Integration of Digital Technology in the Classroom and Mathematics Project on Twitter

ABSTRACT

Within the framework of a collaborative research, a mathematical project on Twitter was conducted in ten classes of two elementary schools in French-speaking Belgium. In this context, a techno-pedagogical accompaniment of the teachers was implemented. This article describes the effects of this support on the teachers' feeling of digital competence and on their desire to integrate digital technology in their teaching practices. Students' perceptions of this project were also collected.

Keywords: technology, Twitter, mathematics, problem solving, math for real

1. Introduction

In October 2018, French-speaking Belgium adopted a Digital Strategy for Education. It is part of a reform, the Pact for Excellence in Education, and more specifically, in the framework of the digital transition. The latter aims at integrating digital technology into classroom practices and the acquisition of digital skills by students. This article presents the implementation of a mathematical project on Twitter within the framework of a techno-pedagogical support conducted in ten classes of two elementary schools. On the one hand, we assess the effects of this support on the teachers' feeling of competence in digital technology and their desire to integrate it into their teaching practices. On the other hand, we collect the students' perceptions of this project. The collaborative research explained below was conducted as part of the research

work for the Pacte, where techno-pedagogical support for field practitioners was set up.

2. The integration of information and communication technologies in the classroom

Information and communication technologies (ICT) influence the social, technical, and economic dimensions of our society (Redecker, 2009). The educational field is no exception; it is also changing learning and digital education is a necessity (Dohn, 2009). However, the integration of ICT into classrooms is not progressing well (Maddux et al., 2011; Thibert, 2012). As Chaptal (2011) states, technologies are often used by teachers for their professional use and, to a lesser extent, in a pedagogical context. Thus, only a minority of teachers use digital technology to enrich their teaching or as a learning support (Guzman & Nussbaum, 2009; Liu, 2011). This under-use of digital technology is believed to be rooted in teachers' lack of competence with digital technology (Tsai & Chai, 2012; Villeneuve et al., 2012). One of the factors facilitating the integration of ICT is professional development opportunities (Gotkas et al., 2009). Indeed, several authors consider that there is a positive link between the digital pedagogical training teachers undergo and their integration initiatives in their classrooms (Collis & Jung, 2003; Bullock, 2004; Jung, 2005). Support must be provided to teachers so that they can integrate it into their pedagogical practices, while addressing any technical concerns (Cody et al., 2016). We believe that techno-pedagogical training is necessary in order to integrate technologies into classroom practices. The technical aspect of the tools dealt with in the training sessions is not enough to ensure on its own effective and relevant integration of digital technology; pedagogical reflection should not be neglected. A shift is thus taking place from techno-centric training to a pedagogical-centric approach (Charlier, 2010). Not only does digital technology lead to the digitization of actual pedagogical practices, but also to the emergence of new learner-centered practices (Sanchez, 2012), leading to a redefinition of the poles "teacher, student, knowledge" and the relationships that link them (Houssaye, 2015). The system presented in this article is part of this second modality. Our approach is based on individualized support provided to teachers to facilitate the integration of technologies in their teaching-learning situations (Giroux et al., 2013). This coaching takes place within the classes of these teachers in order to allow them to "situate the observations they make

of their own practices, in their classrooms, in a situation of integration of ICT, and to be able to appreciate their progress in this sense" (Coulombe et al., 2017, p. 10). In addition to individualized support in a real classroom context, it is recommended that the teacher actively participate in the development of the techno-pedagogical device (Kumps et al., 2019).

3. Context

This research took place during the 2018–2019 school year and took place over a two-month period. This device aims at the development as well as the resolution of mathematical challenges on Twitter by allowing the reinvestment of previously learned mathematical concepts. The objective of this project is to distance itself from the purely abstract approach of mathematics. Ten teachers from two elementary schools took part in this project. The two schools involved are located in the province of Hainaut in French-speaking Belgium. Access to a WiFi connection is available in the classes taking part in our project. The first school has recently been equipped with a set of twelve Android tablets. The teachers told us that they had not had the opportunity to use them before our arrival. As for the second school, it has a mobile interactive whiteboard. The latter is mainly in the class of the CM2 teacher, who is a regular user of this equipment and shows a certain interest in digital technology. This teacher also provides his students with two tablets, obtained with his own funds, during workshops. He offers them applications that he considers beneficial for their learning.

Table 1. Work context of teachers participating in this scheme according to school, grade and number of students

School A teachers			School B teachers						
CE1 17 students	CM1 20 students	CM2 18 students	CP 16 students	CP 18 students	CE1 17 students	CE2 21 students	CE2 18 students	CM1 19 students	CM2 17 students

Source: Dragone, Temperman, De Lièvre (UMONS, 2022)

Although the teachers themselves carry out the activities in their respective classrooms, a researcher is involved in the implementation of the project in the field. She ensures the smooth running of the project and accompanies each teacher individually from the design of the to the publication of the Tweets. The

aim of our research is to assess the effects of individualized techno-pedagogical support on the teachers' sense of competence and their desire to integrate digital technology into their classrooms, as well as the relevance of such a system for student learning.

