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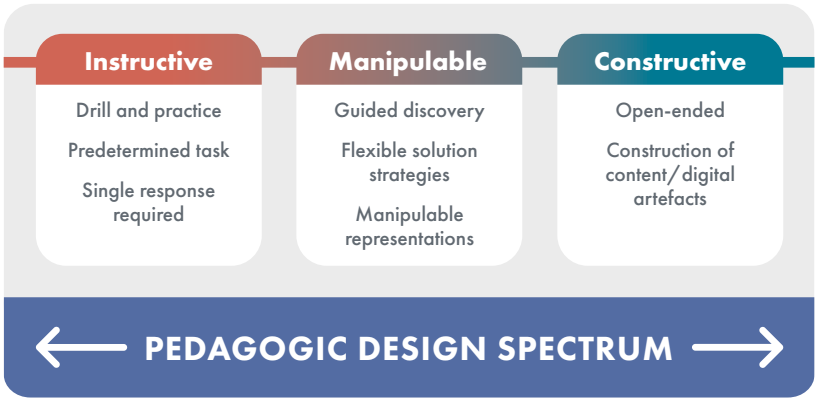
TALKING POINT:

WHAT DOES THE RESEARCH SUGGEST ABOUT REMOTE MATHEMATICS LEARNING?

How would you classify the design principles of your digital maths learning resources?



Adapted from ideas in Highfield & Goodwin (2013)

IN SUMMARY

- There is a variety of methods to teach and learn remotely and use of synchronous and asynchronous methods is likely to be complementary
- There is little research at present on remote mathematics learning and most is with 18+ learners; this research is mixed
- Remote maths learning is an opportunity to try new pedagogies; it increases flexibility and connections for isolated students
- It can be more difficult for teachers to notice student anxiety or disengagement when working remotely, and it may increase workload and stress for parents or carers
- One of the biggest barriers to successful remote learning is student and teacher access to computers, mobile devices and the internet
- Selection of resources for remote learning is particularly key: online activities and apps for maths learning exist, but many are of poor quality, or fall only into the instructive category
- Both constructivist and objectivist methods may be used to teach maths remotely
- Representing mathematics in dynamic and visually rich ways and encouraging peer interaction supports remote maths learning

1

Remote (or distance) learning refers to students being in a different place to the teacher, including asynchronous (not in real time) communication such as assigning resources (e.g. games and digital activities) email, discussion forums and recorded video; and synchronous (real time) communication such as video calling, webinars, live messaging/chat, and audio calling. It has been suggested that synchronous and asynchronous communication play complementary, supporting roles in education[1] and one is not necessarily better than the other.[2] The development of online educational technologies has allowed new pedagogical models to emerge.[3] However, research on remote learning in mathematics is scarce, and most of the research available is with students aged 18 and above. The evidence in comparing face-to-face and distance learning in maths is mixed; some studies have found that there is no significant difference in quality of learning or student achievement between distance versus classroom learning.[4] A recent meta-analysis suggests that "the quality of remote teaching is more important than how lessons are delivered... what matters most is whether the explanation builds clearly on pupils' prior learning."[2]

IMPLICATIONS: There is a variety of effective methods to teach and learn remotely and use of synchronous and asynchronous methods is likely to be complementary

The little research on remote mathematics learning is mostly with older (18+) learners

The research comparing remote and face-to-face mathematics learning is mixed

"It feels intuitive that we would want to best replicate the experience of being in a classroom and that live lessons online would be the closest to this. The problem is, it doesn't take into account all the ways that online lessons will differ from those in the classroom"

Mark Enser, 2020

"Given that non-educators design many apps, perhaps looking for a quick profit, the poor mathematical structuring of future apps is likely to continue"

Kevin Larkin, 2016

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2

Using online technology to teach mathematics offers opportunities to disrupt traditional teacher-centred models, for collaborative and reflective learning, and for supporting students who are geographically or socially isolated.[5] Remote learning can be more flexible in terms of scheduling and may make learners feel more comfortable than traditional face-to-face courses;[6] it may also provide high-quality data in large quantities which can be analysed and used to shape future learning.[7] However, when learning at a distance it is harder for teachers to recognise negative effects or disengagement among students;[8] it may also increase isolation for students, which may exacerbate maths anxiety.[9] Remote maths learning is likely to narrow communication between student, teacher and, often, a parent (acting as educational supervisor);[10] this new role for parents/carers is labour-intensive, can be stressful, and requires organisation and motivation.[11] One of the biggest barriers to successful remote maths learning is access to computers and mobile devices, and internet access; the focus on closing this digital divide is a "pressing need" during the COVID-19 pandemic.[12]

IMPLICATIONS: Remote maths learning can be an opportunity to disrupt traditional knowledge transmission models, increase flexibility for students and connect students who would be otherwise isolated; it may also provide high quality data for analysis

Some learners may feel more comfortable using remote learning; others may feel more anxious, and it can be difficult for teachers to notice this anxiety or disengagement when working remotely

Remote learning usually requires the parent or carer to be an educational supervisor, which is labour-intensive and can be stressful

A significant barrier to remote learning is access to computers, mobile devices and the internet

3

Use of digital technology to teach maths is likely to take focus away from the teacher and towards the resources used;[13] remote maths learning relies even further on unmediated resource use for effective learning, so the selection of resources and the way they are structured is likely to be more crucial than in face-to-face learning, where teachers are critical mediators.[14] The quality of many of the apps and digital activities to support online maths learning is poor[15] and there is little research examining the pedagogic elements of the design underlying them.[16] The vast majority of apps fall at the instructive end of the spectrum, with only a few manipulable and none at all constructive (see infographic), showing a need for a broader range.[16] One way to evaluate digital mathematics learning tools is to consider their *pedagogical*, *mathematical* and *cognitive* fidelity: the degree to which they can be used to further student learning; reflect mathematical properties, conventions and behaviours; and assist the learner's thought processes while engaged in mathematical activity, respectively.[15]

IMPLICATIONS: Appropriate selection of resources is particularly key in remote learning

A large number of online activities and apps for maths learning exist, but many are of poor quality; one way to evaluate them could be to consider their pedagogical, mathematical and cognitive fidelity

There is a distinct lack of maths learning apps that are manipulable and constructive compared with the number that are instructive; a range of such experiences is suggested for learners

4

Although some research on maths distance learning supports constructivist methods, both objectivist (transferring objective knowledge from teacher to student) and constructivist (discussion and collaboration to create shared meaning) teaching strategies can be viable and effective.[9] Evidence from distance learning in remote and rural communities suggests mathematics is not typically represented in dynamic, socially connected ways and that using visually and communicatively rich technologies, and ensuring students have access to collaboration, are critical in enhancing learning opportunities and sense making.[10] Peer interaction – including peer marking and feedback, sharing models of good work, and opportunities for live discussions of content – is suggested as effective.[2]

IMPLICATIONS: Both constructivist and objectivist methods may be used to teach maths remotely

Representing mathematics in dynamic, visually rich ways and encouraging peer interaction supports remote maths learning

Lucy Rycroft-Smith, Darren Macey, Rachael Horsman & Lynne McClure, 2020

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