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European Journal of Psychology of Education
A Journal of Education and Development

ISSN 0256-2928

Eur J Psychol Educ
DOI 10.1007/s10212-020-00499-w

Springer

European Journal of Psychology of Education
https://doi.org/10.1007/s10212-020-00499-w

Does the treatment integrity of a literacy instruction program foster student reading comprehension? A field experiment

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Received: 18 November 2019 / Revised: 10 August 2020 / Accepted: 17 August 2020
Published online: 01 September 2020

Abstract
This study focuses on conditions that improve reading comprehension at grade 7th. We analyze the impact of the *Lirécrire* program, and related treatment integrity, on student performance. *Lirécrire* program should improve students' reading comprehension, and follow-up sessions should lead to greater instructional change, then improve learning. Nineteen schools were randomly assigned to one of two experimental conditions (with or without follow-up for teachers) or to the "control" group. Reading comprehension was measured pre- and posttest and treatment integrity through intensity and conformity. Students benefiting from the program outperformed students in the "control" group, with an additional effect of intensity.

Keywords Program effectiveness · Implementation · Reading comprehension · Teaching practices · Treatment integrity

Introduction

Reading comprehension is a complex cognitive activity (Bianco et al. 2014) within which students can encounter many difficulties. These difficulties—and their impact on education and employment—are regularly highlighted by international studies such as PISA (OECD 2010). One way to reduce students' reading difficulties would be to improve teaching practices (Gersten et al. 2001; Vaughn et al. 2015). Several scholars (e.g., Gersten et al. 2001; Rupley et al. 2009; Spörer et al. 2009) have suggested that the explicit teaching of reading strategies

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10212-020-00499-w) contains supplementary material, which is available to authorized users.

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offers a promising way to improve students' reading comprehension. However, this requires teachers to move from the standard content-based approach, centered on a mental representation of what the text says, to a strategy-based approach that directly targets the mental processes involved in reading (Andreassen and Braten 2011). However, there are very few tools available to set up such activities, especially for expository texts (Cartier et al. 2012; Bonnéry 2015). Consequently, teachers often remain uncertain as to how to teach reading comprehension (Andreassen and Braten 2011).

Research has demonstrated the complexity of instructional change, especially with respect to pedagogical issues (Janosz et al. 2011; Dupriez 2015). Although many reforms have failed to improve teaching practices (Hopkins and Levin 2000; Haruthaithanasan 2017), comparative research on Comprehensive School Reforms (CSR) in the USA has shown that successful CSR, which has positive effects on instructional improvement, provide evidence-based programs based on a structured approach (Rowan and Miller 2007). A collaborative approach—through follow-up sessions (Stormont et al. 2015)—appeared to have similarly positive effects (Quinn and Kim 2017).

However, these approaches do not guarantee the reliable use of teaching practices. Indeed, converging evidence highlights the importance of treatment integrity in understanding change processes (Goulet 2016; Ransford 2007; Resnicow et al. 1998). Assessing treatment integrity facilitates a description of what has really been implemented by teachers compared with what was initially planned and how it was implemented. As such, measuring treatment integrity elucidates the effectiveness of specific instructional practices.

This study therefore tests the effects of a literacy instruction program—centered on reading comprehension strategies—and how treatment integrity affects its efficacy in developing students' reading competencies. A field experiment was conducted which comprised both instructional conditions (instructional program vs. control) and implementation conditions (individual training vs. collaborative implementation).

Theoretical framework

Reading comprehension

Reading comprehension—which can be foundational for school learning (Diakidoy et al. 2016)—is a complex and global process involving cultural, social, cognitive, and technical skills. Following Giasson (2012), Cèbe and Goigoux (2007, 2009), and De Croix and Ledur (2016), reading a text can be defined as the (co)construction of meaning by a reader in a particular context. Reading is a cyclical process where new information enables the reader to gradually reorganize the meaning they are constructing (Cèbe and Goigoux 2007). This is the product of an interaction between the text, the reader, and the context (Bianco 2015).