The goals of our project are to promote the professional development of teachers in the use of digital technology through a professionalizing approach (Uwamaryia & Mukamurera, 2005) and to build common knowledge regarding the integration of digital technology in the school context. Thus, we promote a "collaborative research" approach (Desgagné & Larouche, 2010; Morrissette, 2012). In this framework, the teacher becomes a partner from the co-design of the device to the analysis of the data, informed by his or her perspective as a field practitioner. We explain each step of this process according to the model of Desgagné et al. (2001). First, a meeting was organized between the researcher and the teachers to define the expectations of each. On the one hand, the researcher wanted to investigate the effect of techno-pedagogical support on the teachers' sense of competence and, on the other hand, she wondered about the interest of such a project for the students' learning. As for the teachers, they wanted to benefit from techno-pedagogical training in their classes. They also felt it was relevant to participate in this project, which they considered innovative, both in terms of the use of digital tools and the proposed approach (COSITUATION). The next step (COOPERATION) is the experimentation of the device which was co-constructed in partnership with the teachers. On this occasion, questionnaires were submitted to the teachers and their students in order to collect data. The last step (COPRODUCTION) aims at analyzing the data and communicating the results to the teachers. A meeting with all the teachers took place in order to discuss these results and to complete them with their expert view of the field.

4. Presentation of the "Math for Real" scheme

Our program is inspired by the "Math for Real" project, which usually takes place around the month of April. For four weeks, a new mathematical theme is proposed every Monday. The teacher carries out a brainstorming with the students, this step allows to reactivate the students' knowledge. The students must then identify elements in the classroom where the concept can be observed and propose a mathematical challenge that they will submit on Twitter to the other classes participating in the project. After presenting their problem to the teacher, students send a tweet with their math challenge. Each day, a few min-

utes are given to check the #MathForReal Twitter feed to try to find answers to questions from other classes also participating in the project. Students must also check the accuracy of the proposed solutions to their problems.

Figure 1. Official "Math For Real" Twitter account.
Source: Dragone, Temperman, De Lièvre (UMONS, 2022)

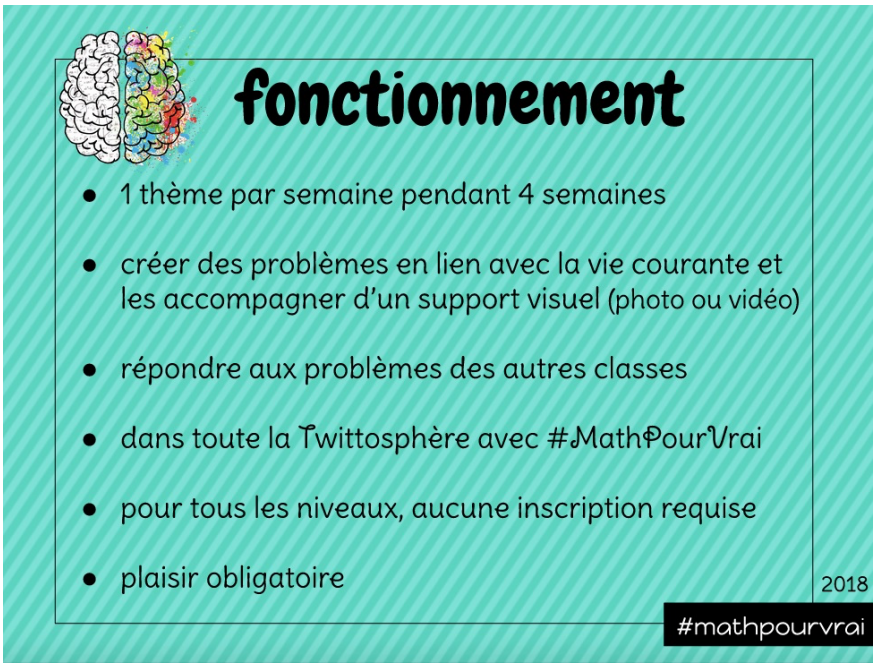

Figure 2. How to participate in the Math for Real project?
Source: Dragone, Temperman, De Lièvre (UMONS, 2022)

The citizen registered in a digital society in constant evolution is led to develop new skills from this digital culture. The school plays a role in the development of these digital skills. The DigComp model (Carretero et al., 2017) is a reference framework of digital competences adopted by a number of European actors. It is composed of 21 competencies divided into five domains: information and data literacy, communication and collaboration, digital content creation, security as well as problem solving. In this project, several skills are solicited such as "interacting through digital technologies", "sharing with digital technologies", "managing digital identity" or "protection of personal data and privacy" (Carretero et al., 2017, p.11). The design of techno-pedagogical devices requires the teacher to master digital skills and to enable the development of these skills in their students (Redecker, 2017). In addition to using digital technology in teaching practices (digital education), it is also about considering it as a learning object (digital education). This project is situated in this dual approach.

4.1 Arrangements of the device

We are not aiming for a "simple" implementation of the device in the classes involved. Indeed, we consider it important to consider the difficulties that teachers anticipate in their practices as well as those assumed for their students, thanks to their expertise. We are also attentive to the involvement of teachers in this process, which, in our opinion, also involves adaptations when they take up the device. Therefore, it seems necessary to us to ensure a reflection in collaboration with the researcher on the taking in hand of the device in order to carry out the opportune adjustments taking into account the context of its implementation.

