## Neuer Bildungsserver in der Schweiz

*H.R. Schneebeli*

In der Schweiz wurde ein neuer Bildungsserver aufgebaut, zu finden unter:

www.swisseduc.ch

Auf diesem Server finden Interessierte auch einiges Material zum Einsatz von CAS-Rechnern im Unterricht:

- Wachstum und Zerfall mit Anhang über Finanzmathematik
- Skalarprodukte, Schwingungen, Signale: eine elementare Einführung in DFT
- Lineare Gleichungssysteme (wird demnächst aufgeschaltet)

## 25 Jahre Mathematikinformation

*Michael Toepell*

Soeben ist das Jubiläumsheft Nr. 44 der *Mathematikinformation*, der Zeitschrift des Vereins *Begabungsförderung Mathematik e.V.* erschienen. Der Gründer des Vereins und langjährige Herausgeber der am 12.1.1981 erstmals publizierten Zeitschrift StD i.R. Dr. KARLHORST MEYER kann auf eine reichhaltige Themenvielfalt - mit geometrischem Schwerpunkt - zurückblicken. Das erste Heft war eine Schul-Informationsschrift über die Einführung des Integrierens für die Mathematikfachkollegen am Gymnasium Starnberg bei München. Inzwischen haben die halbjährlich erscheinenden Hefte eine beachtliche Auflage von 400 bis 500 erreicht.

Die Zeitschrift versteht sich weder als Didaktikzeitschrift noch als wissenschaftlich mathematisches Publikationsorgan, sondern als Kontaktforum von Lehrern für Lehrer. Ziel ist es, Lehrern Anregungen sowohl für den regulären Unterricht aber auch für den Ergänzungsunterricht mit mathematisch interessierten bzw. begabten Schülern zu vermitteln. Dazu gehören anspruchsvolle Aufgaben mit ihren vielfältigen Lösungswegen, generell die zwischen Universität und Gymnasium angesiedelte Mathematik, aber auch die am Wege liegenden Probleme der Sekundarstufe I, Fragen der Binnendifferenzierung des Unterrichts und das Ziel, Lehrer verstärkt dazu anzuregen, wieder mehr selbständig Mathematik zu treiben.

Im Namen der GDM wünschen wir Dr. KARLHORST MEYER und seinem Herausgeberkollegen Dr. FRANK HEINRICH weiterhin Anerkennung und Erfolg in ihrem Wirken um einen qualitativ hochwertigen Mathematikunterricht und in der Förderung begabter und interessierter Schülerinnen und Schüler (s.a. Tagungshinweise S. 132f.).

Homepage des Vereins und der Zeitschrift: www.bfmathematik.info

# International Review

## Students learn better when the Numbers don't talk and dance[1]

Most teachers believe that students learn better when abstract concepts are taught using concrete materials or examples - but a new study suggests they may be wrong.

*Vladimir Sloutsky*

Researchers found that when college students were taught an artificial form of mathematics and physics, they learned it better when it was presented using simple, abstract symbols - such as plain stars and raindrops - rather than more visually engaging and concrete 3-D objects that moved dynamically on a computer screen.

The students were also more successful in applying what they learned to new situations when they were taught with abstract symbols rather than concrete objects, said VLADIMIR SLOUTSKY, co-author of the study and professor and director of the *Center for Cognitive Science at Ohio State University*[2].

The results of this study suggest that teachers may need to rethink one of the most widely accepted truisms of their profession, said SLOUTSKY, who is also associate dean of research at the university's *College of Human Ecology*.

"Many teachers believe that concrete materials make learning more fun for students, and that will increase their motivation and help them understand the concepts," he said. "While this may be true, in many cases, the concrete materials also interfere with what they are trying to learn."

A real-life example of how concrete materials may be used inappropriately is a common tactic for teaching children about numbers and letters. Books and educational television

[1] Columbus, Ohio State University - http://researchnews.osu.edu/archive/absconc.htm
[2] http://cog.ohio-state.edu/

shows often present letters or numbers with human features such as faces, which dance and talk.

While some believe this makes the concepts more approachable, the authors believe SLOUTSKY said it simply confuses young children.

