



Note from the CSEN —

— October 2022, n° 7

Does distributing games to students before the summer holidays improve their mathematics achievement ? A randomized controlled trial^a

Written by Marie Lubineau, Stanislas Dehaene, Cassandra Potier-Watkins, Marc Gurgand, Adrien Pawlik, Caroline Bévalot, Nathan Viltard^{b, c}

Abstract

Several laboratory studies have shown that student's understanding of arithmetic could be enhanced through games involving numerical content. Thus, could encouraging students to play such games over the summer be enough to improve their achievement when they return to school ? In collaboration with the French Federation of Bridge, thousands of children in their first year of primary school (CP) received, right before the summer holidays, a card game called « Le petit bridge » and a board game called « Lianes et cascades ». A hundred voluntary schools, all located in priority education areas (REP/REP+) in 4 highly disadvantaged departments (Guadeloupe, Nord, Pas de Calais and La Réunion) were randomly assigned either to the experimental schools' group (receiving the games) or to the control schools' group (without the games). Students in the intervention schools received the games during the final week of CP (at the end of June 2021) and could play briefly in class before going home with the games. At the end of the holidays, at the beginning of their second year of primary school (CE1), their progress was assessed using the national evaluations (the Evalaïde program) and a survey.

Results have shown that :

- Students who received the games reported greater confidence in their abilities in both mathematics and reading
- Many reported playing the games daily or weekly, particularly those who had initially performed least well in mathematics and language.
- However, on average, pupils who received the games did not outperform pupils in the control group after the summer break, either in mathematics or in language skills. Nor did they display higher levels of school motivation or lower levels of anxiety.

^a This note supersedes and replaces the note of the same title published in May 2022, which contained several errors, particularly concerning the use of the games by CP students. We apologize for these errors.

^b Authors' affiliations: Marie Lubineau, Cassandra Potier-Watkins, and Caroline Bévalot are members of the Cognitive Neuroimaging Unit at NeuroSpin; Stanislas Dehaene is Chair of the Scientific Council of National Education (CSEN); Adrien Pawlik is Project Manager at IDEE; Marc Gurgand is Scientific Director of IDEE; and Nathan Viltard is Research Assistant at the CSEN.

^c Acknowledgements: We thank the IDEE teams, and especially Léon Marbach, for his assistance with sample randomization and statistical analyses; the French Bridge Federation for providing the games; Michel Gouy and Patrick Schilli for teacher training and game-design ideas; and Pauline Martinot for her assistance in processing the national assessment results. We also thank the Lille, La Réunion, and Guadeloupe academies, and in particular Marion Desmarest, Véronique Dubois, Régine Heudre, Jean-François Salles, Jean-Noël Chaffre, and Fabrice Lomon for their management of the project in the field, as well as all the assessors who administered the questionnaires. Finally, we thank the members of the CSEN Working Group on "Assessment and Interventions" for their helpful comments on earlier drafts of this report.

Several factors may account for this limited impact. One possible explanation is the limited amount of time available before the school holidays to teach sophisticated games. Consequently, it seems likely that those stronger effects might be obtained by integrating the games into classroom activities throughout the school year, within a structured educational approach that teaches not only the rules of the games but also the mathematical concepts and forms of reasoning on which they are based. Such an initiative, known as the « Oiseaux compteurs » is currently under way.

This study highlights the importance of rigorous experimentation, even when the results are negative. Without such evidence, it might have been tempting to distribute games to all students, and the ineffectiveness of the intervention would likely have remained unnoticed.

Several studies suggest that board games provide an excellent way for children to learn while having fun, particularly in the area of numbers and mathematics.^{1-5,7} Inspired by the initiative of distributing La Fontaine's Fables to all students in their final year of primary school (CM2) before the summer holidays, the Scientific Council of National Education (CSEN) wished to investigate the value of distributing a mathematics game to all pupils at the end of CP (the first year of primary school). Although the idea was appealing, no large-scale study had yet demonstrated its effectiveness in improving pupils' learning outcomes. For this reason, the CSEN recommended that a rigorous evaluation be conducted before such a programme could be extended to all students. The Well Played Summer 2021 project (Bien Joué Été 2021) was designed to assess this intervention.

Why conduct an experiment?