Firstly, the teachers were met with the aim of accompanying them in the creation of a class Twitter account and to prepare an introductory sequence on Twitter as well as on its stakes before the project.

This social-digital network seems relevant to us for several reasons:

1. tweets are limited to 280 characters, which makes the project accessible to first and second graders. The concise nature of the tweets leads the students to synthesize their messages (Deschenes & Parent, 2012);
2. the fun aspect increases motivation to read and write;
3. it raises students' awareness of critical use of the Internet and social networks (Leclerc-Coulmain, 2014);
4. it establishes a real communication framework and that the use of social-digital networks is particularly interesting in social and active learning contexts (Macfarlane, 2015);

5. in addition to the mathematical concepts addressed, handwriting, spelling, conjugation and syntax are worked on (Leclerc-Coulmain, 2014) and take on their full meaning because what the students write will be published and read by others.

The digital social network Twitter is not known – or at best, little known – to students who are not familiar with it. Therefore, it is necessary to prevent risks in the use of Twitter and to define rules that students must respect. To this end, a charter for the use of Twitter was posted in each classroom. It was read, explained and commented by the teacher to the students who then signed it. This step seems necessary to us in order to make them aware of good practices, of the traces left on the Internet and to make them aware of their digital identity (Cardon, 2011). Behind the apparent ease with which students use digital tools and despite the widely conveyed image of "digital natives" (Palfrey & Gasser,

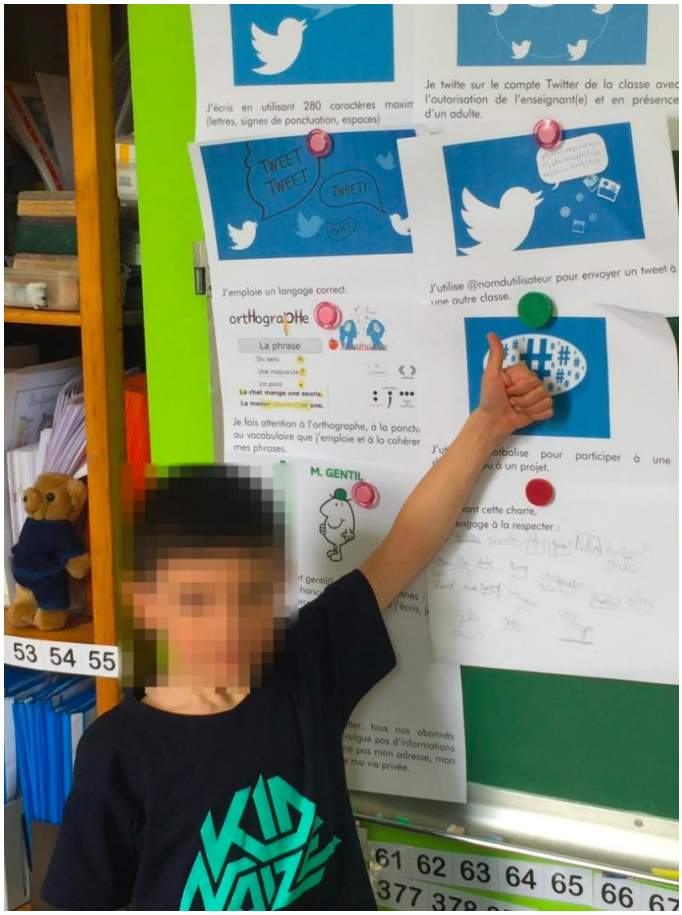

Figure 3. Charter posted in classrooms.
Source: Dragone, Temperman, De Lièvre (UMONS, 2022)

2008; Prensky, 2010) lies a mastery of digital skills that falls short of what is predicted by this theory. Indeed, this mastery depends on other intragenerational variables (Bennett et al., 2008) such as socio-economic background, gender and culture. It should also be noted that students' use of digital tools in the school context differs from their usual use in the private sphere (Dioni, 2008) and their use is generally rather passive. On the other hand, the creation of digital content, sharing, solving technical problems... are uses that concern only a portion of young people (Amadieu & Tricot, 2014). The role of the school is to prepare the students as well as possible in order to integrate this technological society and to develop their critical spirit in their uses of the socionumeric networks (Entraygues, 2017) in order to become aware of their impacts.

