

KNOWLEDGE INTO ACTION

INFORMING WHAT WORKS
... RAISING ATTAINMENT
AND REDUCING INEQUITY

November
2015



A Knowledge Into Action resource for practitioners and education staff

Briefing 1:

DIFFERENTIATED LEARNING IN NUMERACY AND MATHEMATICS

This briefing summarises research on differentiated learning and considers how it could be used to improve learner outcomes in numeracy and mathematics. It has a particular focus on meeting the needs of children from disadvantaged backgrounds. The briefing draws on a range of research including small and large scale studies and reviews. The majority of research comes from the USA. Teachers, local authority staff and others may find the briefing a useful starting point in becoming familiar with the research in this area, although it does not claim to be a comprehensive overview of the research base.

OVERVIEW OF THE RESEARCH

- Differentiated learning involves adapting learning, teaching and assessment to meet the learning needs of individual children. It is not a single approach, but includes a number of elements, for instance modifying learning content, processes, products or the wider learning environment. It is an integral part of learning and teaching.
- Key drivers for success in differentiated learning include effective assessment and monitoring of individuals' progress in learning, as well as increased teacher knowledge, skills and strategies supported by professional learning and strong leadership.
- Research has found that children from disadvantaged backgrounds may be affected by factors which significantly affect their life outcomes and educational experiences, although it also highlights that it is important not to have a 'deficit' view of these learners.



- There is some evidence to suggest that differentiated learning has an impact on outcomes for all children. However certain approaches to differentiating learning using ability groupings, i.e. using setting or streaming, may actually widen the attainment gap for children from disadvantaged backgrounds.
- In numeracy and mathematics, research suggests that the most effective teachers use a range of differentiated strategies with all children, including flexible grouping, ongoing assessment to ascertain next steps, as well as a variety of daily numeracy activities that vary in complexity and open-endedness. There is some evidence that differentiated teaching strategies in mathematics have had a positive impact on improving learning for children from disadvantaged backgrounds.

WHAT IS MEANT BY DIFFERENTIATED LEARNING?

Differentiated learning is not a single approach, but includes a number of elements. Broadly speaking, differentiated learning involves adapting learning, teaching and assessment to meet individual children's needs. By differentiating learning, teachers develop multiple starting points and pathways which are tailored to children's individual learning needs. This can be achieved through modifying the following aspects of learning:

- **Content** e.g. use of learning materials at different levels.
- **Process** e.g. varying the length of time children have to complete a task.
- **Product** e.g. giving children choice in how to express ideas or required learning.
- **Learning environment** e.g. having areas in the classroom for some children to work quietly without distraction. (Tomlinson, 2000).

Another key aspect of differentiated learning involves monitoring children's progress in learning through the use of assessment information to make decisions about a learner's next steps, building on their prior learning. Information gathered through assessment supports teachers to make informed decisions about next steps and teaching strategies to meet the learning needs of all children whilst maintaining high expectations and recognising individual need. Heacox (2002) described differentiated learning as "one dimension of equitable teaching". It is also consistent with the principles of Curriculum for Excellence, which promotes flexible approaches to take account of children's varied learning needs.

WHAT ARE THE PRACTICAL CHALLENGES FOR DIFFERENTIATED LEARNING WITHIN SCHOOLS AND HOW CAN THESE BE OVERCOME?

Differentiated learning presents challenges to teachers and schools in three main areas: time, skills and resources. The literature points to some perceived challenges to differentiation, including time for planning differentiated approaches, large class sizes and a desire to cover curriculum content. Research suggests that teachers typically do not differentiate more when class sizes are reduced. It also indicates that differentiated learning is not intended to be an add-on to what teachers are already doing, rather learning is planned in a differentiated way from the outset (Tomlinson and Imbeau, 2012). Tomlinson (1999) argued that schools should be evaluated on the amount of progress shown by children. This is facilitated by ongoing assessment of children's prior learning to decide if they are progressing appropriately. A key characteristic of high quality teachers is that they continually adjust teaching, as informed by these on-going assessments. It is argued that the amount of time spent on differentiated learning is worthwhile as it lessens the need for interventions later.