Unfortunately, PISA data (2015, 2018) show that in many countries, a substantial number of 15-year-old students do not reach level 2 in reading (on a scale of 1 to 6) (Lafontaine et al. 2019), which is the minimum level that needs to be reached to read daily messages. Students with lower scores encounter immense difficulties in locating and reproducing explicit information from a single text (Pfost et al. 2014). These difficulties increase when they are confronted with a selection of multiple texts (Bautier et al. 2012; Pérez et al. 2018).

Low performing readers also experience trouble reformulating the main ideas of a text, particularly when the information is spread throughout the text and connections need to be

made (Fayol et al. 2007; Nonnon 2007; De Croix & Ledur 2016). Moreover, they are less likely to use linguistic indices that could help them construct the overall meaning of the text (Gersten et al. 2001; Cain 2009). Poor readers also have difficulty in making the inferences needed to integrate information from several parts of a text (Hall 2015) and in linking information from the text with their personal knowledge (Cain and Oakhill 2006). They also find it challenging to identify effective reading strategies and to monitor their reading activity.

Nevertheless, research on reading and teaching practices has provided evidence to show that it is possible to help students overcome these difficulties. Indeed, the explicit and planned teaching of reading practices and reading strategies can improve the appropriation of language codes and therefore reading comprehension (Marin et al. 2007; Rupley et al. 2009; Spörer et al. 2009; Slavin et al. 2010). Furthermore, studies have shown that embodying these practices in efficient tools enables teachers to help students become more effective readers; for instance, by helping them to reach a higher level of understanding, to extract complex meaning from a text, and to self-regulate their cognitive activity (Bautier and Rayou 2009; Rochex and Crinon 2011).

Instructional improvement

Strategies for change

Although research provides evidence for the effect of instruction quality on student reading comprehension (Andreassen and Braten 2011; Gersten et al. 2001; Vaughn et al. 2015), the pathways to instructional change remain unclear (Andreassen and Braten 2011; Sleeter 2014; Yoon et al. 2007). In the USA, the CSR movement offers relevant opportunities to examine the issue of instructional improvement (Rowan et al. 2004). CSR adopts a whole-school approach aimed at implementing evidence-based practices; it pays particular attention to treatment integrity to avoid the gradual shift of reform objectives. Therefore, studies on the adoption of these reform models can provide a deeper understanding of the steps required to achieve effective instructional change.

Comparing several CSRs, the Consortium for Policy Research in Education found that instructional change was promoted better using a programmed approach—which promotes conformity to a set of well-defined evidence-based practices—rather than by an adaptive approach—which encourages pedagogical innovations in line with school background and staff goals but without clear guidelines regarding instruction (Rowan and Miller 2007). More precisely, the adaptive approach encourages teachers to discover and experiment with new pedagogical practices by giving them sufficient autonomy and discretion to adapt and transform these practices according to their classrooms.

Other quasi-experimental studies (Bianco and Bressoux 2009; Rowan et al. 2009) have identified an advantage of incentives for change based on specific tools (e.g., guidelines for teachers, manuals for students) that support teachers and guide their activities. Importantly, changing educational practices also seems to require, within institutions, a convergent set of elements facilitating the development of new teaching practices. In particular, Desimone (2002) emphasized the importance of providing complete training (involving a whole-school approach, facilitators, extensive and frequent training days, specific material, and specific examples of instructional practices) from a professional development perspective to support the implementation of new practices.

Treatment integrity as a key process

Providing a well-designed program does not guarantee its reliable use by teachers nor does it guarantee benefits for students (Vermeir et al. 2017). Treatment integrity therefore needs to be measured to assess the effectiveness of practices and determine whether the (absence of) observed effects are due to the program or to other sets of variables (Fixsen et al. 2005; Jacob et al. 2019).

However, there is no commonly accepted definition and measure of treatment integrity (Quinn and Kim 2017), which is also called implementation. In this study, we employed the following definition: treatment integrity is what a program becomes when it is used in a specific context (Durlak and DuPré 2008). A distinction is often made between two components of treatment integrity: (1) intensity, which mainly refers to the number of activities performed (Fortin 2012; Payne et al. 2006; Resnicow et al. 1998); and (2) conformity, which is linked to the quality with which implementers deliver the activities proposed in the program (Dusenbury et al. 2003). To satisfy the conformity requirements, teachers had to deliver activities by respecting the core theoretical principles and goals underlying the program (Dumas et al. 2001).

