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A connected approach to mathematics learning: The Cambridge Mathematics Framework

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1. Background to Curriculum Concern

Why is connectedness important in mathematics learning?

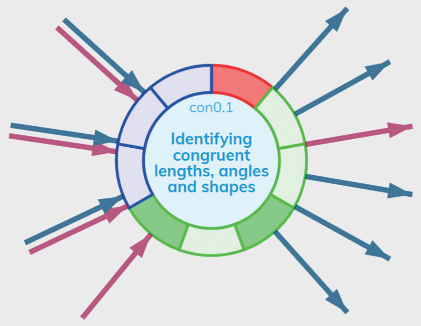
The Cambridge Mathematics Framework is designed to be a common frame of reference for those involved in mathematics education, curriculum design, and resource and assessment design as well as teaching (Jameson, 2019). Principles which have guided the development of the Framework include connectedness. Current curricula are linear in presentation; linking concepts which have a common mathematical structure can offer more options for those making decisions in curriculum design, resource design and delivery (Cambridge Mathematics, 2018a). Thurston (1990) describes the structure of mathematics as broad, tall and connected. It is 'tall' as concepts build on each other and broad because it includes many interconnected concepts, which support its tall structure. This suggests that understanding is developed by accessing a web-like scaffolding structure (Cambridge Mathematics, 2018b). A growing body of work has investigated learning progressions, trajectories and pathways as well as the connections that students make when building understanding of concepts (e.g. Black, Wilson, & Yao, 2011; Daro, Mocher, & Corcoran, 2011; Maloney, Confrey, & Nguyen, 2014). Michener (1978) for example, developed a framework which maps mathematical understanding, similar to the connected graphs in the Cambridge Mathematics Framework.

What is the curriculum concern?

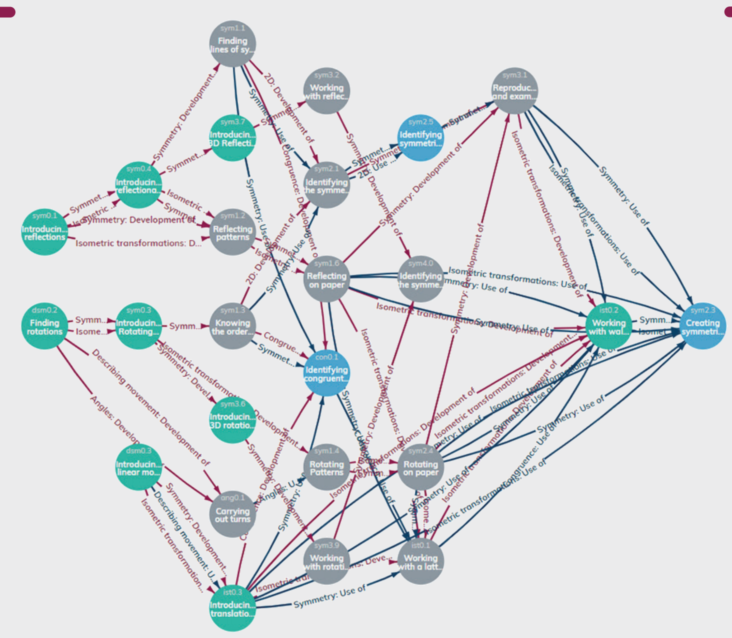
- Lack of clear connections between concepts in mathematics learning
- Difficulties of working with a linear structure which does not emphasise connectivity

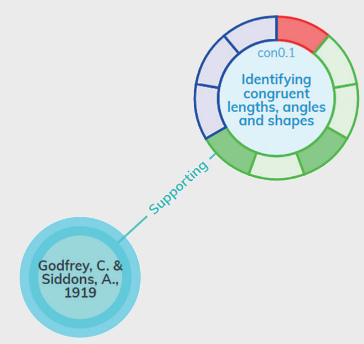
2. Addressing the Curriculum Concern

Connectedness



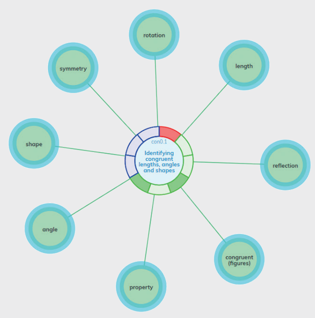
Waypoints refer to 'places where learners acquire knowledge, familiarity or expertise about a mathematical idea'. The two main types of waypoints include exploratory and landmark waypoints. Exploratory waypoints often come at the beginning of a connection, may introduce students to an idea and provide essential foundations for understanding a concept. Landmark waypoints bring together and synthesise ideas; therefore the whole may seem greater than individual concepts at this point. Waypoints are linked by edges. Edges are connections labelled according to whether the connection is best described as development of a concept, skill or procedure or whether it is best described as the use of the learnt concept, skill or procedure.

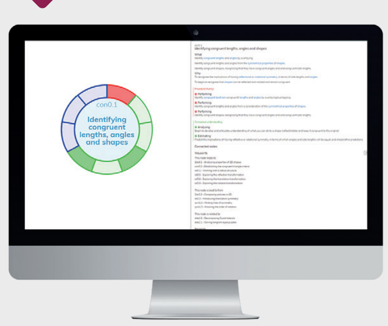




Our design is informed by research evidence and collaboration with researchers and curriculum designers. Waypoints are supported by theoretical and empirical sources which are considered to be of good quality within the mathematics education research literature. The team conducts systematic literature reviews in areas of mathematics education. When evaluating the quality of each source, we judge how trustworthy the source is by looking at the methods used. The Framework is therefore underpinned by the research base.

When writing waypoints, the team notes key words that are relevant to that area of mathematics learning. Key mathematical terms are defined in glossary nodes, which are linked to the waypoints in which they appear. This allows the team to search by key terms and will ultimately inform the glossary layer in the Framework.





Each waypoint contains a summary of the 'what' (what is the mathematical idea?) and the 'why' (why is this concept important?). Each waypoint also lists examples of 'student actions' (what students might do to help them build an understanding of a mathematical concept).

Further information

Please see www.cambridgemaths.org for more information.

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References

Black, P., Wilson, M., & Yao, S.-Y. (2011). Road Maps for Learning: A Guide to the Navigation of Learning Progressions. *Measurement: Interdisciplinary Research & Perspective, 9*(2–3), 71–123. https://doi.org/10.1080/15366367.2011.591654
Cambridge Mathematics. (2018a). *An Update on the Cambridge Mathematics Framework*. Retrieved from: https://www.cambridgemaths.org/Images/cambridge-mathematics-framework.pdf
Cambridge Mathematics. (2018b). *In more detail: Supplement to March 2018 Framework Update*. Retrieved from: https://www.cambridgemaths.org/images/cambridge-mathematics-symposium-2018-framework-supplement.pdf
Daro, P., Mosher, F., & Corcoran, T. (2011). *Learning trajectories in mathematics*. Madison, WI: Consortium for Policy Research in Education.
Jameson, E. (2019). *Background for the case study micro-report series*. Retrieved from Cambridge Mathematics website: https://www.cambridgemaths.org/Images/case-study-micro-report-series-background.pdf
Maloney, A. P., Confrey, J., & Nguyen, K. H. (2014). *Learning over time: Learning trajectories in mathematics education*. IAP.
Michener, E. R. (1978). Understanding understanding mathematics. *Cognitive Science, 2*(4), 361–383.
Thurston, W. P. (1990). Mathematical Education. *Notices of the AMS, 37*(7), 844–850.

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