Studies

- Effectiveness trial , Transfer Center for Neuroscience and Learning (ZNL), University of Ulm
- International comparison study Eva-CBTM (Evaluation of Computer Based Training Programs for Mathematics), University of Münster
- Case study, Intel® Education Alliance Programms

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Evaluation of the bettermarks system

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About the evaluation

In 2009, bettermarks GmbH hired the ZNL to conduct an effectiveness trial and acceptance test of the pilot project of their learning system in 34 schools in the winter term of 2009/10. In total, 34 pilot schools from six German states took part. The investigation focussed on the module "Addition and Subtraction of Fractions". The purpose of the trial was to clarify: (1) how the learning system is adopted by schools and teachers, (2) what effect implementing bettermarks has on the performance of schoolchildren, (3) what areas require improvement. The evaluation took place using a pre/post design with intervention classes and control classes. The intervention classes used the online learning system to practise and gain more knowledge about the lesson topic. The control classes had their standard lessons. ZNL designed the study. Prof. Dr. Martin Stein and Kathrin Winter from the Institute of Education in Mathematics and Computer Sciences at the University of Münster developed the performance test. The evaluation drew on data from nearly 1000 schoolchildren. The trial was carried out from the middle of September to the end of December 2009. The period studied varied from two to five weeks depending on the type of school. The acceptance analysis was carried out by means of an online survey.

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SUMMARY OF THE RESULTS AND THE DISCUSSION

Overall, the pupils have profited from using the bettermarks system. The results from all schools show a significant positive effect: the pupils who worked with the bettermarks system achieved on average better results than those in the control group, who did not use the system. The effect was more pronounced for male pupils and for those pupils with the best pre-existing arithmetical ability. Also, those pupils whose teachers were in the half that more actively used the system and regularly offered exercise programmes profited especially. During this investigation, working with the bettermarks system had no influence on the pupils' attitude towards mathematics or computers.

The pupils evaluated the bettermarks system and took the opportunity to make suggestions for improvement (such as technical improvements or changes in the way the system works). They were particularly pleased with the instantaneous feedback that the system gives, and that they receive comprehensive explanations if needed. The pupils also valued the freedom to work with the bettermarks system at their own speed.

The teachers also evaluated the bettermarks system and their experience with it. The 20 teachers gave very varied feedback about the time they needed to get to know the bettermarks system. The largest group claimed to need two hours to learn the system themselves, and a further school period to teach it to their pupils. During this assessment, the bettermarks system was above all used by the pupils at home for their homework. All except three teachers used bettermarks at least twice a week. They used the "generate exercise" function the most. They also judged this function as the most useful. Most of the teachers claimed that the bettermarks system was well suited to giving feedback on the learning progress of their pupils, developing varied tasks and challenging the pupils based on their individual performance. Four out of five teachers would recommend the bettermarks system in the mathematics lesson for both preparation and practice. Nine out of ten believed that online learning systems should be made available for students for lessons and homework.

This study demonstrates the positive effect of the bettermarks system on the pupils' performance in mathematics. This effect is probably due in part to the increased individualisation of the learning process that the system makes possible. There are various hypotheses about why some groups of pupils profited more than others from using the bettermarks system. One reason why male pupils benefited more than female pupils could be due to their wider experience with computers. The short time of the study is a possible reason why those students with the best pre-existing abilities in arithmetic profited especially. The few weeks of work with the bettermarks system favoured those with a solid grasp of the basics of mathematics. Though it is also possible to review those mathematical basics with the bettermarks system, this was not available to participants in this study.

A further group who particularly benefited from using the system was the one whose teachers used the system actively. By regularly making exercise programmes available, these teachers improved the performance of their classes. Though this result should not be a surprise, it is nonetheless important: it shows that the extent to which pupils profit from the bettermarks system also lies in the hands of their teachers.

Eva-CBTM (Evaluation of Computer Based Training Programs for Mathematics)

Prof. Dr. Martin Stein, Institute for Didactics of Mathematics and Computer Science

What really matters for online learning platforms for mathematics?