Optimal implementation—and resulting program effectiveness—relies simultaneously on intensity and conformity (Dusenbury et al. 2003; Durlak and DuPré 2008). Numerous studies have identified a positive link between treatment integrity and outcomes (Durlak and DuPré 2008; Nunnery et al. 2006; Topping et al. 2007). For example, Stevens et al. (2001) found a positive correlation between conformity with the implementation of an antibullying prevention program and a reduction in observed bullying behavior. Another study on social behavior and youth development found that program exposure (i.e., intensity) enhances program outcomes (Gerstenblith et al. 2005). A study on the relation between the quality of implementation of a computer-based approach and student outcomes in math found that higher conformity is related to higher student outcomes at posttest (Crawford et al. 2012). However, because intensity and conformity have not been systematically studied together, their specific contribution remains unclear.

To conclude, assessing treatment integrity makes it possible to describe what has really been implemented compared with what was initially planned by program designers (Goulet 2016). It therefore provides a better understanding of the effectiveness of an intervention (Durlak and DuPré 2008). Indeed, without measuring the level of conformity in the implementation of an intervention, or even its intensity, possible conclusions are relatively limited. If the results are significant, researchers cannot conclude whether this is related to the quality of the intervention itself or to a series of unknown variables. Conversely, if the results are not significant, it is impossible to know whether this is due to a lack of program effectiveness or to a problem of internal or external validity (Dumas et al. 2001; Jacob et al. 2019).

Sharing practices to improve treatment integrity

Several scholars have argued that instructional change needs to involve collaboration between teachers if it is to have a chance of substantially changing these practices (Borko et al. 2010; Kallery 2018) and improve treatment integrity (Durlak and DuPré 2008; Ford and Youngs 2018). Teachers themselves report that collaborating with colleagues creates a powerful learning environment (Lohman 2005). However, the literature shows that the organizational configuration of schools hinders collaboration

between teachers (Dumay 2009). Indeed, the cellular structure of education systems—which divides teachers by year and by class—favors their isolation (Weick 1976; Dupriez 2015). Furthermore, collaboration is not a process that emerges naturally (Hargreaves and Fullan 2012; Vangrieken et al. 2015).

Follow-up sessions facilitated by an expert could help to overcome these limitations (Savoie-Zajc 2010). This person should foster reflective dialogs between teachers on core values and instructional practices (Horn and Little 2010; Savoie-Zajc 2010). Indeed, sharing practices allows teachers to create learning opportunities that could lead to instructional improvement (Horn and Little 2010; Meirink et al. 2010; Horn et al. 2016). These opportunities allow teachers to acquire a deeper understanding of the program implemented and how its core elements interact with the local context. This could help teachers to integrate new techniques into their own classroom practice more successfully.

More generally, follow-up aims to enhance teacher motivation and engagement, improve their skills regarding the practices implemented, and solve—with teachers—local problems of implementation (Durlak and DuPré 2008). Hepburn and Beamish (2019) add that brief and explicit follow-up which provides feedback to teachers and guides goal setting improves implementation. For instance, Stormont et al. (2015) found that follow-up increased the use of new practices in 86% of the studies they reviewed. Follow-up therefore seems a useful way to foster treatment integrity.

The current study

The purpose of this study is to assess the effect of a literacy instruction program on reading comprehension with respect to the conditions of implementation. Based on the evidence reviewed in the previous section, we hypothesized that students participating in a literacy instruction program would make greater progress than other students (Hypothesis 1: *no program vs. program*). We also hypothesized that students whose teachers received support through follow-up intervention sessions during the school year would outperform students whose teachers were only trained to use new practices (Hypothesis 2: *training vs. training+follow-up*). Finally, we hypothesized that students whose teachers implemented the program with a higher level of treatment integrity (intensity and conformity) would outperform students whose teachers have implemented the program to a lesser degree (Hypothesis 3: *implementation effect*).

Methods

Design

The*Lirécrire* Project

Data stem from an experimental study—named *Lirécrire pour apprendre* [Read&Write to Learn]—that manipulates both instructional practices and implementation conditions. This literacy intervention aimed to improve students' reading skills in French during the transition from primary school to high school. It took place in the French-speaking part of Belgium.