"Instead of learning that letters and numbers are symbols that can be used in many different ways, children in this example see them as very concrete examples of humans."

The belief in the value of making the abstract concrete is widespread, however. For example, 84 percent of secondary school mathematics teachers in one survey said they believed concrete materials in their classes help students learn.

SLOUTSKY conducted the study with JENNIFER KAMINSKI, graduate student at Ohio State and ANDREW HECKLER, assistant professor of physics at Ohio State. Their results were published in a recent issue of the journal *Psychonomic Bulletin & Review*[3].

**For the study, the researchers did three related experiments.**

In one, 30 undergraduate students were taught a novel, artificial mathematics and a novel, artificial science. Half of the students were taught the math first and then the science, and the other half were taught the science first and then the math.

The *math* used simple, abstract symbols such as raindrops, stars and snowflakes. Students learned, for example, that combining a star and a snowflake resulted in a raindrop. They were then tested in their knowledge of this new, artificial math. All of the training and testing was done on a computer.

The *science* portion used much more concrete symbols - this portion of the experiment used 3-D objects that moved across the computer screen. Students were shown two of these 3-D objects moving towards each other and colliding to form a third, different object. The rules of this science portion were exactly the same as the math portion - only the objects were different. Again, they learned this new science and were tested on what they learned.

Results showed that most participants successfully learned both the science and math portion. However, participants who learned the math *first* did significantly better on the science portion than did those who did the science portion first.

*"This suggests that knowledge presented in the more generic, abstract format helped students better learn the more perceptually rich, concrete format," SLOUTSKY said. "If they learned the science portion without the benefit of learning the more abstract math portion first, they did not do as well."*

A second experiment involving 30 undergraduates was nearly the same except for one crucial difference - the math symbols were replaced by images of 3-D objects, such as swords and goblets. In this experiment, the math objects were more concrete than those

[3] http://www.ingentaconnect.com/content/psocpubs/pbr



in the science condition because they were real-life items. Real items such as swords or goblets make poor symbols because it is difficult for people to interpret them as something other than what they are.

In this second experiment, contrary to the first, students did better when they learned the science first and then the math. But the key was that, just like the first experiment, learning with *less concrete symbols* helped students when they had to use their knowledge in new situations that were more concrete. "Students were better able to transfer what they learned when they were taught using more abstract symbols," SLOUTSKY said.

Moreover, students also did better when tested on the science concepts than they did on the math concepts. "That suggests concreteness of objects hinders not only transfer of knowledge but learning itself," SLOUTSKY said.

To confirm this finding, the researchers conducted a third experiment in which 81 students - all different from those in previous experiments - learned the same artificial math as used previously. In this case, they were separated into four groups, each of which learned from a different set of symbols, from very abstract and simple to intricate photos of real objects. In general, even though the learned material was otherwise identical, students who used the most intricate, concrete symbols did poorer on testing than those who learned using the most simple, abstract symbols.

Overall, the results suggest that students may often benefit when knowledge is presented in abstract, generic forms.

There are many reasons why concrete may not be better for learning, according to SLOUTSKY. For one, concrete objects have more "perceptual richness," meaning there is more for students to look at and process. That means there is more to distract students from what is important.

Also, concrete symbols are less "portable." For example, a child can use a stick - a relatively abstract item - and imagine it is a car, or a space ship or a flower. However, it is more difficult for a child to take a toy train and pretend that it is a flower.

"Less structured entities make better symbols, and these generic symbols are easier to learn," he said.

This research was supported by a grant from the *National Science Foundation*.

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## Highly Qualified Teachers

**What qualities should a teacher have for students to learn mathematics well?**

*A Position of the National Council of Teachers of Mathematics (NCTM)*[4]

Every student has the right to be taught mathematics by a highly qualified teacher- a teacher who knows mathematics well and who can guide students' understanding and learning. A highly qualified teacher understands how students learn mathematics, expects all students to learn mathematics, employs a wide range of teaching strategies, and is committed to lifelong professional learning.

The No Child Left Behind (NCLB) legislation defines "highly qualified teachers" as teachers who have a bachelor's degree and full state certification or licensure. But teaching mathematics well demands much more. Mathematics teaching at any level requires that teachers have an extensive knowledge of mathematics, including the specialized content knowledge specific to the work of teaching, as well as a knowledge of the mathematics curriculum and how students learn.

