U. As they were leaving the carpet, some children were talking about splitting the number in half. This was a literal interpretation of what they were seeing, and was something we would need to address as a class in the next research lesson.

We were now aware we needed to ensure that children can handle the resources instead of just seeing the teacher modelling using the equipment. We felt that through the handling of the resource, the children were more familiar with knowing that units were small cubes and 10s were rods, and that they could represent 2-digit numbers correctly using these. When we interviewed the case study pupils we learned:

- **Pupil A:** Stated that "it was easier to split the numbers now" and suggested that her understanding of the value of the Dienes' blocks made it easier to do this practically. This was confirmed when asked what she had learned, she said "how to use the Dienes' blocks...because they were all together for you (in 10s)" – this indicated that she now understands that the rods are worth 10.
- **Pupil B:** Absent from research lesson.
- **Pupil C:** Talked about "using the blocks helps you to count quicker"

Our next research lesson will focus on case pupils using Dienes' blocks independently to represent partitioned numbers

### Third research lesson (RL3)

We wanted pupils to apply their knowledge of using Dienes' blocks to work independently at partitioning numbers into T and U, and learn to apply this to 3-digit number as appropriate.

We used the following teaching approaches: The class teacher modelled as before but this time made mistakes for children to correct. We also team taught the lesson – working together one of us would make a point and the other would build on this. For example, the class teacher split the number 24 using a line down the middle as before; we then explained that this wasn't splitting the number in half as that would be 12. Instead we are splitting the number in T and U.

We continued to plan the lesson together. The class teacher taught the initial part of the lesson and then we team taught and observed the three identified pupils

When we discussed the lesson we discovered that the children had a much better grasp of how to use the Dienes' blocks independently and with practice were partitioning 2-digit numbers successfully:

- **Pupil A:** Was much more confident in using unit cubes and 10s rods when representing 2-digit numbers. With some support, pupil A also had a go at partitioning and representing 3-digit numbers.
- **Pupil B:** This time had a go at using Dienes' apparatus to represent a 2-digit number when partitioned but still needed some adult guidance.
- **Pupil C:** She was much more confident in using unit cubes and 10s rods when representing 2-digit numbers that have been partitioned. Pupil C had a go at partitioning and representing 3-digit numbers but only with some support.
- **Whole-class learning:** Overall the children had acquired a good understanding of how to use the Dienes' apparatus to represent 10s and units. The class teacher introduced the flats to represent 100s and worked on how to represent 3-digit numbers. Generally children understood this as turning 10 rods into a flat 100 square.

As before, we needed to ensure that we spend sufficient time, more time than we thought would be necessary, making the links between the resources. We demonstrated that the 10 rods were placed together to make the square etc and had children model the partitioning at the front of the class with other children watching and prompting when necessary. We also felt that we must ensure we look at the closely language we're using – "splitting the number down the middle" – some children think this meant we wanted them to halve the number.

When we interviewed the case study pupils we learned:

- **Pupil A:** Pupil A enjoyed getting to partition 3-digit numbers using the Dienes' blocks.
- **Pupil B:** Said that this time "I understand it more than before".
- **Pupil C:** When asked what aspect of the teaching worked best for her, she said that "using the Dienes' blocks really helped"

## Impact on pupil learning and progress

We both agreed that one way this Lesson Study impacted on pupil learning is that it provided the learners a good amount of time to develop their understanding. It was taught at a manageable pace for them and we identified misunderstanding that we could address to help them to get a firm grip on what was being taught to them. Each of our case pupils made good progress in their understanding of how the Dienes' apparatus was constructed and they learned how to use them to partition 2-digit and some 3-digit numbers. Closely observing the three learners really showed their individual progress. For example, in the case of Pupil A, she went from not understanding the value of each piece of equipment to the final lesson in which she had a good firm grasp of using unit cubes and 10s rods to represent and create 2-digit numbers. This will impact on pupil learning and progress in the future as we will ensure pupils fully understand how mathematical equipment should be used and its role in demonstrating place value.

In terms of implications for future learning, children's understanding of how to use Dienes' blocks to partition 2-digit and 3-digit numbers will aid in their learning and understanding of how a

partitioning strategy can be used for the addition and subtraction of these numbers. Children will be able to use the resource as a visual representation of the numbers they wish to add together and have an awareness of the value of the digits in each number.

## Impact on practice and future teaching

Our experience of lesson study has helped us to understand the importance of the pace of learning and the need to match work to the progress and attainment of our pupils. We have learned that we should not assume learning but look carefully at what children are doing and how they respond in the lesson.

In future we will:

- Allow sufficient time for children to develop a concept – not move on too quickly but allow them to develop ideas and secure learning.
- Ensure tangible resources are properly explained and modelled to ensure link between the practical work and children’s abstract understanding.
- Give children time to use resources and to practice using them.
- Look into what other resources might offer children as well as Dienes’ apparatus.
- Focus on the observation of a small numbers of learners and track their learning/progression and use follow-up interviews.
- Develop the role of the pupil’s voice, plan the structure of interviews to make effective use of child friendly open questioning.

We plan to:

- Lead a staff meeting to feedback on this particular Lesson Study exercise describing our learning and the impact on pupils’ learning and our practice.
- Give staff a better insight into how lesson study works, so that they are able to undertake the approach within their year groups.
- Undertake further lesson study work to focus on specific areas across the curriculum, especially in mathematics.

## References

Burghes, D. and Robinson, D. (2010). *Lesson Study: Enhancing Mathematics Teaching and Learning* (CFBT, Reading).

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