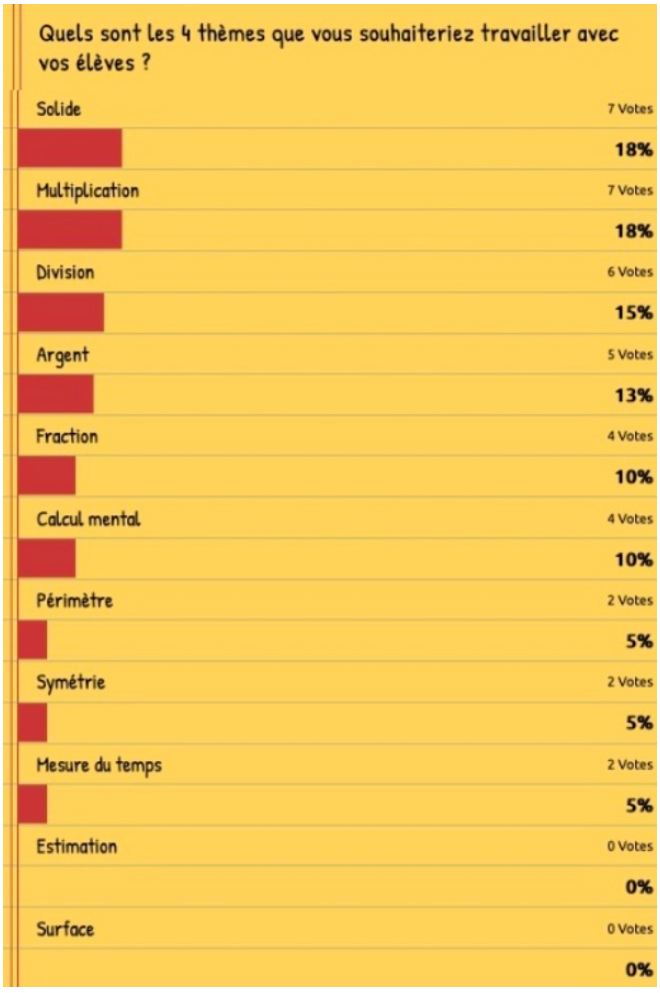

Figure 4. Teacher selection of themes via a StrawPoll.
Source: Dragone, Temperman, De Lièvre (UMONS, 2022)

The ten classes started the project from May 6 until May 30, 2019 and were connected to each other to participate in our project. A hashtag was created for this purpose "#mathdelavie". The mathematical themes for the four weeks were chosen by the teachers from a list of themes from previous years' Math for Real projects through an online survey using the StrawPoll tool.

The four math themes were "solid" (week 1), "multiplication" (week 2), "division" (week 3) and "money" (week 4).

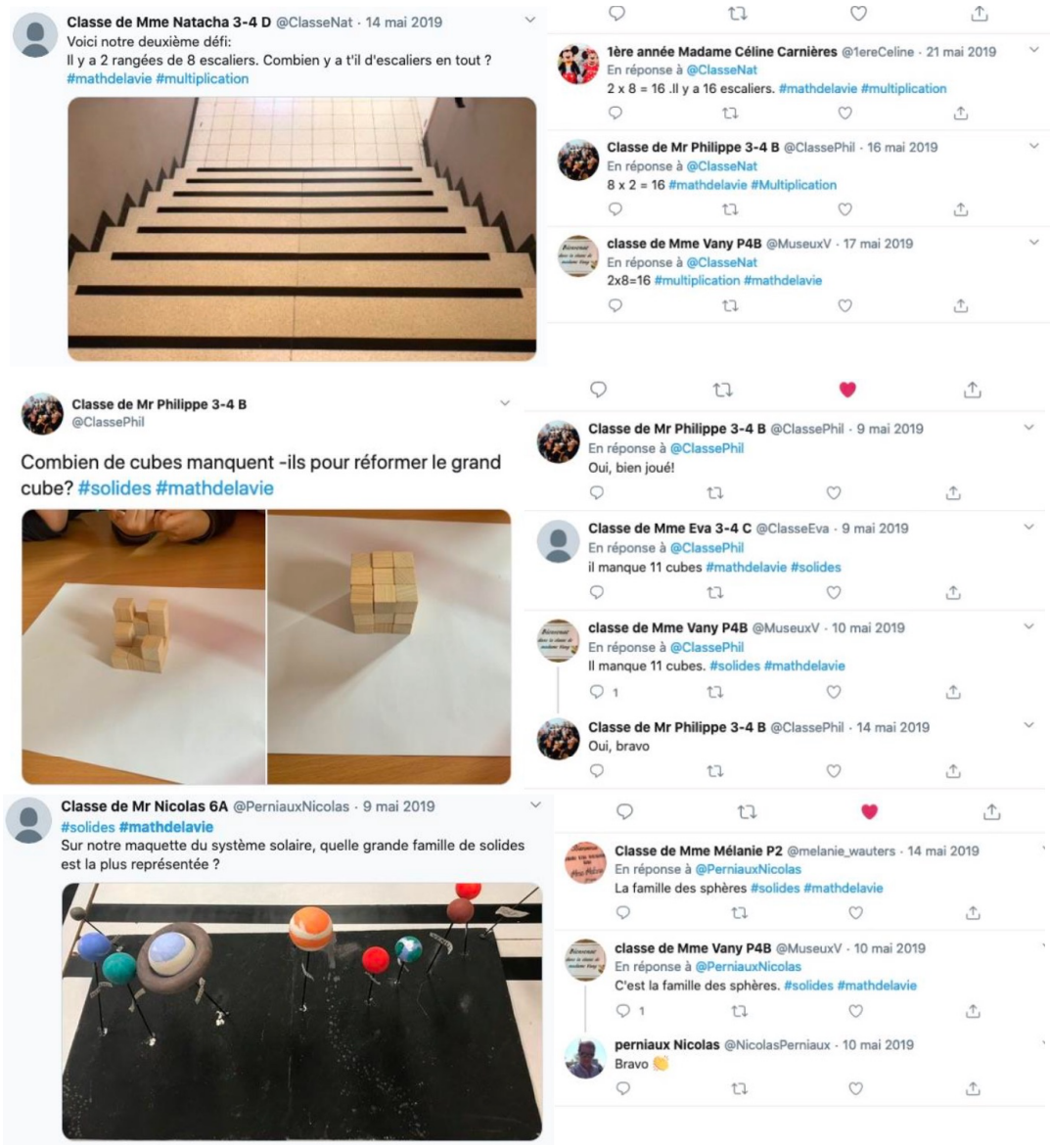

Figure 5. Twitter exchanges between classes participating in the #mathdelavie project.
Source: Dragone, Temperman, De Lièvre (UMONS, 2022)