As the Council explains in Translational Research in Education: Why and How, conducting educational experiments means: "Building on collaboration between teachers and researchers, and drawing on their intuitions and knowledge, carefully planning a study so that its conclusions are as clear as possible and free from bias and ambiguity."⁶ Well-designed experiments lead to conclusions based on evidence rather than opinions based on intuition.

The purpose of educational experimentation is to provide rigorous answers to practical questions arising in schools. In doing so, it helps teachers adopt more effective practices and gain a better understanding of both the strengths and limitations of their students.

How to experiment well? Randomized controlled trials

Randomized controlled trials are based on two fundamental principles :

1. Comparison between groups : The outcomes of an experimental group, which receives the intervention, are compared with those of a control group, which does not. Students are assessed before and after the intervention, and statistical analyses are used to determine whether significant differences exist between the two groups at the end of the study.

2. Random assignment : Students, classes, or schools are assigned to either the experimental group or the control group through a process of random allocation. This randomization ensures that there are no systematic differences between the two groups before the intervention begins.

Randomized controlled trials are the most reliable method for determining whether educational policies and pedagogical practices have a causal impact, while controlling for all the bias that may affect results. However, such studies require a long implementation process, and cannot usually be conducted by an individual teacher acting alone, as they require the participation of large numbers of students.

Consequently, they are generally undertaken only after smaller-scale studies have produced promising findings. High-quality experiments take time, but the benefits are well worth the effort. The Bien Joué project forms part of the broader movement towards evidence-based education.

The Bien Joué Été 2021 Project

Studies involving several dozens of children have shown that board games present a substantial cognitive interest because they make the structure of the mental number line more intuitive.^{3,5} This is particularly true for games that require players to move a token along a board arranged as a left-to-right oriented number line, with spaces representing successive numbers.

Other research suggests that card games such as War (La Bataille) can help children learn to estimate, order, and compare numbers, recognize numerical symbols, and develop an intuitive understanding of numerical magnitudes.⁴



There are therefore good reasons to believe that board games may provide an effective and enjoyable way for children to acquire fundamental mathematical skills.

Organization of the project

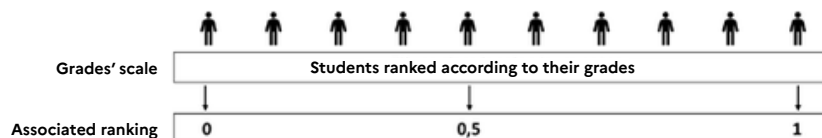
In June 2021, to support this study, the French Bridge Federation donated more than one thousand card and board games to schools located in priority education areas within the Lille, Guadeloupe, and La Réunion academies. The aim was to encourage pupils to play games with mathematical content during the summer holidays, including [Le Petit Bridge](#) and [Lianes et Cascades](#) (a game inspired by the North American game Snakes and Ladders).

The académies issued a call for participation and identified volunteer classes. A total of 2,838 students from 214 classes within the Priority Education Network participated in the study.

Random assignment was carried out by the IDEE Equipex programme, controlling carefully for factors such as class size, school district, and other relevant characteristics. Half of the classes were assigned to receive the games (the intervention group), while the remainder formed the control group.



In the intervention group, each child received a game, and each teacher attended a training session delivered by Michel Gouy, former school inspector and creator of Le Petit Bridge. During this training, teachers were introduced to the rules of several games and provided with examples of pedagogical activities to support their implementation. Teachers then had one to two weeks to introduce the games to pupils before the start of the summer holidays.



How to assess student's progress?

To measure students' progress in each group, it was necessary to assess them both before and after the intervention. All pupils, in both the intervention and control groups, completed the national beginning-of-CP and mid-CP evaluations (EvalAide programme). At the start of the 2021 school year, following the intervention, all pupils completed the national beginning-of-CE1 assessments. In addition, they were asked to complete a questionnaire measuring confidence in their abilities, motivation for school, school-related anxiety, and practice of board-game activities.

Well known to teachers, the EvalAide programme is designed to assess pupils' skills at the beginning, during, and at the end of CP in order to provide more effective support. It focuses on two main domains — language and mathematics — each of which is divided into a range of competencies. In the present study, we use pupils' average scores across all competencies within both domains.

To compare results between the two groups, we use percentile rank scores. A pupil's rank is calculated as follows: all pupils who participated in the study

are ordered according to their percentage of correct responses. A rank of 1 corresponds to the highest level of performance, whereas a rank of 0 corresponds to the lowest. The median rank (0.5) corresponds to the level of performance achieved by half of the students.

