ISSN 2942-1373

8

Peter Baptist

Digitalization at School – but in a Well-Balanced Way

University of Bayreuth
Center for Mobile Learning with Digital Technology

CMLDT publications

Publisher University of Bayreuth
Center for Mobile Learning with Digital Technology (CMLDT)
Universitätsstraße 30
95447 Bayreuth
Germany
+49 921 55 3266

Series CMLDT publications

ISSN 2942-1373

Editor Carsten Miller, carsten.miller@uni-bayreuth.de
Alfred Wasserman, alfred.wassermann@uni-bayreuth.de

Layout Carsten Miller, carsten.miller@uni-bayreuth.de

Internet https://mobile-learning.uni-bayreuth.de/CMLDTpublications

Issue 8 **Year of publication** 2025

Title Digitalization at School – but in a Well-Balanced Way

Autor Peter Baptist

UNIVERSITÄT BAYREUTH

CMLDT

Digitalization at School – but in a Well-Balanced Way

Peter Baptist
Center for Mobile Learning with Digital Technology
University of Bayreuth
peter.baptist@uni-bayreuth.de

Digitalization is necessary and important, especially at school. However, there are now complaints that digitalization has often been exaggerated, leading to negative effects on learners, such as poor concentration and weak writing skills. So, is the digital school a mistake? Should we abandon digitalization and ban laptops, tablets, and smartphones from the classroom in the future?

This question is the subject of controversial public debate. The end of the digitalization euphoria in some Scandinavian countries is often cited as an argument for a return to purely analog teaching and learning. However, the cause of the decline in school performance in these countries is not considered in a differentiated manner. For education researchers at the Karolinska Institute in Stockholm, one reason for the failure is that, during digitalization, students have used the internet as a broad knowledge resource rather than developing their own digital learning tools. Especially younger schoolchildren do not yet have the cognitive abilities to acquire knowledge independently.

However, a return to purely analog schooling cannot be the solution. Digital technologies permeate and shape both our personal lives and the world of work. Schools, as places that prepare us for life, cannot ignore these media. However, digital support does not necessarily lead to better education. Teaching and learning can only be improved if these media are integrated into the classroom in a well-designed way.

In geometry lessons suitable digital support can be used to promote interest in and understanding of mathematics in the long term, starting as early as 5th grade. (Paper) worksheets contain tasks and instructions. Smartphones or tablets with the appropriate software are suitable for discovery and experimentation, and the results are recorded by hand. Analog and digital "learning worlds" are meaningfully linked with each other.
The success of digital teaching and learning in schools also depends largely on teachers' competence in using digital media and the available teaching concepts. To ensure that this approach becomes widespread, it must be possible to use mobile devices and software without extensive training. Students learn how to use these tools in class, not theoretically, but in relation to subject-specific content. Modern teaching takes advantage of both analog and digital learning environments. The key is to find the right balance.

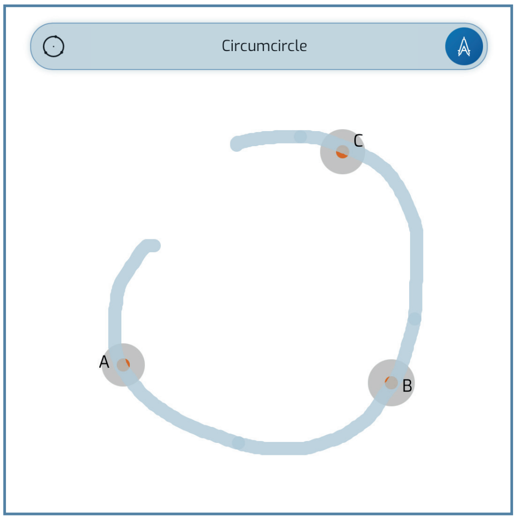
Going your own way in learning – added value through digital tools

