

The ATM response to the PISA 2021 consultation

by Ian Benson, convenor, functional programming and computer algebra working group.

PISA is an international assessment, carried out in April-May of Year 10 every three years. The 2021 test will major on mathematics. England participates, but does not offer any special training to participating schools. These comments are intended to inform the work of the PISA test item designers for 2021.

The main innovation in the new test is the addition of a computational thinking strand to what PISA call mathematical literacy. They also propose the systematic use of computer-based assessment of mathematics (CBAM). They say, “Mathematical literacy goes beyond problem solving, to a deeper level, that of mathematical reasoning and computational thinking, which provides the intellectual acumen behind problem solving in the 21st century”. Their conception of mathematical literacy supports the importance of students, “developing a strong understanding of concepts of pure mathematics and the benefits of being engaged in explorations in the abstract world of mathematics.” (PISA, para 20)

PISA identify the 21st century skills that mathematical literacy both relies on and develops. These are critical thinking, creativity, research and inquiry, self-direction, initiative and persistence, information use, systems thinking, communication and reflection.

The associated background questionnaire will collect information on “how classroom pedagogy is evolving on account of the impact that technology is having on our exposure to mathematics and mathematical artifacts and on what it means to do mathematics. In the case of students, it is of interest to better understand how technology is impacting on student performance which could be explored in the task performance module of the questionnaire framework. The pedagogical issues could be explored in both the learning time and curriculum and teaching practices modules.” (PISA, para 164)

The Association has a special contribution to make to the pedagogy and content required to meet the PISA objectives. ATM members have pioneered a unique pedagogy that postulates that an awareness of our somatic nature is intrinsic to developing as mathematicians (ATM, 2018). ATM members conduct research and development on a mathematics and computer science curriculum that teaches algebra before arithmetic. This helps learners develop a strong understanding of the concepts of pure mathematics (Benson and Cane, 2017). Both strands of this research build on the work of pure mathematician and educationist Caleb Gattegno, ATM’s founding Director of Studies, who proposed the teaching of algebra before arithmetic (Gattegno, 1974; Young and Messum, 2011; ATM 2017).

The Association:

- Strongly agrees with the revised definition of mathematical literacy.
- Agrees that it is important to incorporate the 21st century skills into the test items.
- Argues for a pedagogy that builds mathematical and computational thinking skills on each learner’s awareness of their mental powers.
- Recommends that textual programming languages, such as the functional programming language Haskell, are preferred to block-based languages in implementing computational thinking in mathematics. They are nearer to the syntax and semantics of conceptual mathematics. (Lawvere and Schanuel, 2004; Wells 1995)
- Warns that most of the sample test items are limited to manipulating values until a number converges on the right answer. This will not test any deep level of mathematical understanding, nor will it assess computational thinking in mathematics.
- Notes that the broadening of the mathematics curriculum to include assessment items from computational thinking to the use of simulations and dynamic geometry in computer-based assessment has implications for school IT infrastructure, teacher training and education. We believe that this investment is warranted and small compared to the scale of the expected benefits for mathematics education.

References

- ATM (2017). *Working with the rods and why*. Derby: ATM.
- ATM (2018), *Teaching and learning mathematics with awareness*. Derby: ATM.
- Benson, I. and Cane, J. (2017). Using Haskell with 5-7 year olds in *Helloworld, Journal of computing at school*. Issue 2, Summer 2017.
- Gattegno, C. (1974). *Common sense of teaching mathematics*. New York: Educational Solutions.
- Lawvere, W. and Schanuel S. (2004). *Conceptual mathematics*. Cambridge: Cambridge University Press.
- PISA, GB(2018). PISA 2021 Mathematics framework first draft.pdf.
- Young, R and Messum, P. (2011). *How we learn and how we should be taught: An introduction to the work of Caleb Gattegno*. London: Duo Flumina.
- Wells, C. (1995). Communicating mathematics : Useful ideas from computer science. *The American Mathematical Monthly* (102) 5.

The attached document has been downloaded or otherwise acquired from the website of the Association of Teachers of Mathematics (ATM) at www.atm.org.uk

Legitimate uses of this document include printing of one copy for personal use, reasonable duplication for academic and educational purposes. It may not be used for any other purpose in any way that may be deleterious to the work, aims, principles or ends of ATM. Neither the original electronic or digital version nor this paper version, no matter by whom or in what form it is reproduced, may be re-published, transmitted electronically or digitally, projected or otherwise used outside the above standard copyright permissions. The electronic or digital version may not be uploaded to a website or other server.

Any copies of this document MUST be accompanied by a copy of this page in its entirety. If you want to reproduce this document beyond the restricted permissions here, then application must be made for express permission to copyright@atm.org.uk. The exception to the above is for the original author(s) who retain individual copyright.

ATM is a not for profit professional teaching association. The majority of funding used to produce and prepare the MT journal is procured through our membership subscriptions.



Mathematics Teaching does not seek to conform to an 'official' view on the teaching of mathematics, whatever that may be. The editorial board wishes to encourage contributors to express their personal views on the teaching and learning of mathematics.

ATM is an association of teachers in which everyone has a contribution to make, experiences and insights to share. Whether practical, political, philosophical or speculative, we are looking for articles which reflect on the practice of teaching mathematics. We aim to publish articles that will be of interest to the breadth of our membership, from the Foundation Stage to Higher and Further Education; as well as a balance between those derived from research and from practical experience. Submitted articles are accepted for publication based on their clarity, topicality, the extent to which they reflect upon knowledge and understanding of mathematics teaching and learning, and their contribution to inspiring further development and research.



Join ATM at any time and receive twelve months of membership, including instant access to member discounts and resources. Spread the cost and pay in ten monthly instalments.

Membership Includes:

- Five copies of the ATM journal Mathematics Teaching (MT)
- A 25% discount on all shop items
- Considerable discounts at the hugely popular annual ATM conference
- Electronic access to thousands of online MT journal articles
- Access to all online member-only resources
- Professional support and enrichment – being part of a community where ideas are generated and shared
- Regular ATM e-newsletters, containing current news and activities
- A network of local branches offering regular meetings
- Accreditation - ATM is proud to offer members the opportunity to apply for the CMathTeach Designation, making ATM membership the route to Chartered Mathematics Teaching status
- Influence and having a voice - eligibility to vote on resolutions that shape the direction of ATM

Join ATM Today