The researcher was present for every activity throughout the project, from brainstorming to taking problem pictures, posting Tweets on the class Twitter account, and checking the Twitter feed to respond to the mathematical problems of the other classes participating in the project. We used the term "problem" just as we did in the "Math for Real" project (see Figure 2). However, we agree with Glaeser (1973) who distinguishes between a problem, which involves trial and error and research to identify appropriate solution procedures, and an exercise, which involves an algorithmic procedure. The tasks proposed by the students and relayed on Twitter, both in the "Math for Real" project and in our adaptation of it, are more like exercises.

Our support is technical support to allay teachers' fears about technical problems and the use of digital technology in the classroom. If the teachers felt the need, they could ask us for help. So, we never intervened in the activities carried out. Both for the creation of the mathematical challenges and for their resolution, we relied on the expertise of the teachers' professional gestures. Through their interactions with the students, the teacher's guide their thinking by scaffolding.

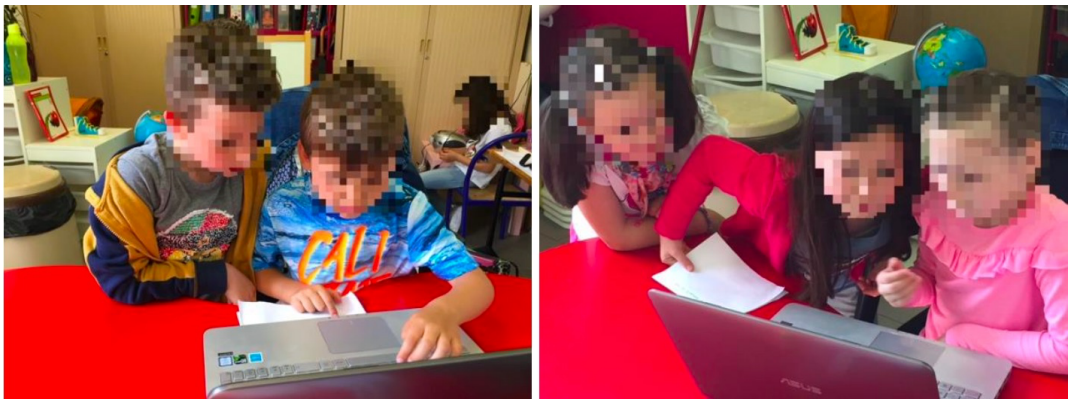

Figure 6. Writing math challenges on Twitter.
Source: Dragone, Temperman, De Lièvre (UMONS, 2022)

4.2 Our device with respect to the PST model (Wang, 2009)

A device can be seen as a configuration designed to facilitate a learning process (Blandin, 2002). It constitutes the framework in which different resources are chosen to enable learning. The role of teachers is essential because they are the vectors of pedagogical intentions (Guichon, 2006).

The PST model (Pedagogical, Social and Technological affordances) focuses on the affordance of technologies and their use according to the pedagogical, social and technological dimensions in the design of a learning device (Wang, 2009). Affordances are the properties perceived by the user of the tool. They are inherent to the context of a device. However, they depend on the subject's effectiveness, i.e., what he or she is capable of achieving, which is itself marked out by the affordances of the object (Grassin, 2015). We evaluate the appropriateness of the chosen tool, Twitter, for our device along the three dimensions of the PST model.

4.2.1 Under the pedagogical dimension

The device presented above aims at the elaboration and the resolution of mathematical challenges, resulting from an exchange between classes. A mathematical problem should be concise and structured. We believe that the number of characters allowed in the Tweets leads the students to organize their ideas and to ensure the clarity of their words in order to write their challenge. Furthermore, we want our system to be accessible to first graders. We feel that this tool can help us achieve the learning objectives.

4.2.2 Under the social dimension

Social interaction is an integral part of our system, going beyond the classroom or school setting. Communication, in this case asynchronous, is the sine qua non condition for setting up exchanges of mathematical problems between classes from different schools and for solving challenges. Twitter seems to us to be an appropriate choice to ensure this process.

4.2.3 Under the technological dimension

We chose Twitter as our technology medium for two reasons. First, students as young as 6–7 years old must be able to participate in our learning device. While older students are constrained to be concise, this constraint allows the device to be accessible to younger students. Secondly, we want to establish a real framework for exchange and communication between classes. The technological tool must allow interaction, sharing and publishing of the mathematical problems created by the students.

5. An analysis of a project combining mathematical problem solving and Twitter

Given the support teachers need to integrate digital technology into their pedagogical practice (Cody et al., 2016), we are field-testing individualized coaching (Giroux et al., 2013) to allow teachers to assess their evolution in their technology integration practices (Coulombe et al., 2017).

