Equitable access to quality education in elementary school mathematics

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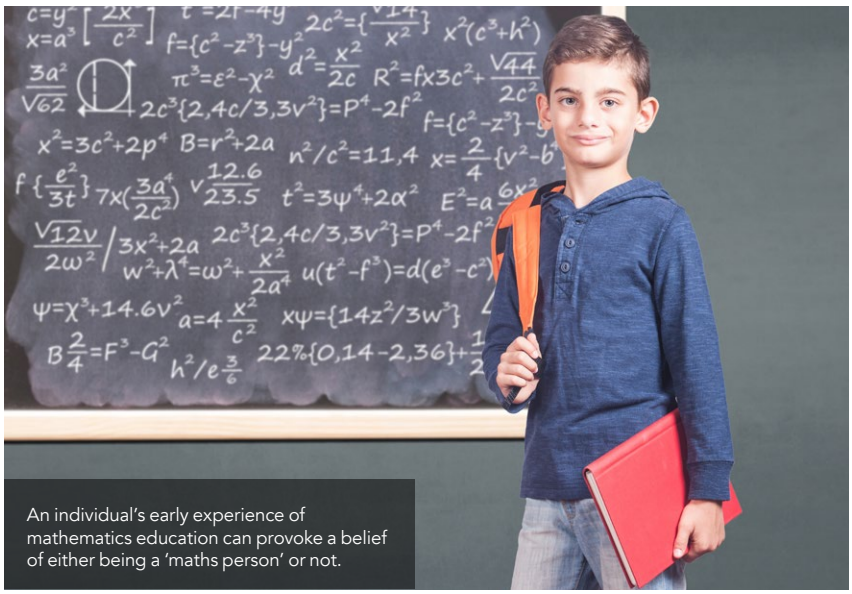
In a study contrasting an assessment-heavy approach that concentrates on 'getting the answer right' with one that promotes the development of mathematical thinking in the elementary school classroom, Professor Brian Hudson, from Karlstad University and the University of Sussex, examines what constitutes educational quality in terms of mathematics education. This research demonstrates that in order to ensure fair and impartial access to quality education, epistemic quality is paramount. Consequently, the goal is to create curriculum principles that give all pupils the best possible chance of accessing a high-quality mathematics education.

Mathematics can be viewed as a 'love it or hate it' subject, with the common notion that some people can do it and some people can't. An individual's experience of mathematics education can provoke a belief of either being a 'maths person' or not, with the associated impact on their learning. Labelling a learner as 'not a maths person' has been shown to oppress the learner, supressing their creativity and limiting their autonomy.

Brian Hudson, Senior Professor in the Department of Educational Studies at Karlstad University in Sweden, Emeritus Professor at the University of Sussex and Honorary Professor at the University of Dundee, examines a variety of approaches to mathematics education. In a study that contrasts an assessment-heavy approach, concentrating on demonstrating knowledge and 'getting the answer right', with an approach that promotes the development of mathematical thinking in the primary classroom, Professor Hudson simultaneously addresses the challenges of the United Nations Sustainable Development Goal 4 (SDG4): 'to ensure inclusive and equitable quality education' for all. SDG4 poses challenges at both global and national levels for societies and their educational systems, particularly in an age of mass migration.



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An individual's early experience of mathematics education can provoke a belief of either being a 'maths person' or not.

This equitable access to quality education is not simply a question of school enrolment. It has been shown that enrolment figures are an inadequate indicator of access to education because students enrolled in school are not necessarily in school, and students in school are not necessarily engaged in productive learning. Professor Hudson explains that, "it is necessary that the curriculum be underpinned by the curriculum principle of epistemic access that maximises the chances for all pupils to experience high-quality education in school mathematics."

EPISTEMIC QUALITY

Professor Hudson argues that in order to ensure fair and impartial access to quality education, the epistemic (relating to knowledge) quality of, "what students come to know, make sense of and be able to do in school mathematics" in relation to their mathematical knowledge and skill is paramount. This is related to a trajectory in the development of expertise from novice towards becoming an expert in the subject. Consequently, the goal is to create curriculum principles that give all pupils the best possible chance of accessing a high-quality mathematics education.

JOINT ACTION THEORY IN DIDACTICS

The theoretical framework of Joint Action Theory in Didactics (JATD) developed from French didactics (a theory of teaching), which holds 'learning from the situation' as a fundamental principle, influences Professor Hudson's research.

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A didactic activity involves someone teaching and someone learning and forms part of a didactic system comprising three subsystems: knowledge, the teacher and the student. This didactic triad cannot be separated as it is considered that one cannot grasp the meaning of the teacher's action without having an understanding of the relationship between his/her action, the students' action, and the structure of the knowledge being imparted.