How to assess students' self-confidence?

A survey developed by the research team was used to estimate children's confidence in their own abilities. Because children may find it difficult to assess their performance directly, they were instead asked to evaluate themselves relative to their classmates. The scale shown below, adapted from previous research, was accompanied by the following instructions:



"We are going to do a reading exercise (or a mathematics exercise). Here are all the children in your class. They are all going to do the same exercise as you. The children are arranged according to how well they perform. Here is the child in your class who does least well in reading. And here is the child who does best in reading. Where would you place yourself?"

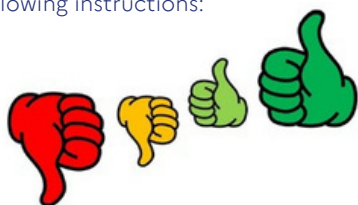
The more successful children believed themselves to be in mathematics or reading, the further to the right they positioned themselves on the scale.

^d The IDEE programme is a major research infrastructure initiative (ESR/EquipEx) funded by the French National Research Agency (ANR). Its aim is to develop large-scale experimental research in education and to promote the use of research findings. Led by J-PAL Europe at the Paris School of Economics (PSE) and coordinated by Paris Sciences & Lettres University (PSL), the programme brings together a multidisciplinary consortium of leading laboratories in economics, sociology, psychology, education, and cognitive science. Website: <https://www.idee-education.org/>

How to assess students' motivation and school anxiety?

Self-confidence is not the only psychosocial factor that may influence academic achievement. Pupils' motivation towards school and their level of school-related anxiety may also play a role.

A second section of our questionnaire was therefore devoted to measuring these two variables. Statements such as "I like going to school," "I go to school to get rewards," or "I am afraid when we do mathematics in class" were read aloud to the child, who was then asked to indicate the extent to which he or she agreed with each statement. To do so, we used a second response scale, also adapted from the research literature, together with the following instructions:



"Now I am going to read you some sentences. If you completely agree, point to this thumb (the thumb on the far right). If you do not agree at all, point to this thumb (the thumb on the far left). If you agree a little, or disagree a little, point to one of these two thumbs (the thumbs in the middle)."

Pupils' levels of motivation and school-related anxiety were estimated by averaging their responses to the statements associated with each dimension.

Game	% d'enfants qui disent connaître chaque jeu	Game	% d'enfants qui disent connaître chaque jeu
Mille bornes	18,8	Petit chevaux	69,5
Lynx	25,1	Qui est-ce	71,1
Jeu de l'Oie	45,3	Monopoly	77,6
7 familles	49,4	Cartes	80,5
Dobble	64,2	UNO	85,5

The final section of the questionnaire assessed children's familiarity with board games more generally. Images of commercially available games (Mille Bornes, Lynx, Guess Who?, and Ludo) as well as the games distributed by the French Bridge Federation were shown to the children, who were asked whether they knew the games and whether they played them regularly.