5.1 Research questions

We question the effects of our techno-pedagogical support and the value of this project. We also question the learners' perceptions of the device submitted, and the technological tool used. This leads us to construct four research questions:

Q1: Is the proposed device relevant to students' learning?

Q2: Did our techno-pedagogical support have an effect on our teachers' desire to integrate digital technology into the classroom?

Q3: Has our techno-pedagogical support had an effect on our teachers' sense of competence?

Q4: What are the perceptions of the learners subjected to our learning device?

5.2 Data collection

The perceptions of the teachers involved in our experiment were collected on different variables. Questionnaires were developed as part of joint research with fellow researchers (De Lièvre et al., 2019). We asked teachers about these dimensions before and after the experimentation. Students' perceptions were also surveyed but post-experimentation. We questioned four variables: ease of use of the digital tool Twitter, gamification, need for external help, and motivation. Given the levels of the classes, it is appropriate to adapt the methods used to question the students according to their age. Indeed, our sample is made up of ten classes of different levels. Two versions of our questionnaire were proposed: an adapted version, for the first to third grades, favoring an oral administration with pictorial answers where we read the questions aloud, and a "standard" version with 4-level Likert scales. The adapted version was designed following the recommendations of the vade mecum of the Institute for Research in Psychological Sciences of the Catholic University of Louvain (IPSY-UCL) for the realization of qualitative surveys with young children.

5.3 Data processing methods

For closed-ended questions with one possible answer and ordered variables, we assigned a number to each response modality. This allowed us to convert the textual data into numerical data.

Table 2. Treatment of responses to closed-ended questions.

"Strongly disagree"	0
"Disagree"	1
"Agree"	2
"Strongly agree"	3

Source: Dragone, Temperman, De Lièvre (UMONS, 2022)

For the qualitative open-ended questions, we processed them via Voyant Tools by targeting the most cited occurrences in the text as well as the words associated with them.

5.4 Results

We present our detailed results, below, according to our four research questions.

Q1: Is the proposed system relevant to student learning?

Before experimentation, six of the ten teachers believe that this project is probably relevant from the point of view of student learning. The other subjects are certain of its relevance. Given that these teachers responded positively to participate in this project, we could expect teachers to have a positive representation of this project for their students' learning. After experimentation, our sample was unanimous about the relevance of the project. The post-test analysis of the project by the teachers was carried out in three ways.

Regarding the effectiveness of the digital tool and its usefulness in this activity: 60% of our sample emphasize the usefulness of Twitter to communicate and correspond with other classes: "Useful to communicate with other classes and involve the child more.", "The tool allows to communicate with other schools.", emphasizing the participation of all students: "All children are actors (they came to write several answers each in turn).".

Regarding the effect of the use of this digital tool on the students: four teachers out of ten note an increased motivation: "Motivation++++, interest,

participation of ALL". Three teachers report that students are enthusiastic about taking part in the tasks offered: "Students are curious and interested in working with digital tools.", "Children enjoy using a tool that is usually very little used by them in the classroom.", "Happy to be able to use a tool that only the big kids can use.".

Regarding improvements to this project: two teachers suggest that challenges between classes of the same level with specific themes be introduced: "A sort of challenge between classes. We could even start the challenge in class and select the 3–4 best questions.".

Q2: Has our techno-pedagogical support had an effect on our teachers' desire to integrate digital technology into the classroom?

After experimentation, 60% of our teachers said they were "completely in agreement" with integrating digital technology into their classrooms. They were also asked to justify their choices. Three teachers said that digital technology allows for increased motivation in their students: "It helps motivate students (interactivity and diversity).". One teacher out of five believes that it would allow their students to understand the digital world in our society, "To diversify my way of working and to teach my students to use the digital tools that are now an integral part of our lives.".

Q3: Has our techno-pedagogical support had an effect on our teachers' sense of competence?

The teachers were asked to evaluate their feeling of competence with regard to the technical mastery of digital tools and the development of activities using digital technology. Regarding the feeling of technical competence, 60% of the teachers surveyed consider themselves "getting by" in the use of digital tools, while the rest of the sample said they "have good knowledge" before the experimentation. We observe a positive evolution of teachers' perceptions after experimentation. Indeed, seven out of ten teachers report good knowledge, and three teachers consider themselves experts. The feeling of competence in the pedagogical uses of digital technology also improved for all teachers. While 60% considered themselves to have no knowledge and 40% had little knowledge, 60% said they had good knowledge and 40% considered themselves to be "experts" after experimentation.

Q4: What are the perceptions of the learners subjected to our learning device? We note that nearly seven out of ten students say they "totally agree" on the motivating nature of the project and 63% of the students interviewed really enjoyed taking part in it. This is in line with what the teachers said: "The children were very motivated, interested and involved.", "They were very happy and looking for something.", "They were motivated by the idea of using digital tools, as they are not used to them, and they were also very enthusiastic about the idea of sharing with other classes.". Regarding the item about the ease of use of the Twitter account, one out of two students agreed with it. Moreover, 80% of our sample stated that they did not need any external help in writing and posting Tweets on their class' Twitter account. The teachers' testimonies also support this, "They really liked it. They were 100% invested in the activities. I was only the resource person in case of questions about the tool (computer). They found a lot of situations, but it was impossible to use them all properly. They were very curious.".