PARALLEL STUDIES

Professor Hudson's research questions centre on the quality of the teacher-students joint action together with the epistemic quality of the knowledge being communicated. This study draws on the research findings of two projects: Developing Mathematical Thinking in the Primary Classroom (DMTPC), which was directed by Professor Hudson and funded by the Scottish Government, and a parallel study examining the assessment practices of mathematics teachers in Ghana. Both empirical research projects focused on mathematics education in elementary schools.

The DMTPC project involved a group of 24 primary school teachers participating in a Masters course created to promote the development of mathematical thinking in the classroom. The course was designed around three key questions:

- What is mathematics?
- What is mathematical thinking?
- What is good mathematics teaching?

Participants also completed an action research project, with their reports forming the course assignment.

WHAT IS GOOD MATHEMATICS TEACHING?

Examining what constitutes good mathematics teaching prompted the teachers to review and contrast their own experiences of mathematics at school. This brought about one of the key findings of the study, emphasising how mathematics can disintegrate from what was envisaged in the curriculum. Vivid memories of 'not understanding the relevance of mathematics' and 'learning to pass exams' featured in interview responses. Furthermore, being labelled according to their performance in the mathematics classroom, together with the stigma that went with it, was prevalent among the participants' recollections. Consequently, the teachers expressed their aspirations to 'make a difference' to the mathematics education experienced by their pupils, encouraging them to develop their understanding of both how mathematics works and why mathematics works together with an appreciation of how mathematics is more than simply right or wrong.

Professor Hudson presents one DMTPC project participant's action research project as an exemplary case study demonstrating both high-quality joint action between teacher and students and high quality of content in primary school mathematics. This assignment illustrates accessible and inclusive mathematics in the classroom that could advance mathematical thinking and lead to high-quality epistemic access for all.

The goal is to create curriculum principles that give all pupils the best possible chance of accessing a high quality mathematics education.

MATHEMATICAL FALLIBILISM AND MATHEMATICAL FUNDAMENTALISM

A discussion of the contrasts between mathematical fallibilism and mathematical

Example tasks showing active involvement in learning games

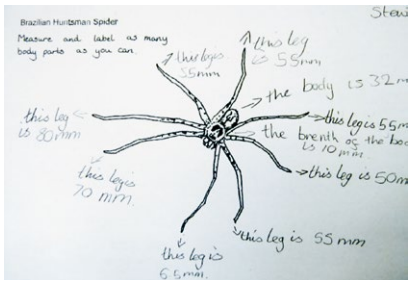

Image 1: Kaye's measurements of the spider

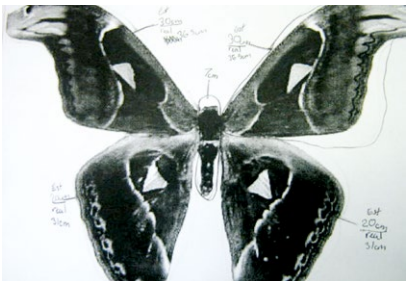

Image 2: Jenny's measurements of the moth

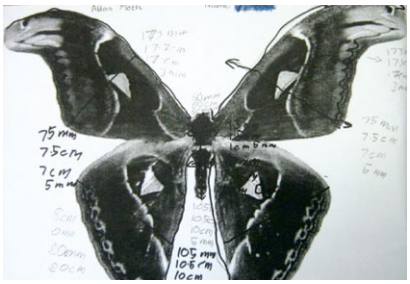

Image 3: Paul's measurements of the moth

fundamentalism also highlighted the nature of the mathematics that the participants sought to teach. Mathematical fallibilism is based on a heuristic view of mathematics as a human activity and proposes that this human mathematical activity actually produces mathematics. It involves viewing mathematics as fallible and refutable with an uncertainty that promotes critical thinking and creative reasoning, where it is possible to generate multiple solutions and learn from errors and mistakes. Mathematical fundamentalism reflects an authoritarian viewpoint where mathematics is absolutist, irrefutable and infallible. Learners have a fearful and anxiety-inducing experience of mathematics as a subject that is boring and demotivating, involving the following of rules and strict procedures with right or wrong answers, leading to alienation from mathematics itself, mitigating against inclusive education.

The counterproductive impact of the mathematical fundamentalism is apparent when one considers the pressures that go with high stakes external testing, inspections, summative assessment and school league tables. The impact of assessment practices was highlighted in the Ghana study, which revealed an emphasis on memorising, drill and practice, factors that can exacerbate low epistemic quality.