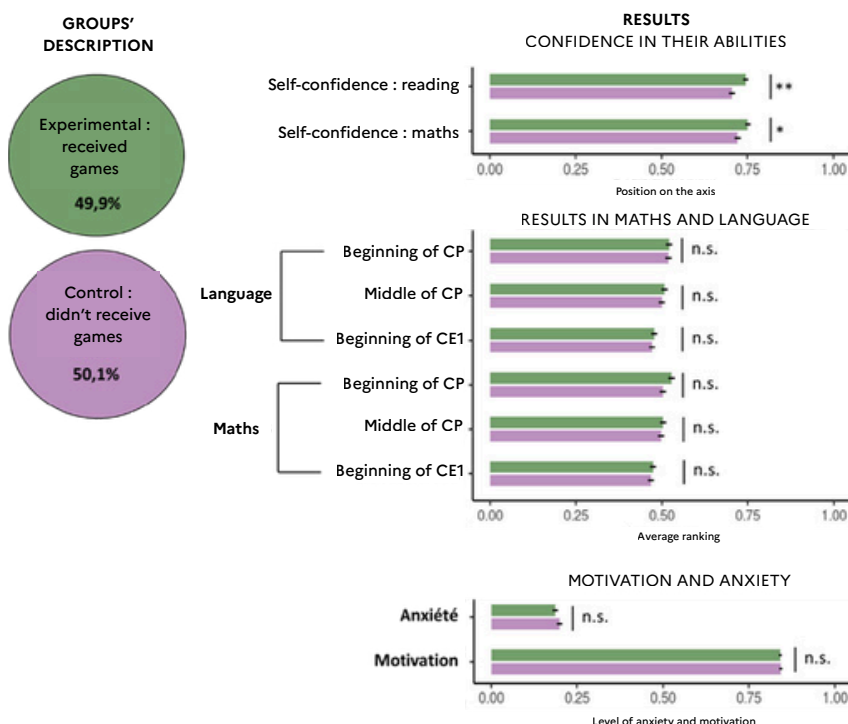


Figure 1 - Comparison of the results of students in the intervention group and those in the control group

Note : The symbol * (respectively **) indicates that the smallest error rate allowing rejection of the hypothesis that the means are identical is below 5% (respectively 1%). In other words, the observed differences are significant. Non-significant differences are indicated by the symbol n.s.

Mille Bornes, the least popular game in our sample, was familiar to approximately 20% of pupils. More generally, the vast majority of pupils reported playing board games at home.

What are the results?

Receiving the card games increased students' confidence in their abilities, but produced no measurable improvement in those abilities

Students in the intervention group expressed greater confidence in their abilities than pupils in the control group, both in reading and in mathematics (Figure 1).

Unfortunately, this increase in subjective confidence was not accompanied by any objective improvement in performance. Although Figure 1 suggests a slight advantage for the intervention group, differences between the two groups on the national evaluations were not statistically significant, either before or after the intervention.

It therefore appears that receiving the games did not lead to greater academic progress. This conclusion remains unchanged when regression models are used to control for age, gender, familiarity with board games, and baseline performance in language and mathematics (as measured at the beginning and midpoint of CP).

Receiving the card games didn't affect students' motivation for school or their school-related anxiety

In addition to assessing pupils' confidence in their abilities, our questionnaire also allowed to measure their motivation towards school and their levels of anxiety related to reading and mathematics.

The results shown in Figure 1 indicate that, overall, the CP students in our sample were highly motivated by school (mean score: 2.6 out of 3) and displayed relatively low levels of anxiety (mean score: 0.6 out of 3). This is an encouraging finding: at this age, pupils do not yet appear to

experience the school disengagement that, according to the OECD's PISA surveys, is particularly prevalent among secondary-school students in France. However, the distribution of the card games did not significantly increase their motivation or further reduce their anxiety. Although the observed trends slightly favoured the intervention group, none of the differences between groups reached statistical significance.

Yet almost all students used our games during the summer holidays

To interpret these findings correctly, it is important to ask whether the children actually used the games during the summer. The questionnaire responses, presented in Figure 2, show that more than 90% of pupils in the intervention group recognized the games at the start of the school year, and nearly 75% reported having played them. More generally, pupils participating in the project were enthusiastic game players. On average, they recognized six of the ten games presented in the questionnaire, and more than one third reported playing games every day. Games such as War (La Bataille) are widely played and familiar to most pupils, both in the intervention and control groups.

For the intervention to have a measurable impact, it may have been necessary for pupils to learn more complex games such as Le Petit Bridge or Lianes et Cascades. However, because teachers received their training only at the very end of the school year and the games were distributed shortly before the summer holidays, they had very little time to familiarize students with these activities. One possible explanation for the absence of measurable benefits is therefore that pupils continued to play familiar card games during the summer, in ways that differed little from the experiences of pupils in the control group.

In addition, the fact that nearly 30% of pupils in the control group reported having used the project games during the summer raises important questions.

		Groupe	
		Expérimental	Contrôle
Frequency of use of our games during the summer holidays	Daily	209 22,5%	56 6,0%
	Weekly	144 15,6%	34 3,7%
	Sometimes	333 36,0%	195 21,0%
	Never	157 17,0%	112 12,1%
	Didn't recognize any of our games	82 8,9%	531 57,2%

Figure 2 – Share of students who recognized our games and used them in each group

It is possible that the distinction between the intervention and control groups was not entirely maintained because pupils in the intervention group shared the games with friends or classmates assigned to the control group.