- A systematic comparison of products in German and English
- Prof. Dr. Martin Stein, Institute of Education in Mathematics and Computer Sciences, University of Münster

There are many online learning platforms for mathematics. However, until recently there has been no effective, systematic framework for analysing and comparing the many programs on the market. Now there is the Eva-CBTM project, in which the systems available on the international market were objectively compared. For this purpose, Prof. Martin Stein of the University of Münster has developed an instrument for evaluating mathematical learning programs, with regards to the specific requirements of learning and practising mathematics. Special consideration is given to the fact that solving mathematical problems – even on a computer – is a dynamic process.

Making online learning platforms for mathematics comparable – The EVA-CBTM project

For the Eva-CBTM project (Evaluation of Computer Based Training Programs for Mathematics), specialised criteria catalogues were created for evaluating educational programs. These use a points-based system developed to fulfil the specific requirements of learning and working with mathematics and its dynamics. Sixty English and German online platforms were considered, from which fifteen were selected for a more detailed evaluation. The platforms that were eliminated were found not to fulfil the necessary criteria - for example, they did not cover the required class levels, or concentrated exclusively on explanation rather than practice. Results of the evaluation: Two German platforms left the well-respected English competition far behind. Read on to find out more about the criteria and results of the study.

What is an online learning system? – The criteria catalogue

1. *Evaluation systems as well as help systems:* To experience success in learning, students need feedback about their work, and in most cases they need help. These two components often work closely together - for example, the marking system recognises a mistake and activates the help. Relatedly, it is important to look at which phases of an exercise offer help - only at the end, or also at the beginning and in the middle?
2. *System structure and exercise selection system:* Every system needs a pool of exercises, which has to be organised and structured in some way. The system structure should be set up so that it presents suitable follow-up exercises or exercise series according to whether the student was successful or not at solving the current exercise.
3. *Level of freedom:* Systems can also differ greatly in the degree to which they make decisions themselves or leave them to the user. Are the exercises predominantly multiple choice or does the system allow for free entry of number, terms or equations? Does the user get a "second chance" after a mistake? The flexibility of possible answers is also decisive for the quality of a system. For example, the result of $^1/_4 + {}^2/_8$ could be $^2/_4$ or $^1/_2$ if it is not stated that the answer must be given in its lowest terms.
4. *Topic completeness:* One further criterion is how completely the subject matter is covered. For this evaluation, systems were chosen that covered the material from classes 5 to 10 as completely as possible.

Solving mathematical problems as a process

Solving mathematical problems takes place over many phases - from understanding the problem to selecting a way to solve it to finding the solution in several smaller steps. To create a learning effect, an educational platform should support and assist the user in each of these phases.

A process model was developed for Eva-CBTM. It recognises that solving an exercise using an online learning platform is an interaction between the actions of the user and those of the system. The criteria – especially the availability of suitable help systems – are evaluated for each phase separately:

- *At the start of the work process:* Before the user even begins to start to solve the problem, the online system should already provide help on the theory behind the problem, etc. This allows users for whom the exercise appears too difficult to catch up. It is also conceivable that the system can make information about early user activity - success and mistakes - available.
- *During the work process:* Especially with more challenging exercises, it is important that the problem is split up into smaller steps. When a system gives immediate feedback after small steps, even users who otherwise are unable to solve complex problems can make progress. This increases the learning effect and motivates users to continue.
- *At the end of the work process:* This is the standard form of evaluation, used by every teaching and practise system. However, a good online system does not just say "right" or "wrong", but explains where the mistakes have been made and offers an example solution.

The result – German online systems win out

Fifteen online learning platforms were examined in detail. In first place by a long way was the German online learning system bettermarks, followed by Mathegym, also developed in Germany. Places three to five were occupied by the famous English learning platforms Tenmarks, IXL and Khan Academy.

bettermarks beat the other systems in every single aspect of the evaluation. Its evaluation system and help system especially set it apart from the other products. This is because bettermarks has a system constructed to evaluate more than just the end results. Users can enter intermediate results in all exercises, and these are also evaluated. It is always possible to make a second attempt. The system recognises equivalent solutions and accepts alternative solution methods, therefore offering a high level of freedom. As users work through problems, there are usually buttons with tips and explanations, offering content-based and strategic help. bettermarks is even capable of evaluations that are diagnostic - such as the feedback that denominators should not be added. The small stick figure "Betty" motivates and encourages the users. bettermarks also scores highly in terms of exercise structure, offering three difficulty levels and creating a teaching plan that adapts to fit the performance of the individual user.