The *Lirécrire* program[1] was based on a twofold analysis: (1) the subject to be taught—the reading of expository texts in secondary school—and (2) the difficulties frequently encountered by students when confronted with these materials (Penneman 2018).

The program embodied three core elements, all of which are supported by research evidence: (1) the explicit teaching of reading strategies (Graham and Hebert 2011; Lovett et al. 2008; Snow 2002; Spörer et al. 2009); (2) the development of metacognition to help students regulate their own activity (Bucheton 2014; Cèbe et al. 2012; Muijselaar et al. 2017); and (3) fostering collaboration among students by encouraging exchange and open interaction (Baye et al. 2016; Graham and Hebert 2011; Pérez et al. 2018).

The three core elements have previously been applied in a reading program composed of three volumes (for details, see De Croix et al. 2017). The first volume was a detailed methodological guide for Language Arts teachers[2] that specified precise guidelines for each activity. The other two volumes were for students: one contained activities and exercises on reading and writing while the other was a textbook with different kinds of expository texts. The program lasted approximately fifty class hours. Five hours per week was devoted to the Language Arts course in the schedule of 7th graders. Teachers were free to decide how many hours per week were allocated to the implementation of the program on the proviso that they complete all the activities before the end of the school year.

Activities were structured around five modules, each of which had specific objectives that were designed to foster the reading comprehension of expository texts. Table 1 presents each module, its main objective, an example of an activity, the number of activities proposed to students, and the average duration.

Each module was structured in workshops, which in turn consisted of learning activities. One or two integration tasks at the end of the module allowed students to reinvest—on new documents and partially new contexts—all the activities carried out and trained during the module. This enabled students to consolidate their learning.

Participants

Following preliminary contact with the Ministry of Education and the approval of an ethics committee, comprehensive schools within a radius of 50 km around our university were contacted to attend a presentation of the project. Thirty principals voluntarily attended the presentation. Eleven school principals were not interested in the project. Subsequently, the research team went to the 19 remaining schools to present the project to teachers. In each school, a secret vote of the Language Arts teachers was held regarding their agreement to participate in the study. A 60% level of acceptance had to be obtained. The agreement rate turned out to be over 90% in each school. A procedure of passive consent was employed with the parents. They received a letter informing them of the research project and were asked to return this if they did not want their child to participate. Students provided active consent to participate.

[1] A detailed description of the reading activity, the program, and the operationalization of the core elements is available online: (Electronic supplementary material).

[2] Language art teachers—also known as French teachers—denote teachers working to deepen students' understanding of the French language through reading, writing, and speaking.

Table 1 Description of the main objective of each module of the program

Module	Main objectives	Example of an activity	Activities	Time (min)		
				Min	Max	Mean
Module 1	Getting acquainted with expository texts and their uses	Sort texts according to their communicative intent	14	20	50	39.58
Module 2	Selecting information in 1 or more texts simultaneously and linking them	Find out from which text given information is derived and specify whether it is explicitly or implicitly mentioned in the text.	11	25	120	49
Module 3	Rephrasing, summarizing a text, and discussing it	Create a mind map for a text	21	25	100	43.75
Module 4	Organizing information from a double page in a manual	Select relevant information according to communicative intent	11	25	75	38.5
Module 5	Answering questions and justifying answers	Analyze questions to discover the different response formats	14	20	100	44.23

Overall, 1867 students in grade 7 (from 12 to 14 years old) and 85 Language Arts teachers participated in this study. The average number of classrooms engaged per school was 4.53 (min = 1; max = 10) and the average number of students enrolled per school was 133.01 (min = 14; max = 224). The average class size was 22.4 (min = 12; max = 26).

Schools were randomly assigned to one of the following conditions (Table 2): (1) a group without the literacy instruction program; (2) a group—experimental condition 1—trained in the use of the literacy instruction program; and (3) a group—experimental condition 2—trained and coached through follow-up intervention sessions.