Students who used our games during summer most frequently were those struggling most in mathematics and language, but they are also those most motivated by school

Although simply receiving the games did not improve students' outcomes, it is possible that the frequency with which pupils used them mattered. While around one fifth of pupils reported playing the games every day, others reported never using them at all (Figure 2). A final analysis, restricted to pupils in the intervention group, examined the relationship between frequency of game use and pupils' mathematics and language outcomes, self-confidence, motivation, and anxiety (Figure 3). Students who did not even recognize the games when they returned to school were excluded from this analysis because it was impossible to determine what had happened to their games: they may never have received them, may have lost them, or may have left them at school. Their results are nevertheless displayed as yellow bars in Figure 3.

Figure 3 shows that among students who recognized the games (shown in green), those who reported using them most frequently during the summer were also those who had the lowest

levels of achievement before the intervention. This pattern reached statistical significance in both mathematics and language. The same tendency remained visible after the intervention, although it was no longer statistically significant in mathematics. Frequent use of the games was not associated with lower anxiety levels or greater self-confidence. However, pupils who played the games most often also reported the highest levels of motivation towards school.

When age, gender, familiarity with games, and baseline performance in language and mathematics are taken into account, only motivation remains significantly associated with game use. In other words, pupils who played the games most frequently during the summer did not make greater academic progress than other pupils, did not become less anxious, and did not report greater confidence in their abilities. However, they were the pupils who expressed the strongest motivation towards school.

These findings should be interpreted with caution, since correlations alone do not establish causality. We cannot conclude whether pupils were more motivated because they played the games, or whether more motivated pupils were simply more likely to play them. Nevertheless, the results suggest that the games may have met a need among some pupils who were experiencing academic difficulties but remained highly motivated and became sufficiently engaged with the games to play them weekly—or even daily.

GROUPS' DESCRIPTION



Language

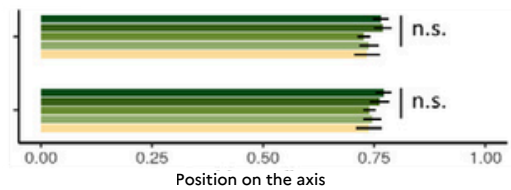
Maths

RESULTS

CONFIDENCE IN THEIR ABILITIES

Self-confidence : reading

Self-confidence : maths



RESULTS IN MATHS AND LANGUAGE

Beginning of CP

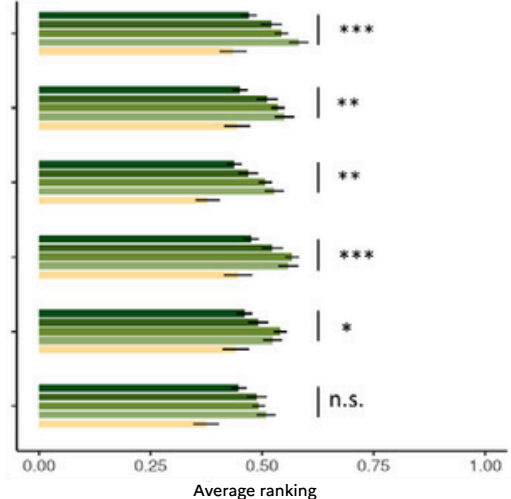
Middle of CP

Beginning of CE1

Beginning of CP

Middle of CP

Beginning of CE1



MOTIVATION AND ANXIETY

Anxiété

Motivation

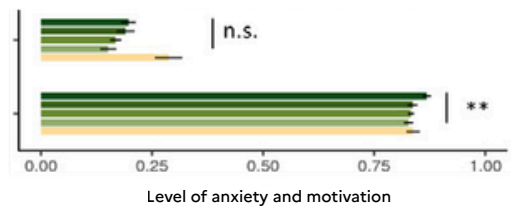


Figure 3 - Comparison of the results of students who played our games daily, weekly, sometimes or never, or who didn't recognize them

Note : The symbol * (respectively **) indicates that the smallest error rate allowing rejection of the hypothesis that the means are identical is below 5% (respectively 1%). In other words, the observed differences are significant. Non-significant differences are indicated by the symbol n.s.

What are the implications for the future ?

Our conclusion is straightforward: simply giving games to students and encouraging them to play during the summer holidays is not sufficient to improve their academic achievement, despite the increase in their self-confidence. Nor does it appear to reduce school-related anxiety or increase motivation towards school. These findings should nevertheless be interpreted in light of the late distribution of the games. It is possible that Le Petit Bridge and Lianes et Cascades were introduced only briefly—or not at all—in some classrooms, with teachers instead favouring simpler games such as War (La Bataille).