NCTM expects that high school teachers will have completed mathematics course work equivalent to that required for a major in mathematics. Middle school teachers should have acquired the depth and proficiency in mathematics equivalent to at least an undergraduate minor in mathematics. Elementary teachers, resource teachers, and all others charged with providing instruction in mathematics should have completed the equivalent of at least three college-level mathematics courses that emphasize the mathematical structures essential to the elementary grades (including number and operations, algebra, geometry, data analysis, and probability). Furthermore, all teachers need to know how mathematics is used in interpreting the statements, solutions, and questions of students, using such responses to build future understandings.

All teachers must understand how students learn mathematics. They must know how to plan conduct, and assess the effectiveness of mathematics lessons and know how and when to make teaching decisions (e.g., listening, modeling, questioning). Highly qualified teachers of mathematics not only understand-but also invest in-the particular culture of their students and school. They are adept at knowing how to actively engage students of diverse backgrounds and strengths in significant and challenging mathematical tasks that help them understand concepts, learn skills, and solve problems. A highly qualified mathematics teacher at any level recognizes the need for, and commits to, lifelong professional learning involving mathematics and its instruction. Overall, the

[4] NCTM: http://www.nctm.org/about/position_statements/qualified.htm (National Council of Teachers of Mathematics) - Education Week, Sept. 14, 2005, www.edweek.org/ew/articles/2005/09/14/03qualified.h25.html



mathematical knowledge, informed actions, positive attitudes, and high expectations of highly qualified mathematics teachers lead to mathematics learning, confidence, and the development of a positive attitude toward mathematics on the part of students.

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NCTM Positions and Position Statements - see http://www.nctm.org/about/position_statements/ - define a particular problem, issue, or need and describe its relevance to mathematics education. Each statement defines the Council's position or answers a question central to the issue. The NCTM Board of Directors approves all positions and position statements.

## A Call to Action on the Education of Young Children

*The Alliance for Childhood*[5]

We are deeply concerned that current trends in early education, fueled by political pressure, are leading to an emphasis on unproven methods of academic instruction and unreliable standardized testing that can undermine learning and damage young children's healthy development.

Many states are moving toward universal preschool so that all children can benefit from early education. We strongly support these efforts, provided that preschool programs are based on well-established knowledge of how children learn and how to lay a foundation for lifelong learning-not on educational fads. We call for early education that emphasizes experiential, hands-on activities, open-ended creative play, and caring human relationships.

Preschool education must not follow the same path that has led kindergartens toward intense academic instruction with little or no time for child-initiated learning. If such practices were effective for five-year-olds, we would have seen better long-term results by now. We call for a reversal of the pushing down of the curriculum that has transformed kindergarten into de facto first grade.

Education is not a race where the prize goes to the one who finishes first. To help young children develop literacy and a lifelong love of learning we need to respect and, when needed, to strengthen their individual abilities and drive to learn. Instead, current trends in early education policy and practice heighten pressure and stress in children's lives, which can contribute to behavioral and learning problems. We call for research on the causes of increased levels of anger, misbehavior, and school expulsion among young children.

[5] http://www.allianceforchildhood.org/

Justified concern for low-income children, who often lag academically, has been a powerful force behind the current overemphasis on early instruction in literacy and math. This well-intentioned but misguided policy may actually put children at increased risk of school failure by denying them positive early learning experiences. We call for additional research that examines the long-term impact of different preschool and kindergarten practices on children from diverse backgrounds.

Creative play that children can control is central to their physical, emotional, and cognitive growth. It contributes greatly to their language development, social skills, and problem-solving capacities, and lays an essential foundation for later academic learning. Yet many children do not have the opportunity to develop their capacity for sociodramatic play. Preschool is the place to intervene and restore childhood play. We call for teacher education that emphasizes the full development of the child including the importance of play, nurtures children's innate love of learning, and supports teachers' own capacities for creativity, autonomy, and integrity. ---

Prepared by *The Alliance for Childhood*, a partnership of educators, health care professionals, researchers, and other childhood advocates who are working together to improve the health and well-being of all children.