Tomlinson (1999) suggests that the barriers to differentiating learning can only be overcome if there is strong, sustained leadership and support in the school, as changing practices that are familiar and convenient needs a well-defined vision and buy-in from all staff. As well as strong management support and leadership, teachers need high quality professional learning, including time to work together. Research evidence (Anthony and Walshaw, 2007) suggests that professional learning that aims to increase teachers' awareness of mathematics in everyday life, to encourage greater awareness of home and cultural factors and to improve mathematical knowledge and teaching skills, leads to positive outcomes for both teachers and children.

IS THERE ANY EVIDENCE THAT DIFFERENTIATED LEARNING HAS AN IMPACT ON EDUCATIONAL OUTCOMES?

As noted above, differentiated learning is not a single approach but includes a number of different elements. There appear to be few studies which include large scale use of differentiated learning over a period of time. In one Canadian study, differentiated learning consistently produced positive results for learners (McQuarrie, McRae & Stack-Cutler, 2008).

There is also evidence to support the use of a number of the elements that make up differentiated learning. Teachers can ensure all children make appropriate progress by using differentiated teaching strategies based on their expected next steps. This can alleviate disengagement and can be effective to reduce barriers and ensure all learners make appropriate progress, e.g. less motivated learners, high achievers

and those requiring support with basic skills and conceptual understanding. Also, used effectively, differentiated learning produces learners with an improved sense of self-belief, engagement and passion for learning (Hillier, 2011). A heightened awareness of each child's background and ability can allow teachers to successfully match learners to beneficial educational approaches and curriculum content. There is also evidence that some forms of differentiation, such as establishing ability groupings (i.e. setting or streaming), may not be effective for all children. Baines (2012) analysed the effectiveness of setting and streaming in schools and found learners in high ability classes benefitted when taught a curriculum matched to their ability. However less able learners performed worse when taught in separate streams than when taught in mixed ability classes. He concluded that less able learners appeared to benefit more from mixed ability grouping, while more able learners benefitted equally from both approaches. The Education Endowment Foundation, which aims to identify strategies which are effective for 'closing the gap' for children from disadvantaged backgrounds, also concludes that setting or streaming do not appear to be effective strategies for raising the attainment of these children, as they are more likely to be assigned to lower groups (Education Endowment Foundation, 2015).

Teacher knowledge of individual children appears to be a key driver for success in differentiated learning. Research from the USA shows the link between increased teacher knowledge of learners and successful use of frameworks for progression (e.g. Doerr & Lesh, 2003). Studies exploring the impact of curriculum and pedagogical knowledge show that what teachers do in the classroom is dependent on what they know and believe about a subject. Jacobson and Lehrer (2000) found that in classes where teachers were more knowledgeable about a subject, not only did children learn more than their peers, but this difference persisted over time.

HOW CAN DIFFERENTIATED LEARNING BE USED IN NUMERACY AND MATHEMATICS?

In numeracy and mathematics, research suggests the most effective teachers consistently use a range of differentiated strategies, including flexible grouping, ongoing assessment and a variety of daily numeracy activities (e.g. mathematics stations) that give starting points that vary in complexity and open-endedness. To meet the diverse learning needs of all children, teachers can also use interest or learning centres (i.e. where similar materials are grouped together to encourage specific activities and experiences) or using anchor activities (i.e. tasks related to the current topic, which children work on independently) (Cox, 2008).

Research has also shown that differentiated learning has a positive impact on children's learning and attitudes towards mathematics (Konstantinou-Katzi et al., 2013). When teachers built on children's strengths, they were able to create effective learning environments. Extensive research on task and activity found that effective teachers make decisions on lesson content that give children opportunities to develop and apply mathematical thinking. These decisions significantly influence learning, however developing mathematical thinking requires teachers and schools to work in partnership with parents and carers.