Two points deserve particular attention. First, distributing the games increased pupils' confidence in their own abilities. Greater self-confidence may, in turn, lead to stronger engagement and more effective learning over time. In the present study, pupils' performance was measured only immediately after the summer holidays. It would therefore be valuable to investigate whether the observed increase in confidence ultimately translates into genuine differences in academic achievement later in students' school careers.

Second, our questionnaire revealed that pupils were already highly familiar with board games in general. Games such as War are widely played and were commonly used even among pupils in the control group.

Future interventions should therefore introduce pupils to more complex and more targeted games designed to develop specific skills, thereby increasing the likelihood of detecting meaningful differences between groups. It would also be useful to assess pupils' mastery of the games more precisely in order to better interpret the results.

Although simply distributing games before the summer holidays does not appear sufficient to improve pupils' outcomes, it remains plausible that sustained classroom use throughout the CP year could prove more effective by allowing pupils to engage with more complex games. This is precisely the rationale behind the Les Oiseaux Compteurs initiative launched by the Ministry of Education in November 2021

This large-scale randomized controlled trial involves approximately 67,000 pupils, with those in the intervention group using the games regularly in class from the end of the autumn half-term break onwards. Results were expected in autumn 2022.

Finally, despite its disappointing findings, this study highlights the importance of rigorous experimentation. In spring 2021, the Ministry was preparing to distribute games to all CP pupils in France, much as it has distributed La Fontaine's *Fables* to CM2 pupils for several years.

Without a rigorous evaluation, the ineffectiveness of this intervention would likely never have been identified. For this reason, in its report *Translational Research in Education*, the Scientific Council of National Education emphasizes the essential role of experimentation in identifying effective educational practices.

Key takeaways

- Educational experimentation makes it possible to draw rigorous conclusions about the effects of an intervention. When several small-scale studies suggest that an intervention may be effective, it is important to test this hypothesis on a larger scale through a randomized controlled trial.
- An experiment is always valuable, even when its findings are negative.
- Distributing games increased pupils' subjective confidence in their abilities, but did not improve their objective outcomes in the short term. Pupils who received the games made no greater progress than those in the control group, either in mathematics or in language skills. Nor were they less anxious or more motivated towards school.
- Pupils who used the games during the summer were also those with the lowest levels of achievement in both mathematics and language. However, the experiment did not establish whether this correlation reflects a causal relationship.
- Distributing the games earlier in the school year, allowing them to be integrated into everyday classroom practice, may prove more effective, particularly if it helps engage pupils who experience the greatest difficulties in entering the learning process. Testing this hypothesis through a randomized controlled trial is precisely the aim of the Les Oiseaux Compteurs project.

Bibliography

1. Griffin, S., Case, R. & Siegler, R. S. Right-start: Providing the central conceptual prerequisites for first formal learning of arithmetic to students at risk for school failure. in *Classroom lessons: Integrating cognitive theory and classroom practice* (ed. McGilly, K.) 25-49 (MIT Press, 1986).
2. Räsänen, P., Salminen, J., Wilson, A. J., Aunio, P. & Dehaene, S. Computer-assisted intervention for children with low numeracy skills. *Cogn. Dev.* 24, 450-472 (2009).
3. Siegler, R. S. & Ramani, G. B. Playing linear numerical board games promotes low-income children's numerical development. *Dev. Sci.* 11, 655-661 (2008).
4. Scalise, N. R., Daubert, E. N. & Ramani, G. B. Benefits of Playing Numerical Card Games on Head Start Children's Mathematical Skills. *J. Exp. Educ.* 88, 200-220 (2020).
5. Siegler, R. S. & Ramani, G. B. Playing Linear Number Board Games—But Not Circular Ones—Improves Low-Income Preschoolers' Numerical Understanding. *J. Educ. Psychol.* 101, 545-560 (2009).
6. Dehaene, S., Pasquinelli, E., Gurgand, M., Ramus, F. & Spelke, E. La recherche translationnelle en éducation : pourquoi et comment ? *Cons. Sci. Educ. Natl.* (2021).
7. Dehaene, S. et al. L'ouverture aux mathématiques à l'école maternelle et au CP. *Cons. Sci. Educ. Natl.* (2021).

Find all CSEN's publications on the link below:

reseau-canope.fr/conseil-scientifique-de-leducation-nationale