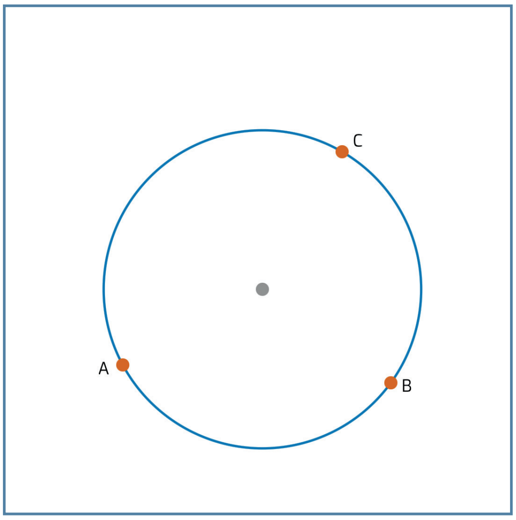
The following section uses mathematics as an example to illustrate how independent learning can be promoted with appropriate digital support. Students work with tablets or smartphones and use the gesture-based software *sketchometry*, which is available online directly in the browser or as an app for various operating systems (http://sketchometry.org). The software can be used for free both at school and at home. A major advantage is that learners can work with their own devices, meaning that they are not dependent on special equipment at school.

Tablets and smartphones – electronic sketchpads

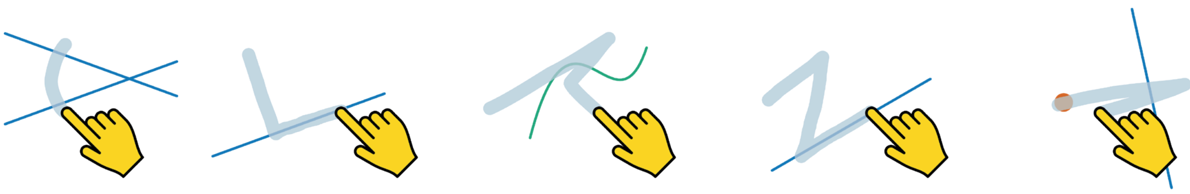
Like calculators, tablets and smartphones can be valuable learning tools in math class when used appropriately. Students use these devices with *sketchometry* as an electronic sketchpad. They draw figures with their fingers, which are automatically converted into accurate drawings. The innovative feature of

sketchometry is its intuitive gestures, which replace the usual tools of conventional dynamic software.
For example, if a circle is to be drawn through three given points, the circle is indicated with a corresponding gesture through the three points. The students consciously make a circular movement with their index finger. As an "extra," the program generates the corresponding center point of the circle at the same time as the circle line.





The *sketchometry* gestures replace the usual tools of dynamic geometry software. These gestures are visually close to the object to be created (e.g., angle, perpendicular, tangent to a curve, parallel to a straight line, reflection on a straight line, etc.) and are therefore easy for students to remember.



The fine motor movements of the finger when sketching gestures involve regions of the brain in the learning process that are not activated when clicking on an icon or an item in a menu list. This is because clicking is always the same process, regardless of the geometric activity it initiates. Gestures, on the other hand, differ from one another, depending on the desired construction.

Learning with your finger

Maria Montessori (1870 – 1952) promoted "learning with the finger" at the beginning of the 20th century. She used letters made of sandpaper to teach the alphabet. The children listen to the letters spoken by the teacher, look at their appearance, and trace them with their index finger.
The finger technique offers further advantages. Several years ago, Australian scientists conducted several studies that demonstrated that tracing shapes with the index finger can assist in solving mathematical problems. The researchers assume that pointing or tracing with the finger increases attention and thus gives this information priority in the brain's processing. Tracing with the finger can also reduce the load on working memory and improve the ability to retain more complex information, as other regions of the brain are activated in addition to visual perception.
Therefore, the results from Australia and also from researchers at the Max-Planck-Institute in Leipzig suggest that the positive learning effects of networking with motor areas of the brain also apply to mathematics when students work with *sketchometry*. This is because they use their index finger to create their constructions and apply the intuitive *sketchometry* gestures. The dynamic possibilities of the software are exploited when the configurations created are modified by dragging with the index finger to discover certain properties or relationships.