## Still Eating Our Lunch

*Thomas L. Friedman*[6]

**Singapore**

Singapore is a country that takes the Internet seriously. Last week its Ministry of Defense granted a deferment for the country's compulsory National Service to a Singaporean teenager so he could finish competing in the finals of the World Cyber Games - the Olympics of online war games. Being a tiny city-state of four million, Singapore is obsessed with nurturing every ounce of talent of every single citizen. That is why, although its fourth and eighth graders already score at the top of the TIMSS international math and science tests, Singapore has been introducing more innovations into schools. Its government understands that in a flattening world, where more and more jobs can go anywhere, it's not enough to just stay ahead of its neighbors. It has to stay ahead of everyone - including us. Message to America: They are not racing us to the bottom. They are racing us to the top.

As LOW-SIM AY NAR, principal of *Xinmin Secondary School*, explained to me, Singapore has got rote learning down cold. No one is going to out drill her students. What it is now focusing on is how to develop more of America's strength: getting Singaporean students and teachers to be more innovative and creative. "Numerical skills are very important," she told me, but "I am now also encouraging my students to be creative -

[6] The New York Times, Friday, September 16, 2005



and empowering my teachers. ... We have been loosening up and allowing people to grow their own ideas." She added, "We have shifted the emphasis from content alone to making use of the content" on the principle that "knowledge can be created in the classroom and doesn't just have to come from the teacher."

Toward that end, some Singapore schools have adopted a math teaching program called *HeyMath*, which was started four years ago in Chennai, India, by two young Indian bankers, NIRMALA SANKARAN and HARSH RAJAN, in partnership with the *Millennium Mathematics Project* at Cambridge University.

With a team of Indian, British and Chinese math and education specialists, the *HeyMath* group basically said to itself: If you were a parent anywhere in the world and you noticed that Singapore kids, or Indian kids or Chinese kids, were doing really well in math, wouldn't you like to see the best textbooks, teaching and assessment tools, or the lesson plans that they were using to teach fractions to fourth graders or quadratic equations to 10th graders? And wouldn't it be nice if one company then put all these best practices together with animation tools, and delivered them through the Internet so any teacher in the world could adopt or adapt them to his or her classroom? That's *HeyMath*.

"No matter what kind of school their kids go to, parents all over the world are worried that their kids might be missing something," Mrs. SANKARAN said. "For some it is the right rigor, for some it is creativity. There is no perfect system. ... What we have tried to do is create a platform for the continuous sharing of the best practices for teaching math concepts. So a teacher might say: 'I have a problem teaching congruence to 14-year-olds. What is the method they use in India or Shanghai?' "

Singaporean math textbooks are very good. My daughter's school already uses them in Maryland. But they are static and not illustrated or animated. "Our lessons contain animated visuals that remove the abstraction underlying the concept, provide interactivity for students to understand concepts in a 'hands on' manner and make connections to real-life contexts so that learning becomes relevant," Mrs. SANKARAN said.

*HeyMath*'s mission is to be the math Google - to establish a Web-based platform that enables every student and teacher to learn from the "best teacher in the world" for every math concept and to also be able to benchmark themselves against their peers globally.

The *HeyMath* platform also includes an online repository of questions, indexed by concept and grade, so teachers can save time in devising homework and tests. Because *HeyMath* material is accompanied by animated lessons that students can do on their own online, it provides for a lot of self-learning. Indeed, *HeyMath*, which has been adopted by 35 of Singapore's 165 schools, also provides an online tutor, based in India, to answer questions from students stuck on homework. Why am I writing about this? Because math and science are the keys to innovation and power in today's world, and American parents had better understand that the people who are eating their kids' lunch in math are not resting on their laurels.

## We All Have a Lot to Learn

**Singapore's students do brilliantly in math and science tests. American kids test much worse but do better in the real world. Why?**

*Fareed Zakaria*[7]

Last week India was hit by a terror attack that unsettled the country. A gunman entered the main conference hall of the Indian Institute of Science in Bangalore, tossed four grenades into the audience and, when the explosives failed, fired his AK-47 at the crowd. One man, a retired professor of mathematics from one of the Indian Institutes of Technology, was killed. What has worried some about this attack is not its scope or planning or effect-all unimpressive-but the target. The terrorists went after what is increasingly seen as India's core strategic asset for the 21st century: its scientific and technological brain trust. If that becomes insecure, what will become of India's future?