Of the 1867 students included in the original dataset, some left the school during the school year (n = 26) or arrived after the first round of data collection (n = 17); others were absent for the pretest (n = 21) or the posttest (n = 67). These students (n = 131) were excluded from the analyses. Students (n = 121) with one or more missing values on variables included in the final analytical model were also excluded. The final analysis presented in this paper is therefore based on data from 1615 students (86.5% of the original sample). The missing data therefore represents less than 15% of the sample, which is common in educational studies (Enders 2003). Analysis of missing data revealed that dropout was not related to any covariates except for encouragement to read received at home (t (1817) = 1.428; p = .153) and grade retention (χ^2 (1) = 19.654; $p < .001$). Students in the final sample may therefore be more likely to be encouraged to read at home and less likely to repeat a grade than other students in the population. These issues will be discussed in the final part of this paper.

Table 2 Random assignment of schools to experimental conditions

Control group	Training group (exp. condition 1)	Training + follow-up group (exp. condition 2)
7 schools	6 schools	6 schools
36 classes	24 classes	25 classes
804 students	502 students	561 students

Control group The *control group* did not receive any specific intervention. This group was utilized to compare the efficacy of teaching practices promoted in the program to standard teaching practices.

Training group In this experimental condition, teachers were invited to two training sessions where they received the instructional material and were asked to implement it in their classes. Teachers were brought together to follow the training. The entire training session took 10 h, during which teachers familiarized themselves with the program, its use, and its core elements. The training was structured around three key elements: recurring difficulties of students in reading comprehension, foundations of the instructional program, and experiencing representative activities.

Training + follow-up group In this experimental condition, teachers attended the same training sessions as the Training Group and participated in three follow-up sessions (3 h each) during the intervention. Sessions were organized every month on each school site. These follow-up intervention sessions aimed to support teachers in the implementation process. Follow-up sessions were delivered by program designers and each session was structured in three parts (Charlier and Biémar 2012). The first was a discussion during which teachers explained how they had used the instructional program in the weeks preceding the session. The second part focused on a discussion of the difficulties and progress/successes the teachers and students had encountered. Importantly, this second part was centered around samples of students' work, making it possible to build descriptions of the problem that were sharable (Borko 2004; Horn and Little 2010). The program designers provided feedback to the teachers and—if needed—practices to overcome their difficulties. In the third part of the session, the teachers were invited to plan the activities they were going to implement until the next follow-up intervention session.

Measures

Reading comprehension

Students' reading comprehension was assessed using a research-developed test adapted from the mandatory tests employed by the Ministry of Education. The pretest was administered in October and the posttest in June. To prevent students from relying on knowledge acquired during the pretest, the posttest included texts with similar levels of difficulty but on different themes. The questions and test structure were similar.

The test was composed of 41 items in the format of multiple-choice questions or short answer questions. Each item was coded "success" (1) or "missed" (0). In the following step, we examined item discrimination using R (version 3.2.5). Items that raised statistical concerns were deleted to build pre- and posttest scores. Of the 41 items, 29 were retained at the pretest and 35 at the posttest. Table 3 presents an overview of the reading comprehension items that were correctly answered in both the pre- and posttest.

A multilevel 2PL IRT model (two levels: students within classes)—which allowed the estimation of a performance score for each student at each wave—was estimated using Mplus (version 6.1) (Muthèn and Muthèn 2009). Performance scores were standardized and pretest performances correlated strongly with posttest performances ($r = .64$; $p < .001$).

Table 3 Reading comprehension items correctly answered in pre- and posttests

	Pretest (29 items)	Posttest (35 items)
Minimum	0	6
Maximum	28	35
Mean	14.69	23.25
SD	4.97	5.56

Treatment integrity

Treatment integrity was assessed through the level of implementation reached by each teacher in experimental conditions with respect to two dimensions: intensity and conformity (Durlak and DuPré 2008; Fortin 2012).

Teachers reported the activities performed in their class on a checklist completed after each classroom session. The response rate was 95.92%. Based on this data, we computed the proportion of realized activities in relation to the planned activities suggested by the methodological guide to create an intensity indicator (Payne et al. 2006). Table 4 shows the intensity per condition.

Conformity was assessed by students and teachers close to the end of the intervention. In the students' version, a 5-point Likert scale (from *never* to *very often*) was used. In the teachers' version, a 7-point Likert scale (from *never* to *always*) was used, as we expected teachers to be more nuanced in their assessment than students. The 17 items comprising this scale measured practices reflecting the three core elements of the program. Table 5 presents several sample items used with respect to the core elements. The response rate for the teachers' scale was 95.5% while the response rate for the students' scale was 97.9%.