WHAT ARE THE SUCCESSFUL STRATEGIES OR APPROACHES FOR DIFFERENTIATING LEARNING FOR CHILDREN FROM DISADVANTAGED BACKGROUNDS WITH A FOCUS ON NUMERACY AND MATHEMATICS?

Research has found that children from disadvantaged backgrounds can be affected by factors which may significantly affect life outcomes e.g. low aspiration and confidence in one's ability, leading to poorer academic achievement (Domina and Saldana, 2011). Those from disadvantaged backgrounds are also more likely to have developmental and language problems and are three times more likely than their peers to experience social, emotional and behavioural problems, which can impact on school readiness and lead to other barriers to learning (Barnes et al., 2010; Willis et al., 2015). Research suggests that the impact of socio-economic disadvantage on education is complex, and that it is important to "view children and families living in poverty in terms of their possibility and promise rather than their deficiencies" (Ciuffetelli Parker, 2015).

There is some evidence that differentiated teaching strategies in mathematics have had a positive impact on children from disadvantaged backgrounds. For instance, Starkey, Klein and Wakeley's (2004) intervention programme targeted pre-school children from disadvantaged families in the USA by introducing targeted mathematics activities and teacher professional learning. Parents and children in the intervention group attended a series of three mathematics classes to discuss strategies and activities to use at home. The significant socio-economic status related gap in mathematical knowledge found at the beginning of the study decreased after the intervention year. In another case study a group of secondary schools appointed a consultant, experienced in mathematics education, to work with the learning community, focusing on improving teachers' mathematics knowledge and diagnostic assessment skills. They jointly devised an effective differentiated curriculum, where children received feedback on actual and expected progression levels, with class assessments confirming progress. School leaders found an improvement in learner motivation, desire to learn, self-directed learning, positive attitudes to school and improvements in attainment (Stradling and Saunders 1993).

FIND OUT MORE

Education Scotland – National Numeracy Progression Framework

<http://www.educationscotland.gov.uk/resources/n/nationalnumeracyprogressionframework/index.asp?strReferringChannel=learningandteaching&strReferringPageID=tcM:4-628498-64&class=l3+d139749>

Ministry of Education, Ontario (Canada) – Differentiating Mathematics Instruction – Capacity Building Guide

https://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/different_math.pdf

Ministry of Education, Ontario (Canada) – Differentiating Mathematics Instruction – Webcast

<http://www.curriculum.org/k-12/en/projects/differentiating-mathematics-instruction>

Education Week – Effectively Differentiating Mathematics Instruction to Help Struggling Students – Webinar

<http://www.edweek.org/ew/webinars/math-webinars.html>

Education Endowment Foundation – Setting or Streaming

<https://educationendowmentfoundation.org.uk/toolkit/toolkit-a-z/ability-grouping/>

WHAT DOES THIS MEAN FOR YOU?

- In what ways do you differentiate for learning in numeracy and mathematics within your classroom? What range of strategies do you use?
- How do you know these strategies are effective?
- Are your learners aware of what differentiation is and how it can support them in their learning?
- In what ways are you meeting the learning needs of children from disadvantaged backgrounds within your class or school?

This briefing is not a comprehensive overview of published research in a particular area. Nor is it a definitive statement of policy or a recommendation to adopt a particular approach.