Professor Hudson argues that assessment for learning that involves low stakes formative and self assessment will promote high epistemic quality. Individual learners find this kind of assessment both engaging and motivating and can gain enjoyment from mathematics, experiencing it as a creative human activity.

KNOWING THAT OR KNOWING HOW

This study also stresses the difference between 'knowing that' (propositional knowledge) and 'knowing how' (procedural knowledge). Moreover, Professor Hudson highlights how these terms can describe every aspect of the curriculum. An over-emphasis on 'knowing that' is simply factual knowledge of low epistemic quality, where students are taught to know things but not understand them. In contrast, 'knowing how' involves understanding how the conceptual knowledge coheres, therefore eliciting higher epistemic quality. This is a precarious kind of knowledge where students learn how to find out new things through experience. Activities such as mathematical thinking and creative reasoning are central to mathematical know how.

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DISSEMINATION

Professor Hudson is a member of the ROSE (Research on Subject-Specific Education) interdisciplinary research group at Karlstad University, whose members share a focus on subject didactics. The ROSE group joins cross-disciplinary educational research groups from Finland and England to form the KOSS network (Knowledge and Quality across School Subjects and Teacher Education).

Recently, members of the KOSS network were at ECER 2019, the conference for Education in an Era of Risk – the Role of Educational Research for the Future, in Hamburg where they organised a two-part symposium on Epistemic Quality across School Subjects and Teacher Education.

FUTURE PLANS

The KOSS network's most recent meeting at the University of Helsinki from 16th to 18th October 2019 centred on 'Epistemic Quality across School Subjects and Teacher Education' and Professor Hudson led a seminar discussing his recent JCS paper 'Epistemic Quality for Equitable Access to Quality Education in School Mathematics', which is also the focus of this article.

Professor Hudson's work with the KOSS network has led to discussions with a publisher about two book proposals:

- *International Perspectives on Powerful Knowledge and Epistemic Quality across School Subjects* and
- *International Perspectives on Powerful Knowledge and Epistemic Quality: Implications for Innovation in Teacher Education Policy and Practice*

Both books have a proposed publication date of November 2020.

NATIONAL SIGNIFICANCE

The significance of this research to the current strong political steer towards a 'knowledge-rich' or 'knowledge-based' curriculum in England is evident. Professor Hudson warns how this context knowledge is heavily influenced by the standpoint of the Core Knowledge Foundation. These are resources imported from the USA that are promoted in English schools. They rely heavily on purely factual knowledge i.e. 'knowing that' and have the potential to jeopardise educational quality. With his long experience in studying mathematics education, Professor Hudson is convinced that an emphasis on 'knowing how' is key for quality learning.

Assessment for learning that involves low stakes formative and self assessment will promote high epistemic quality.

Behind the Research

Professor Brian Hudson

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Research Objectives

Prof Hudson's work examines approaches to mathematics education. He contrasts the effect of an assessment-heavy approach which emphasises 'getting the answer right' and demonstrating knowledge with an approach which emphasises the development of an understanding of how and why mathematics works and the image of mathematics as more complex than simply right or wrong.

Detail

Bio

Brian Hudson is Senior Professor in the Department of Educational Studies at Karlstad University in Sweden. He is Emeritus Professor and former Head of the School of Education and Social Work (2012-16) at the University of Sussex and also Honorary Professor at the University of Dundee.

Funding

Learning Directorate – Scottish Government for supporting the DMTPC project (2010-2012) with a grant of £46,331.

Collaborators

- Members of the ROSE group – Research on Subject-specific Education at Karlstad University https://www.kau.se/en/rose - in particular professors Christine Olin-Scheller, Niklas Gericke and Martin Stolare.
- Members of the JADE project – Joint Action in Didactics in Europe – in particular professors Monique Loquet at the University of Rennes, Anke Wegner at the University of Trier and the late Meinert Meyer at the University of Hamburg.
- Dr Evelyn Owuso Oduro – former Executive Secretary of the National Teaching Council, Ghana.
- Dr Sheila Henderson and Dr Alison Hudson both formerly at the University of Dundee.
- Also members of the KOSS network funded by the Swedish Research Council (2019-21)

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Personal Response

What advice would you give to government education departments to help them develop equitable access to quality mathematics education?

"Policy makers need to recognise that it is at the classroom level that curriculum and pedagogy effectively merge. It is not the role of government departments to import commercial curriculum resources from the USA, or from anywhere else for that matter. Rather government needs to ensure systems of support for teachers as 'curriculum makers' who, through their own professional development and networking, ensure equitable access to quality education for all. In the case of mathematics teaching the emphasis should be on the development of mathematical know how through activities such as mathematical thinking, problem solving and creative reasoning."