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Intel®
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Case Study

Europagymnasium Richard von Weizäcker Thale (Saxony-Anhalt)

ASSESSMENT REPORT
Intel® Education Alliance
School-Tested Solutions

Tools for Joyful Learning

About Thale Gymnasium

Europagymnasium Richard von Weizsäcker Thale—Thale Gymnasium for short—is a secondary school located two hours southwest of Berlin in the German state of Saxony-Anhalt. Thale Gymnasium—an existing Intel® customer—had already deployed Intel® classmate PC – convertibles in one year-three secondary classroom. They were used initially as glorified typewriters but later connected to a Smart Board for word processing and math and science calculations. The school wanted to extend the computers to more students and scale to additional subjects and classrooms. However, such an expansion required additional computers and software.

The Pilot

Between January and June 2012, Thale Gymnasium participated in the Intel® Education Alliance School-Tested Solutions pilot program, which allows schools to test education software from key members of the Intel® Education Alliance at no charge. Local OEMs—in this case, 1edu—provided Intel classmate PCs with the software preloaded.

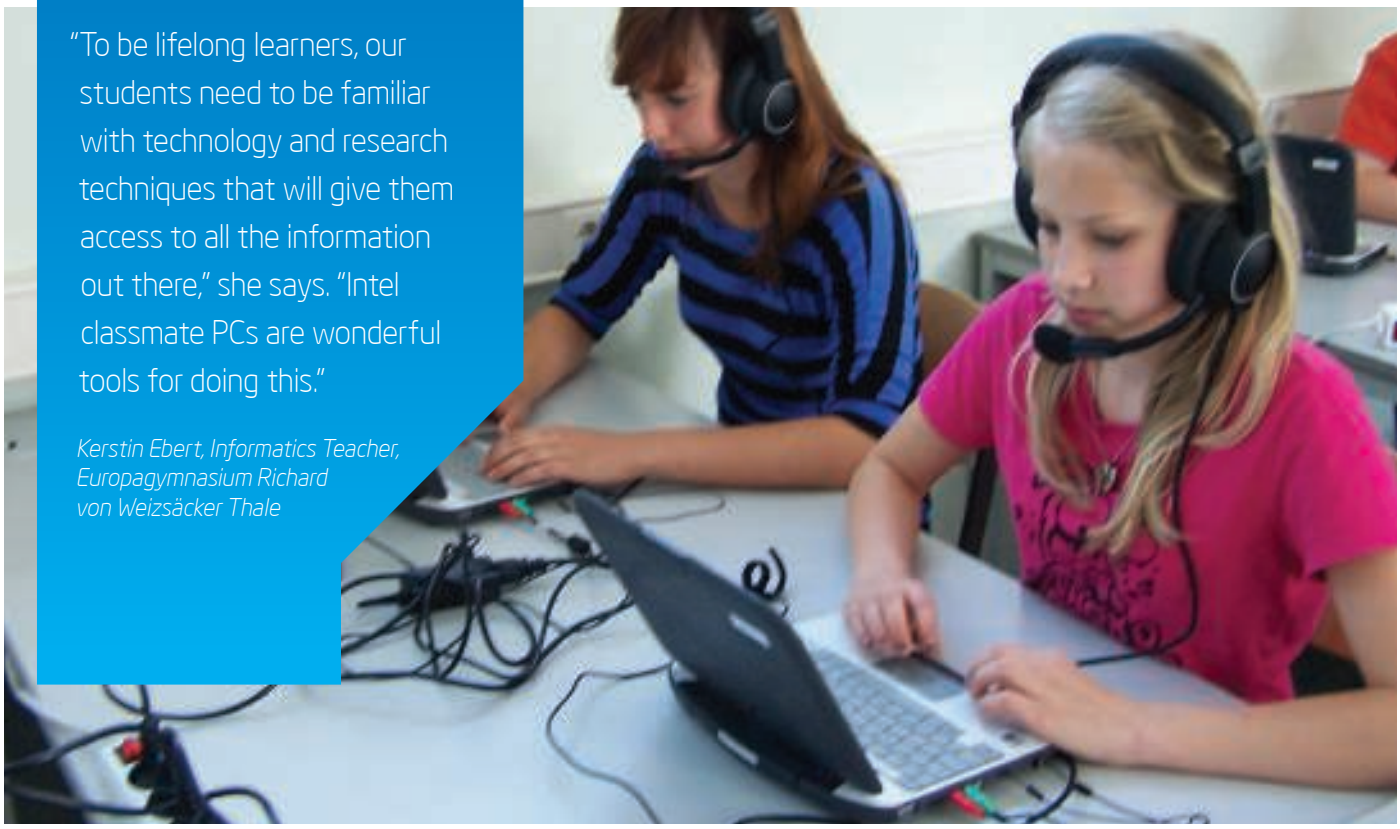
An important goal of the pilot was to expose other teachers, classrooms, and students to Intel classmate PCs in other subject areas, including math and science. Students that were already familiar with the computers helped teachers that were new to the technology.

