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Focus: Pedagogy.

May 2020

Teaching is tricky. Exploring different pedagogical ideas allows us to improve our educational practice but the pedagogy can often be unclear, so this article outlines the pedagogical practices Blutick draws on to support the teaching and learning of mathematics.

> **"It is important that everyone involved in sharing ideas about teaching understands the underlying rationale and evidence base, where one exists"**
>
> Sherrington and Caviglioli, 2020

What is pedagogy?

In a nutshell, pedagogy includes all the behaviours and methods that a teacher uses to teach.

Mathematics teaching is complex. Teachers teach mathematics in a variety of ways just as students learn in a way that makes sense to them. Blutick appeals to a large international audience and so it needs to be able to offer a way of teaching and learning that both students and teachers can relate to. For this reason Blutick does not subscribe to one pedagogical practice in favour of another. Instead, it focuses on students being able to engage with, understand and think about the mathematics but from a variety of starting points.

It is not just teachers who are thinking about pedagogy. School leaders too recognise the need for more understanding about professional learning systems to support teacher development.

Generic Pedagogical Content Knowledge

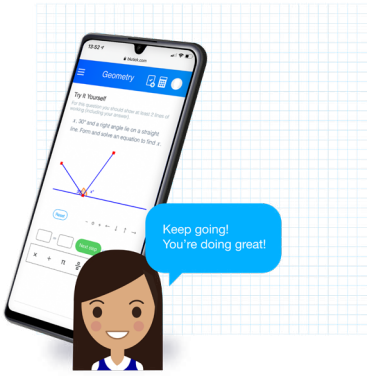
To start with we outline some of the more general pedagogical practices that can be applied to mathematics (and other subjects) that are also prevalent in Blutick.

As with any pedagogical practice, how teachers apply the theory depends on how true they stay to the overarching principles. Similarly, students are free to access the site and may use it in many different ways.

Constructivism

This is the process that Jean Piaget described as schema development in which students assimilate new ideas alongside old ideas and then accommodate them into a new schema by adjustment and restructuring.

Blutick allows students to construct their knowledge one piece at a time by encouraging them to enter line-by-line working, thus allowing them to build up ideas at their pace. Both teachers and students can access the mathematical content in any order too, so it is not a one-way system but instead gives this choice and autonomy to the user.



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Rosenshine's Principles of Instruction

In 2010 Barak Rosenshine published a set of 10 Principles of Instruction, based on evidence from cognitive science, classroom research and other cognitive supports. In its broadest meaning this could include any form of teaching that starts with a review of earlier learning, introduces tasks that have a specific mathematical goal in mind and gives feedback that synthesises and corrects the students' path towards that goal. Tasks offered are usually heavily guided towards a given outcome by one reasoning pathway.

Blutick uses some of the Rosenshine 10 Principles:

- Presenting new material using small steps
- Providing models
- Scaffolds for difficult tasks
- Guided student practice
- Obtaining a high success rate
- Independent practice
- Review of learning (daily, weekly, monthly)

Active Learning

Active learning is essentially about getting students to think, reason and problem solve, as opposed to passive learning where they are fed information with little cause for them to think. Active learning helps students to develop long-term memory. This is not only about storing what went into their memories in the same form as it went in rather, it is mainly about identifying and storing patterns, relationships, connections and generalities, all of which are the products of our active minds. These are key skills for mathematics and in particular, mathematics progress.

Blutick supports active learning through inviting students to show their working, as opposed to just their answer. In this way, it dissuades the student from simply guessing and instead, encourages them to think about the solution and the stages of thinking required to reach an answer.

Cognitive Load Theory

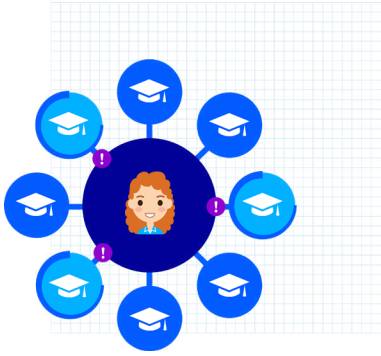
The main idea being used here is that giving students too many things to think about at the same time can be confusing and obstruct learning the target knowledge. The suggestion is that teachers should therefore organise knowledge into small pieces of information that can be drip fed, well learnt and accumulated to make a bigger body of knowledge.

Both teachers and students can choose how much mathematical content to access so they can control the flow of information as required. Students can complete one question or 1000s of questions. Questions are supported with short videos and worked examples, thus helping to manage the flow of information in a systematic and logical way.

Formative Assessment

Although many have written about formative assessment, Dylan Wiliam is probably the most well known researcher to be associated with this practice. Formative assessment is the idea that teaching is adaptive to the student's needs. As part of formative assessment, a teacher's role is to engage in responsive teaching, so that their inputs and interactions with students allow them to adapt and respond, depending on how the learning is going.

Blutick is designed to allow teachers to watch how their students are responding to questions – in real time – so that teachers can be responsive to the needs of their students. Teachers can see their students' answers to questions but also their line-by-line thinking which enables them to provide feedback that will enable them to move learners forward. The intelligent feedback offered also allows students to be owners of their own learning too, thus supporting self-assessment principles.



Mathematics Pedagogical Content Knowledge

In addition to generic pedagogics, there are also those specific to the teaching and learning of mathematics.