This small event says a lot about global competition. Traveling around Asia for most of the past month, I have been struck by the relentless focus on education. It makes sense. Many of these countries have no natural resources, other than their people; making them smarter is the only path for development. China, as always, appears to be moving fastest. When officials there talk about their plans for future growth, they point out that they have increased spending on colleges and universities almost tenfold in the past 10 years. Yale's president, RICHARD LEVIN, notes that Peking University's two state-of-the-art semiconductor fabrication lines - each employing a different technology - outshine anything in the United States. East Asian countries top virtually every global ranking of students in science and mathematics.

But one thing puzzles me about these oft-made comparisons. I talked to THARMAN SHANMUGARATNAM to understand it better. He's the minister of Education of Singapore, the country that is No. 1 in the global science and math rankings for schoolchildren. I asked the minister how to explain the fact that even though Singapore's students do so brilliantly on these tests, when you look at these same students 10 or 20 years later, few of them are worldbeaters anymore. Singapore has few truly top-ranked scientists, entrepreneurs, inventors, business executives or academics. American kids, by contrast, test much worse in the fourth and eighth grades but seem to do better later in life and in the real world. Why?

"We both have meritocracies," SHANMUGARATNAM said. "Yours is a talent meritocracy, ours is an exam meritocracy. There are some parts of the intellect that we are not able to test well-like creativity, curiosity, a sense of adventure, ambition. Most of all, America has a culture of learning that challenges conventional wisdom, even if it means challenging authority. These are the areas where Singapore must learn from America." SHANMUGARATNAM also pointed out that American universities are unrivaled globally - and are getting better. "You have created a public-private partnership in tertiary education that is amazingly successful. The government provides massive funding, and private and public colleges compete, raising everyone's standards." SHANMUGARATNAM highlighted in particular the role that American foundations play. "Someone in society has to be focused on the long term, on maintaining excellence, on raising quality. You have this array of foundations-in fact, a whole tradition of civic-minded volunteerism-that fulfills this role. For example, you could not imagine American advances in biomedical sciences without the *Howard Hughes Foundation*."

[7] Newsweek [Int. Edition] - News Alerts, January 9, 2006 Issue



Singapore is now emphasizing factors other than raw testing skills when selecting its top students. But cultures are hard to change. A Singaporean friend recently brought his children back from America and put them in his country's much-heralded schools. He described the difference. "In the American school, when my son would speak up, he was applauded and encouraged. In Singapore, he's seen as pushy and weird. The culture of making learning something to love and engage in with gusto is totally absent. Here it is a chore. Work hard, memorize and test well." He took his child out of the Singapore state school and put him into a private, Western-style one.

Despite all the praise SHANMUGARATNAM showered on the States, he said that the U.S. educational system "as a whole has failed." "Unless you are comfortably middle class or richer," he explained, "you get an education that is truly second-rate by any standards. Apart from issues of fairness, what this means is that you never really access the talent of poor, bright kids. They don't go to good schools and, because of teaching methods that focus on bringing everyone along, the bright ones are never pushed. In Singapore we get the poor kid who is very bright and very hungry, and that's crucial to our success. 'From where I sit, it's not a flat world," SHANMUGARATNAM concluded. "It's one of peaks and valleys. The good news for America is that the peaks are getting higher. But the valleys are getting deeper, and many of them are also in the United States."

## New Books

1. *SensePublishers* invites you to browse a non-printable PDF of OLE SKOVSMOSE's book *Travelling Through Education: Uncertainty, Mathematics, Responsibility.* 2005: http://www.sensepublishers.com/books/otherbooks/90-77874-03-8.htm
   It does not cost anything. You can then decide if you wish to order the printed book. Part of our policy is to make our books available on PDF at our website at no cost. *SensePublishers* was founded at the end of 2004 and is developing a prestigious book programme in mathematics education.
2. *A math dictionary for kids*. Be sure to check it out!
   http://www.teachers.ash.org.au/jeather/maths/dictionary.html