Teaching and learning with *sketchometry teaching modules*

The concept of *sketchometry teaching modules* enables the transition from passive, receptive teaching to active, inquiry-based learning. The content is not presented as a "finished system." In a *construction phase*, learners first receive instructions on paper worksheets for constructing objects and configurations with *sketchometry*. In the subsequent *exploration phase*, work assignments are given that encourage learners to experiment and observe independently.

They use their tablet or smartphone as an electronic sketchpad. The results are documented by hand (self-formulated texts, freehand sketches) on a structured result sheet or in a study journal. These records are then compared and discussed in pairs. Finally, a discussion takes place in class, moderated by the teacher.

Analog and digital “learning worlds” are linked together. However, this is by no means about bringing technology into schools for technology‘s sake. Digital learning tools such as tablets, smartphones, and software should only be used if they add value to existing teaching methods. Such added value results, among other things, from

- greater and sustained motivation,
- increased clarity through the possibility of dynamic modifications,
- understandable presentation of complex issues,
- individualized learning processes,
- learning independent of time and location.

Structure of a *sketchometry teaching module*

Each teaching module is dedicated to a specific topic and consists of five components:

1. Information sheet for teachers
   - Prerequisites and objectives for the student worksheet.
   - Notes on *sketchometry*: Indication of the gestures needed for the worksheet.

2. Student worksheet
   - Instructions for constructing.
   - Instructions for exploring, experimenting and documenting.

3. Result sheet
   - Predefined structure to facilitate clearly documentation of the results of the exploration and experimentation instructions.
   - Possibility for individual notes.

4. Exercise sheet
   - Tasks for practicing or deepening the topic of the student worksheet.
   - Further tasks or additional topical suggestions.

5. Video for the student worksheet

What are the advantages of using *sketchometry teaching modules*?

The content is not presented as a “prefabricated system”.

- Independent construction familiarizes students with the task at hand.
- A self-created construction provides a sense of success.
- “Slowing down” the process.
- Intensive engagement with the respective topic.
- Being active.
- Working independently.
- Taking your own notes forces you to think and structure your thoughts.
- Determining your own learning pace.
- No prior technical knowledge is required.

For organizational reasons alone, it is not possible for teachers to completely change their teaching methods overnight. A prerequisite for a change in approach is the seamless integration of new elements into the existing teaching script. This is possible with the *sketchometry teaching modules*. This concept allows a gradual and low-threshold transition to independent learning with the use of digital media. Individual teaching modules initially replace conventional teaching units. With increasing experience, this happens more often. Gradually, a collection of teaching modules can be created and then combined into a textbook. Tablets and smartphones prove to be learning tools that students can use for sketching and discovery.

sketchometry teaching modules and the “think-pair-share method“

The *sketchometry teaching modules* are also ideal for teaching according to the proven “think-pair-share method“ tested in the nationwide pilot projects SINUS and SINUS Transfer in Germany. This method combines active, independent work phases for students (guided by tasks involving construction, exploration, documentation, and discussion) with a presentation and results securing phase moderated by the teacher.

Think phase

Students first work independently on the worksheet. They work on the construction tasks and then carry out the exploration tasks. At the same time, they write down their observations, assumptions, and findings on the result sheet. The teacher will provide help for self-help if necessary or on request.

Pair phase

Students compare their results with those of their seatmates or within their learning group. They add to their notes if necessary. The teacher observes each group and is again available to give advice (help for self-help). In this way, the teacher will find out what assumptions or solutions are being made and thus gain an overview of the results achieved.

Share phase

The results are discussed with the whole class. This can be done based on a completed result sheet from a learning group. In this more teacher-centered phase, the teacher guides the discussion and, if necessary, corrects and adds to the results presented. New terms can also be introduced at this stage.