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Conceptual and Procedural Understanding

Conceptual understanding focuses on students being able to understand the mathematics they are doing, rather than just following a set of rules they cannot explain or apply in different situations, known as procedural understanding.

The intelligent feedback embedded in the Blutick platform encourages students to draw on the understanding needed to solve a problem, rather than just allowing them to input an answer.

Worked Examples

Performance on new mathematical problems is sometimes found to be better when students have first seen models of solutions to similar problems.

Blutick provides worked examples and short videos for questions that support and scaffold students. While there are often many different ways to solve a problem, offering worked examples to each question provides a springboard for those students who need that initial step.

Variation Theory

For students to notice particular relationships or patterns of behaviour in mathematics they need to have attention drawn to them. Variation theory says that we learn when we are given a bunch of examples or experiences that are similar in some ways and different in others.

Carefully selected and sequenced questions expose students to pattern and structure.

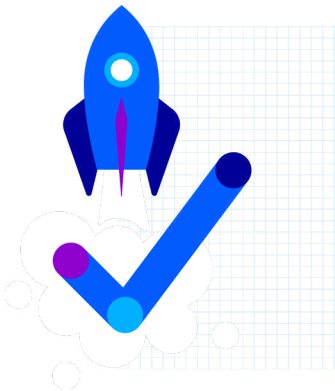
Blutick particularly supports procedural variation (as opposed to conceptual variation) in that it offers the same structure but varies the content. It does this through the 3 million+ questions available for students to solve. This means that there are plenty of opportunities for students to access questions on the same mathematical area, thus supporting procedural variation. These questions also allow teachers to ask: what is the same and different about this question from the previous one?

Mastery

The main idea within mastery pedagogy is that everyone understands the core mathematical idea, with extra support for those who need more teaching. Students' chances of success are maximised if they develop deep and lasting understanding of mathematical procedures and concepts.

Occasionally mastery is interpreted as a one size fits all however, this is not the Blutick view of mastery.

Blutick allows students to practice specific pieces of knowledge so they can know and remember more. It offers a vast range of questions which are levelled, allowing students to go deeper and to secure understanding. Having such a bank of questions, videos and worked examples means that students acquire a deep, long-term, secure and adaptable understanding of the subject but broken down into the small steps offered through the Blutick layout. Another key feature of mastery is the high level of teacher-student interaction, where all students in the class are thinking about, working on and discussing the same mathematical concept. When teachers use Blutick with their classes they can decide which part of the mathematics curriculum to work on and even create their own bespoke scheme or section of work to focus on. Challenge and the opportunity to deepen understanding of the key mathematical ideas are provided for all, through the levelled questions and scaffolds offered.



The Blutick Version of Mathematics Education, Curriculum and Pedagogy

There are many versions, opinions and distinctions about what effective mathematics education should consist of and this can sometimes be quite divisive. For example, direct teaching versus inquiry teaching or procedural knowledge versus conceptual knowledge, mastery curriculum versus a problem-solving curriculum.

Blutick seeks to transcend these divisions by focusing on the quality of the mathematics provision, rather than directing teachers in how to use it or instructing students in how to learn from it. This is why it stands

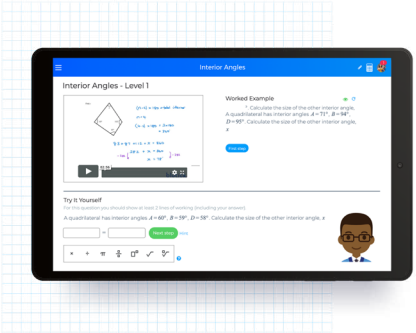
above many other edtech platforms currently available.

The Blutick curriculum is a knowledge-focused (as opposed to a knowledge-rich) curriculum. In other words, it places importance on students knowing mathematical facts but also recognises the importance of reasoning and problem solving, in comparison to a knowledge-rich curriculum, which can lead to an over-emphasis on memorisation.

Blutick supports a knowledge-focused curriculum by enabling the pre-requisite skills of problem solving to be practised (e.g. fluency, flexibility, reasoning). It layers problems by scaffolding students to think about their next steps through the intelligent line-by-line feedback and probes mathematical thinking by offering closely related variants of the original question, causing students to use and apply knowledge learnt.

Blutick does not dictate how teachers should use the curriculum and so this allows for much flexibility. Teachers can adopt a mastery approach to the curriculum by directing their students to focus on particular mathematical areas until they master them, before moving onto new material. Typically a mastery curriculum would spend greater time going into depth with particular concepts. Once these areas have been mastered students do not visit them in depth until the following year.

In contrast, other teachers may choose to adopt a spiral curriculum where concepts are revisited regularly. For other teachers, a problem-solving curriculum is their preference. The autonomy that Blutick gives to its users means that teachers and schools can choose to use Blutick in the way that best suits their curriculum and pedagogy.



For more information on the Blutick Approach please request:

- **Information pack:** Blutick AI Maths
- **Focus:** Problem Solving
- **Focus:** Synchronous and Asynchronous Teaching
- **Q and A with ...** Dr Alison Borthwick (mathematics adviser)
- **Q and A with ...** Will Taylor (teacher and Head of Mathematics at The Perse School, Cambridge)

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References

Sherrington, T. and Caviglioli, O. (2020) Teaching Walkthrus. Woodbridge,UK: John Catt Educational Ltd.