6. Conclusion

Although our conclusions cannot be generalized given our sample size, our experimentation allows us to provide several conclusions. First, we can see that our project as well as the chosen digital tool, Twitter, seem to be adapted to students from CP to CM2. The analysis of the perceptions of our sample of students does not reveal any difficulties in using the class Twitter account. Moreover, they recognize the motivating character of this device. As for the teachers involved, they are unanimous about the relevance of this project for their students' learning. The majority of teachers reported the effectiveness and usefulness of Twitter in this project. It should be noted that the perceived ease of use of a tool – or usability – impacts the perceived usefulness of the tool (Davis et al., 1989). Studies indicate that digital practices conducted with Twitter enhance project methodologies, learner creation, and the valuing of student activities (Delesalle & Marquié, 2015).

Finally, we note that the teachers, following our accompaniment throughout the project and after having taken part in it, would like to integrate digital technology into their teaching practices. We also note that they have progressed in their sense of competence, both technical and pedagogical, and that this is one of the explanatory factors of a low use of digital technology by teachers (Tsai and Chai, 2012; Villeneuve et al., 2012). We hypothesize that our techno-pedagogical support positively influenced our teachers' sense of competence.

REFERENCES

Amadieu, F., & Tricot, A. (2014). *Apprendre avec le numérique. Mythes et réalités.* Paris: Retz

Bennett, S., Maton, K., & Kervin, L. (2008). The «*digital natives*» debate: A critical review of the evidence. *British journal of educational technology*, *39*(5), 775–786. **DOI: https://doi.org/10.1111/j.1467-8535.2007.00793.x**

Blandin, B. (2002). Les mondes sociaux de la formation. *Éducation permanente*, *3* (152), 199–211.

Bullock, D. (2004). Moving from theory to practice: An examination of the factors that preservice teachers encounter as they attempt to gain experience teaching with technology during field placement experiences. *Journal of Technology and Teacher Education*, *12*(2), 211–237.

Cardon, D. (2011). *Internet et réseaux sociaux*. Paris: La documentation Française.

Carretero, S., Vuorikari, R., & Punie, Y. (2017). *DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use*. Luxembourg: Publications Office of the European Union. **DOI: https://doi.org/10.2760/38842**

Chaptal, A. (2011). Un retard français ?. *Administration et Education*, *129*, 43–48.

Charlier, B. (2010). Les TIC ont-elles transformé l'enseignement et la formation ?. In B. Charlier & F. Henri (Eds.), *Apprendre avec les technologies* (pp. 145–156). Paris: Presses Universitaires de France.

Cody, N., Coulombe, S., Giroux, P., Gauthier, D., & S. Gaudreault (2016). Pratiques, objets et finalités de collaboration en lien avec l'intégration des tablettes numériques dans une école secondaire. *Canadian Journal of Learning and Technologies*, *42*(3), 1–16. **DOI: https://doi.org/10.21432/T2KK7S**

Collis, B., & Jung, I.S. (2003). Uses of information and communication technologies in teacher education. In P.A. Danaher & A. Umar (Eds.), *Teacher Education Through Open and Distance Learning* (pp. 171–192). London: Routledge Falmer.

Coulombe, S., Cody, N., Gremion, C., Coen, P.F., Giroux, P., & Rebord, N. (2017). 12 commandements contre l'intégration des TIC. 8ème commandement : Tu proposeras un dispositif de formation standardisé afin d'assurer les mêmes apports pour tous. *Educateur*, *11,* 24–25.

Davis, F.D., Bagozzi, R.P., & Warshaw, P.R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management science*, *35*(8), 982–1003. **DOI: https://doi.org/10.1287/mnsc.35.8.982**

De Lièvre, B., Collard, A.S., De Groove, K., Craps, V., Decamps, S., Degeer, M., Deghorain L., Delforge, C., Descamps, S., Dragone, L., Dupont, J.P., Flamme, X., Henry, J., Hernalesteen, A., Marchesani, A., & Massart, X. (2019). *Consortium 8 : Éducation par le numérique – Rapport Final – Année* 3. [Unpublished document].

Delesalle, C., & Marquié, G. (2015). Pratiques numériques en éducation : l'exemple des usages de Twitter en milieu scolaire. *Terminal, 117,* 1–11. **DOI: https://doi.org/10.4000/terminal.1144**

Deschenes, M., & Parent, S. Les applications pédagogiques de Twitter. (Retrieved February 19, 2012, from https://www.profweb.ca/publications/dossiers/les-applications-pedagogiques-de-twitter)

Desgagné, S., & Larouche, H. (2010). Quand la collaboration de recherche sert la légitimation d'un savoir d'expérience. *Recherches en éducation*, *1*, 7–18.

Desgagné, S., Bednarz, N., Poirier, L., & Couture, C. (2001). L'approche collaborative de recherche en éducation :un rapport nouveau à établir entre recherche et formation. *Revue des sciences de l'éducation*, *27*(1), 33–64. **DOI: https://doi.org/10.7202/000305ar**

Dioni, C. (2008). *Métier d'élève, métier d'enseignant à l'ère numérique.* Paris: INRP.