Confirming the results

Together with the students, a model result sheet can be produced and made available to the whole class, either electronically or as a hard copy. This collaborative work is recommended rather than a result sheet prepared by the teacher. Otherwise, there is a risk that the students will not contribute enough because they know that they will get a sample sheet from the teacher.

Do we need new content in the curricula?
Are we learning for school or for life?

The meaning and usefulness of the knowledge acquired at school is often the subject of controversial discussions. The question “Why do we need this?” reveals an overemphasis on immediate practical application. There are repeated calls to “declutter” curricula! But do curricula really contain clutter?
Of course, it makes sense to review curriculum content at regular intervals and modify it if necessary. But even with the existing curricula, it is possible to deliver contemporary teaching. The mandate of a school providing general education is far more comprehensive than simply imparting directly applicable everyday knowledge. Of course, such knowledge should and must also be considered in education, but teaching must not be limited to this. Who can predict what specialist knowledge current students will need in their future studies or careers?
We usually acquire knowledge within a specific context. This makes it difficult to transfer it to other situations and contexts. If knowledge is not immediately available, it is referred to as inert knowledge. To be able to apply it, we must adapt it to the respective situation, modify it, and possibly expand it. The more intensively the knowledge acquired at school has already been applied and used in different contexts in class, the easier and better this is achieved. Both situational and systematic learning are necessary and should complement each other. Despite the limitations of immediate applicability, knowledge acquired in school in this way is never useless, as it facilitates learning outside of school.
“School” is an abstract concept: the concrete factors are “students“ and “teachers” (...). It doesn‘t really matter what is taught, but how it is taught. It seems to me that classical schooling can also prepare students quite well for modern life: the lessons just need to be designed accordingly!
This demand by Heinrich Mann (1871–1950) remains relevant today. In the pilot projects SINUS and SINUS Transfer, we provided inspiration for new learning methods and developed and successfully tested corresponding

teaching concepts together with teachers. As soon as teachers and learners engage in “experiencing mathematics,” the world of mathematics, which is initially unfamiliar to many students, transforms into a familiar world—a world that is as much about the importance of mathematics for technical, medical, informational, and economic progress as it is about the development of innovative, creative, and critical thinking.

References

[1] Baptist, Peter (2023): Maths with the Index Finger – sketchometry. CMLDT publications, issue 1, https://mobile-learning.uni-bayreuth.de/CMLDTpublications

[2] Baptist, Peter (2025): Active Learning with sketchometry Teaching Modules. CMLDT publications, issue 7, https://mobile-learning.uni-bayreuth.de/CMLDTpublications

[3] Fang-Tzu Hu, Paul Ginns, Janette Bobis (2015): Getting the point: Tracing worked examples enhances learning. Learning and Instruction, vol. 35, pp. 85 – 93.

[4] Ginns Paul, Fang-Tzu Hu, Erin Byrne, and Janette Bobis (2016): Learning by Tracing Worked Examples. Applied Cognitive Psychology, vol. 30, pp. 160 - 169

[5] Lucy Macken, Paul Ginns (2014): Pointing and tracing gestures may enhance anatomy and physiology learning. Medical Teacher, vol. 36, issue 7, pp. 596 – 601

[6] Brian Mathias, Andrea Waibel, Gesa Hartwigsen, Leona Sureth, Manuela Macedonia, Katja M. Mayer, and Katharina von Kriegstein (2021): Motor Cortex Causally Contributes to Vocabulary Translation following Sensorimotor-Enriched Training. Journal of Neuroscience 13, 41 (41) 8618-8631; DOI: https://doi.org/10.1523/JNEUROSCI.2249-20.2021

Author

Prof. Dr. Peter Baptist

Center for Mobile Learning with Digital Technology
University of Bayreuth
95440 Bayreuth
Germany

peter.baptist@uni-bayreuth.de