Thale Gymnasium received more convertible Intel classmate PCs from 1edu and tested three new Intel Education Alliance software programs: MatchWare MindView,* a mind-mapping tool; SANAKO* language-learning software; and Bettermarks* math software. About 120 students used the Intel classmate PCs and new education applications for about half of their lessons—in computer studies, mathematics, English, German, history, physics, writing, and speaking skills.

Results: Test Scores a Full Grade Higher than Peers

Kerstin Ebert, the informatics teacher at Thale Gymnasium that supervised the pilot, reports that students participating in the pilot scored a full grade higher in math when using Bettermarks than other third-grade classes. The software helps students to learn faster at their individual pace and teachers to reduce their workload. "All of the Intel Education Alliance software programs that we piloted were easy for our students to learn and use and made a big difference in their learning," Ebert says. "The students were nervous at first about using the new PCs, but nervousness quickly gave way to excitement."

In fact, students took care of the technology and pushed teachers to use it in their teaching. Teachers found that the computers helped significantly in teaching languages. "We used the SANAKO software to teach English and French and saw systematic improvement in students' language competence," says Christiane Hinze, year three secondary school teacher at Thale. "The software provided instant feedback to both students and teachers and let students pronounce words in private and progress at their own pace."



"To be lifelong learners, our students need to be familiar with technology and research techniques that will give them access to all the information out there," she says. "Intel classmate PCs are wonderful tools for doing this."

Kerstin Ebert, Informatics Teacher, Europagymnasium Richard von Weizsäcker Thale

Adds Ebert, "The students that used the MatchWare MindView mind-mapping software found it useful for visualizing and organizing their ideas. In particular, students that used MindView for outlining written documents benefitted from the Microsoft Word export feature. The teachers found that students were more engaged in their projects and saw an improvement in the quality of their work."

Frederik Wehmeier, Head of Sales at 1edu, adds, "Technology is key to enhancing education with the skills essential to the world of work. Intel classmate PCs outfitted with the right software gives them those skills."

Ebert echoes this sentiment, saying that technology-based learning helps students tackle ambitious topics more confidently and also provides more "joyful learning." "To be lifelong learners, our students need to be familiar with technology and research techniques that will give them access to all the information out there," she says. "Intel classmate PCs are wonderful tools for doing this."

The successful pilot also resulted in more state-level technology funding for Thale. The Saxony-Anhalt Ministries of Finance and Education provide school districts with funding for technology, software, buildings, equipment, and more. Because of the outstanding results of the Intel classmate PC pilot, particularly the improved math scores, the ministries decided to allocate more software and services funding to Thale.

"The computer will be as common as chalk and backpack for the new generation of students."

Kerstin Ebert, Informatics Teacher, Europagymnasium Richard von Weizsäcker Thale

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