PRESS RELEASE

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A new method for boosting the learning of mathematics

UNIGE researchers oversaw a new system of maths learning whose purpose is to promote the use of arithmetic formulas at an early age. After a year, they observed a leap in students' performance.

How can mathematics learning in primary school be facilitated? A recent study conducted by the University of Geneva (UNIGE), Switzerland, had shown that our everyday knowledge strongly influences our ability to solve problems, sometimes leading us into making errors. This is why UNIGE, in collaboration with four research teams in France, has now developed an intervention to promote the learning of maths in school. Named ACE-ArithmEcole, the programme is designed to help schoolchildren surpass their intuitions and informal knowledge, and rely instead on the use of arithmetic principles. And the results are surprising. More than half (50.5%) of the students who took part in the intervention were able to solve difficult problems, as compared to only 29.8% for pupils who followed the standard course of study. The corresponding study can be found in the journal *ZDM Mathematics Education*.

From the age of 6 or 7, schoolchildren are confronted with mathematical problems involving additions and subtractions. Instinctively, they use mental simulations of the situations described by the problems in order to come up with solutions. But as soon as a problem becomes complex, recourse to this representation using imagery becomes impossible or leads the student into error. "We reflected on a method that would enable them to detach themselves from these initial representations and that would foster the use of abstract principles of arithmetic," explains Katarina Gvozdic, a researcher at the Faculty of Psychology and Education (FPSE) at UNIGE. This approach, based on semantic re-encoding, spurs students to achieve knowledge in arithmetic at an early age. It was put into practice by teachers in a primary school arithmetic course called ACE-ArithmEcole that substituted the standard arithmetic curriculum.

So that intuitive mental representations will give way to mathematical representations

At the end of the school year, the UNIGE team evaluated ten classes of children aged 6 to 7 in France (second grade of primary school). In five classes, known as the control classes, the teachers had taught maths in a conventional way. In the other five classes, they had implemented the ACE-ArithmEcole intervention which encouraged students to favour abstraction. "To get the students to practice semantic re-encoding, we provided them with different tools such as line diagrams and box diagrams," says Emmanuel Sander, professor at the Department of Education of the FPSE at UNIGE. The idea is that when they read a problem, such as "Luke has 22 marbles, he loses 18. How many marbles does he have left?", the pupils should detach themselves from the idea that subtraction always consists in a search for what remains after a loss, and should instead manage to see it as the cal-

Katarina Gvozdic, researcher at the Faculty of Psychology and Educational Sciences (FPSE) of the UNIGE, and Emmanuel Sander, professor at the Department of Educational Sciences of the FPSE of the UNIGE.

High resolution picture

culation of a difference, or a distance that has to be measured. It's all about showing students how to re-encode this situation."

After a year of teaching based on this practice, the UNIGE researchers evaluated their intervention by asking the pupils to solve problems that were divided into three main categories: combine ("I have 7 blue marbles and 4 red marbles, how many do I have in all?"), comparison ("I have a bouquet with 7 roses and 11 daisies, how many more daisies do I have than roses?") and change problems ("I had 4 euros and I earned some more. Now I have 11. How much did I earn?"). In each of these categories, there were some problems that were easy to represent mentally and to solve using informal strategies, and others that were difficult to simulate mentally and for which it was necessary to have recourse to arithmetic principles.

Undeniable results

At the conclusion of the tests, researchers observed undeniable results. Amongst students who had learned to solve mathematical problems with the ACE-ArithmEcole method, 63.4% gave correct answers to the problems that were easy to simulate mentally, and 50.5% found the answers to the more complex problems. "In contrast, only 42.2% of the pupils in the standard curriculum succeeded in solving simple problems, and only 29.8% gave the right answer to the complex problems," exclaims Katarina Gvozdic. "Yet their level measured on other aspects of maths was exactly the same," adds Emmanuel Sander.

This discrepancy can be explained by the frequent recourse to the use of mathematical principles rather than to mental simulations by the students who had taken part in the ACE-ArithmEcole intervention. "Thanks to the representational tools that had been offered to them and to the activities they had recourse to in class, the students learned to detach themselves from informal mental simulations and avoid the traps they lead to," comments Katarina Gvozdic enthusiastically.

The results are promising and they provide a foundation for promoting abstraction and breaking away from mental simulations. "Now we want to extend this teaching method to higher classes, incorporating multiplication and division as well," continues Gvozdic. "Moreover, the method could be applied to other subjects—such as science and grammar—for which intuitive conceptions constitute obstacles," adds Sander. The idea is to put semantic re-encoding to widespread use in schools and to incorporate it more amply into teaching methods.

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