We ran factorial analyses to summarize students' perceptions of conformity and teachers' reported conformity. The students' results indicated that a single factor—*conformity perceived by students*—explained 71.03% of the variance (Cronbach's alpha = .88). Teachers' results also indicated that a single factor—*conformity reported by teachers*—explained 70.33% of the variance. Factor analysis scores were used in subsequent analyses (Cronbach's alpha = .81). There was no significant correlation between conformity perceived by students and conformity reported by teachers (r = .16; p = ns). This result is in line with Kunter and Baumert's (2006) findings. The lack of correlation indicates that students and teachers interpret situations from two different perspectives.

Covariates

A set of covariates—selected based on the literature—were measured to control for initial potential differences between conditions. This provided a better understanding of the effects observed by reducing unexplained variance in the outcome and increasing the power and

Table 4 Intensity per experimental condition

	Minimum (%)	Maximum (%)	Mean (%)	SD (%)
Training group	23.94	80.28	53.94	16.27
Training + follow-up group	5.63	84.51	53.1	22.58
Total	5.63	84.51	53.5	19.85

Table 5 Examples of items used to assess conformity to core elements from student (S) and teacher (T) questionnaires

Core elements	Sample items
Explicit teaching of reading strategies	• (S) Our teacher proposed tasks to train some specific reading strategies. • (T) I proposed tasks to train some specific reading strategies.
Development of metacognition to help students to regulate their own learning activities	• (S) Our teacher took time to discuss our difficulties and the procedures to be put in place to overcome them. • (T) I took time to discuss with students their difficulties and the procedures to be put in place to overcome them.
Inciting collaboration among students by encouraging exchange and open interaction	• (S) Our teacher made us discuss our answers with the other students. • (T) I made sure that my students discussed their answers with others (subgroups or collectively).

accuracy of estimated treatment effects (Borman et al. 2005). Furthermore, in studies of academic performance, pretests and demographic factors continue to be powerful predictors of posttest outcomes (Slavin 2008). Appendix A provides an overview of correlations between the covariates retained (initial performances, encouragement to read, reading resources, and grade retention), implementation variables, and the final performances of students.

Previous research also indicated that parental support (i.e., encouragement to read) (Sénéchal and LeFevre 2002) and the home literacy environment (i.e., reading resources at home) (Burgess et al. 2002; Van Steensel 2006) affect reading comprehension at school. The encouragement to read at home was assessed by five items adapted from the parental involvement scale of Sénéchal and LeFevre (2002). Items were answered on a 5-point Likert scale (from *never* to *very often*) and the Cronbach's alpha coefficient was .73. Reading resources available at home (Sénéchal and LeFevre 2002; OECD 2012) was also a 5-point Likert scale (from *zero* to *more than 100*) and consisted of four items. The items on this scale were based on the type of resources students could access at home such as books or comics. The Cronbach's alpha coefficient for this scale was .72.

Grade retention was also retained as a covariate. Indeed, several studies have shown that holding back a grade could have a negative effect on performances (Griffith et al. 2010; Lamote et al. 2014). Students were asked if they had already repeated a grade (*yes* or *no*), to which a positive answer was provided by 19.5% of participants.

Data analysis

Prior to analyzing the effect of the program and of the experimental conditions, a multilevel analysis was conducted to check possible differences between the three conditions at pretest. The results showed there were no significant differences between the three conditions (b = .009; p = .315). However, initial performances were introduced in subsequent analyses to be controlled so that they would not interfere with the effect of the intervention (Dancey and Reidy 2013).

To test the effect of experimental conditions, two contrast variables were computed. The first contrast tested the opposition between the control group and the two experimental conditions (control = − 1; exp1 = 0.5; exp2 = 0.5). The second contrast tested the opposition between the two experimental conditions (control = 0; exp1 = − 1; exp2 = 1). The created

contrasts were orthogonal so that they could be introduced in the analyses at the same time (Judd et al. 2010). The contrasts were introduced at class-level.