Dohn, N.B. (2009). Web 2.0: Inherent tensions and evident challenges for education. *International Journal of Computer-Supported Collaborative Learning*, *4*(3), 343–363. **DOI: https://doi.org/10.1007/s11412-009-9066-8**

Entraygues, A. (2017, 29 June). Les réseaux sociaux numériques (RSN) pour s'informer: une approche citoyenne. (Retrieved June 29, 2017, from https://www.reseau-canope.fr/agence-des-usages/les-reseaux-sociaux-numeriques-rsn-pour-sinformer-une-approche-citoyenne.html)

Giroux, P., Coulombe, S., Cody, N., & S. Gaudreault (2013). L'utilisation de tablettes numériques dans des classes de troisième secondaire: retombées, difficultés, exigences et besoins de formation émergents. *Revue STICEF*, 20, 205–229. **DOI: https://doi.org/10.3406/stice.2013.1065**

Glaeser, G. (1973). *Pédagogie de l'exercice et du problème – Le livre du Problème.* Paris: CEDIC.

Goktas, Y., Yildirim, S., & Yildirim, Z. (2009). Main barriers and possible enablers of ICTs integration into pre-service teacher education programs. *Educational Technology & Society*, *12*(1), 193–204.

Grassin, J.F. (2015). *Affordances d'un réseau social pour une formation en Français Langue Etrangère: pratiques discursives, modes de participation et présence sociale en ligne.* [Doctoral dissertation, Université Lumière Lyon].

Guichon, N. (2006). *Langues et TICE*. Paris: Ophrys.

Guzman, A., & Nussbaum, M. (2009). Teaching competencies for technology integration in the classroom. *Journal of Computer Assisted Learning*, *25*(5), 453–469. **DOI: https://doi.org/10.1111/j.1365-2729.2009.00322.x**

Houssaye, J. (2015). *Le triangle pédagogique : Les différentes facettes de la pédagogie* (2e édition). Paris: ESF Editeur.

Jung, I. (2005). ICT-pedagogy integration in teacher training: Application cases worldwide. *Educational Technology & Society*, *8*(2), 94–101.

Kumps, A., Dragone, L., Housni, S., De Lièvre, B., & Temperman, G. (2019). Réussir la transition numérique par la recherche collaborative. Analyse de cas d'accompagnement d'enseignants dans leur intégration du numérique en contexte scolaire : Successful digital transition through collaborative research. *frantice.net*, 16, 89–104.

Leclerc-Coulmain, S. (2014). *Twitter : un outil pédagogique dans le cadre scolaire ?* [Doctoral dissertation, École supérieure du professorat et de l'éducation, Lille].

Liu, S.H. (2011). Factors related to pedagogical beliefs of teachers and technology integration. *Computers & Education*, *56*(4), 1012–1022. **DOI: https://doi.org/10.1016/j.compedu.2010.12.001**

Macfarlane, B. (2015). Student performativity in higher education: Converting learning as a private space into a public performance. *Higher Education Research & Development*, *34*(2), 338–350. **DOI: https://doi.org/10.1080/07294360.2014.956697**

Maddux, C.D., Gibson, D., & Dodge, B. (2011). *Research Highlights in Technology and Teacher Education 2010*. Chesapeake, VA: Society for Information Technology and Teacher Education.

Morrissette, J. (2012). Faire cas de sa pratique enseignante dans le cadre d'une approche collaborative. *Travail et apprentissage, 9*, 200–214.

Palfrey, J., & Gasser, U. (2008). *Born digital: Understanding the first generation of digital natives*. New York, NY: Basic Books.

Prensky, M. (2010). *Teaching Digital Natives: Partnering for Real Learning*. London: Sage Publishers.

Redecker, C. (2009). *Review of Learning 2.0 Practices: Study on the Impact of Web 2.0 Innovations on Education and Training in Europe.* Séville: Institute for Prospective Technological Studies.

Redecker, C. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu*. Luxembourg: Publications Office of the European Union. **DOI: https://doi.org/10.2760/159770**

Sanchez, E. (2012). Technologies numériques : Un nouveau référentiel pour l'école. *Les cahiers pédagogiques*: *Apprendre avec le numérique*, 498, 15–16.

Thibert, R. (2012). Pédagogie + numérique = apprentissages 2.0. *Dossier d'actualité Veille et analyses*, 79, 1–21.

Tsai, C.C., & Chai, C.S. (2012). The "third"–order barrier for technology–integration instruction: Implications for teacher education. *Australasian Journal of Educational Technology*, *28*(6), 1057–1060. **DOI: https://doi.org/10.14742/ajet.810**

Uwamariya, A., & Mukamurera, J. (2005). Le concept de développement professionnel en enseignement: concept théorique. *Revue des Sciences de l'éducation*, *31*(1), 133–155. **DOI: https://doi.org/10.7202/012361ar**

Villeneuve, S., Karsenti, T., Raby, C., & Meunier, H. (2012). Les futurs enseignants du Québec sont-ils technocompétents? Une analyse de lacompétence professionnelle à intégrer les TIC. *International Journal of Technologies in Higher Education*, *9*(1–2), 78–99. **DOI: https://doi.org/10.7202/1012904ar**

Wang, Q. (2009). Designing a web-based constructivist learning environment. *Interactive Learning Environments*, *17*(1), 1–13. **DOI: https://doi.org/10.1080/10494820701424577**