References

1. Anthony, G., and Walshaw, M. (2007). *Effective pedagogy in mathematics/Pāngarau: Best evidence synthesis iteration [BES]*. Wellington: Ministry of Education. <http://www.educationcounts.govt.nz/publications/series/2515/5951>
2. Askew, M., Brown, M., Rhodes, V., Wiliam, D., and Johnson, D. (1997). *Effective Teachers of Numeracy: Report of a study carried out for the Teacher Training Agency*. London: King's College, University of London. <http://www.leeds.ac.uk/educol/documents/000000385.htm>
3. Baines, E. (2012). Grouping pupils by ability in schools. In P. Adey, & J. Dillon (Eds.), *Bad Education: Debunking Myths in Education*. Open University Press. pp.37-55.
4. Barnes, M., Chanfreau J., and Tomaszewski, W. (2010). *Growing up in Scotland: The Circumstances of Persistently Poor Children*. Edinburgh: Scottish Government. <http://www.gov.scot/Resource/Doc/310430/0097968.pdf>
5. Ciuffetelli Parker, D. (2015). *Poverty and schooling: where mindset meets practice* (Research Monograph 57). Toronto: Ontario Ministry of Education: Student Achievement Division.
6. Cox, S.G. (2008). Differentiated instruction in the elementary classroom. *Education Digest: Essential Readings Condensed for Quick Review*, 73(9), pp.52-54.
7. Doerr, H. M., and Lesh, R. (2003). A modeling perspective on teacher development. In R. Lesh and H. M. Doerr (Eds.), *Beyond constructivism: A models & modeling perspective on mathematics problem solving, learning & teaching*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc. pp. 125-140
8. Domina, T., and Saldana, J. (2011). Does raising the bar level the playing field? Mathematics curricular intensification and inequality in American high schools, 1982-2004. *American Educational Research Journal* 49(4), pp.685-708.
9. Education Endowment Foundation (2015). *Teaching and learning toolkit: setting or streaming*. London: EEF.
10. Heacox, D. (2002). *Differentiating instruction in the regular classroom*. Minneapolis, MN: Free Spirit.
11. Hillier, E. (2011). Demystifying differentiation for the elementary music classroom. *Music Educators Journal*, 97(4), pp.49-54.
12. Jacobson, C., and Lehrer, R. (2000). Teacher appropriation and student learning of geometry through design. *Journal for Research in Mathematics Education*, 31, pp.71-88.
13. Konstantinou-Katzi, P., Tsolaki, E., Meletiou-Mavrotheris, M., and Koutselini, M. (2012). Differentiation of teaching and learning mathematics: An action research study in tertiary education. *International Journal of Mathematical Education in Science and Technology*, 44(3), pp.332-349.
14. McQuarrie, L., McRae, P., and Stack-Cutler, H. (2008). *Differentiated instruction provincial research review*. Edmonton: Alberta Initiative for School Improvement.
15. Scottish Executive, (2007). *A Curriculum for Excellence: building the curriculum 3-18. Active learning in the early years*. Edinburgh: Scottish Executive. <http://www.educationscotland.gov.uk/learningandteaching/thecurriculum/buildingyourcurriculum/curriculumplanning/whatisbuildingyourcurriculum/btc/btc2.asp>
16. Starkey, P., Klein, A., and Wakeley, A. (2004). Enhancing young children's mathematical knowledge through a pre-kindergarten mathematics intervention. *Early Childhood Research Quarterly*, 19, pp.99-120.
17. Tomlinson, C.A. (1999). *The differentiated classroom: Responding to the needs of all learners*. Alexandria, VA: Association for Supervision and Curriculum Development.
18. Tomlinson, C. A. (2000). Reconcilable differences: Standards-based teaching and differentiation. *Educational Leadership*, 58(1), pp.6-11. http://www.ascd.org/publications/educational_leadership/sept00/vol58/num01/Reconcilable_Differences%C2%A2_Standards-Based_Teaching_and_Differentiation.aspx
19. Tomlinson, C. A. and Imbeau, M. B., (2012). Common Sticking Points about Differentiation. *School Administrator* 69.5, pp.8-22.
20. Willis, M., Sime, D., and Lerpiniere, I. (2015). *Poverty and children's health and wellbeing: Policy Briefing*. Glasgow: Scottish Universities Insight Institute.