To test our hypotheses, multilevel models were employed that took the nested data structure into account (students grouped in class). To facilitate interpretation of the results, all quantitative variables introduced in the models were standardized (except for grade retention, which is dichotomic, and intensity, which is a percentage). Table 6 presents descriptive statistics for the variables included in the analyses. Finally, effect sizes (Cohen's *d*) used in following sections are based on standardized mean differences of groups, based on data reported in Table 6.

All the analyses were performed using the SPSS 25 mixed model function. However, because some schools had fewer than five classes—which is the number of units per group recommended (Arrègle 2003; Hair Jr et al. 2010)—a three-level model may have provided incorrect estimations. Thus, to avoid a methodological bias, school level was not included in the analyses.

Results

Lirécrire Program and experimental design effects

The Null Model (model 0 in Table 7) provided variance estimations (random effects) at the student level (level 1) and at the classroom level (level 2). The results indicated that 82.1% of the total variance in reading comprehension of expository texts at T2 was linked to within-class differences and that 18.6% was associated with between-class differences.

In model 1, covariates were included at student level. These led to a reduction of more than a third (38%) in variance at the student level and an even more substantial reduction in variance at the class-level (78%). Fixed effects showed that T1 reading comprehension (γ_{10} = .54; $p < .001$), resources for reading available at home (γ_{20} = .11; $p < .001$), and familial encouragement to read (γ_{30} = .06; $p < .001$) had positive effects on T2 reading comprehension. By contrast, grade retention (γ_{40} = −.31; $p < .001$) had negative effects.

Table 6 Descriptive statistics

	Minimum	Maximum	Mean	SD
Control group				
Final performance	− 2.78	2.64	− .09	1.01
Initial performance	− 2.57	2.62	− .01	.99
Resources for reading	− 1.96	2.54	− .04	.94
Encouragement to read	− 2.31	1.84	− .07	.99
Grade retention (yes/no)	.00	1.00	.20	.40
Experimental groups				
Final performance	− 2.96	2.64	.10	.98
Initial performance	− 3.25	2.64	.02	1.00
Resources for reading	− 1.96	9.84	.03	1.04
Encouragement to read	− 2.31	1.84	.10	.99
Grade retention (yes/no)	.00	1.00	.16	.37
Intensity	5.63	84.51	54.56	20.01
Conformity reported	− 1.85	2.30	− .03	.95
Conformity perceived	− 1.91	1.99	.47	.91

Table 7 Multilevel analysis for reading comprehension

	Null model (model 0)		Covariates (model 1)		Exp. groups (model 2)	
	b (SE)	*p*	*b* (SE)	*p*	*b* (SE)	*p*
Fixed effects (level 1)						
Intercept (γ_{00})	− .02 (.05)	.650	.05 (.03)	.059	.07 (.03)	.016
Initial performance (γ_{10})			.54 (.02)	< .001	.54 (.02)	< .001
Resources for reading (γ_{20})			.11 (.02)	.001	.11 (.02)	.001
Encouragement to read (γ_{30})			.06 (.02)	< .001	.06 (.02)	< .001
Grade retention (yes/no) (γ_{40})			− .31 (.05)	< .001	− .31 (.05)	< .001
Fixed effects (level 2)						
No program vs. program (C1) (γ_{01})					.10 (.03)	.007
Training vs. Training + follow-up (C2) (γ_{02})					− .06 (.03)	.101
>Random effects						
Level 1 (ε_{ij})	.821 (.03)	< .001	.506 (.02)	< .001	.506 (.02)	< .001
Level 2 (μ_{0j})	.183 (.03)	< .001	.037 (.01)	< .001	.030 (.01)	.001
df change	.		4		2	
χ^2 change	.		978.05	.001	9.72	.010

Note: *b* coefficients are standardized

In model 2, the two contrasts were added to test hypotheses 1 and 2. These reduced the unexplained variance at class-level as this model now explained 83.3% of the variance (5.3% more than model 1). Contrast 1 (*no program vs. program*) showed a positive effect (γ_{01} = .10; p = .007) of the program on reading comprehension with a small effect size (d = .20), thus supporting the first hypothesis. The second hypothesis was, however, not confirmed as results indicated no difference between experimental conditions 1 (*training group*) and 2 (*training + follow-up group*) (γ_{02} = −.06; p = .101) with a small effect size (d = .32).

Implementation effect

To test hypothesis 3 for the two experimental groups, subsequent analyses (Table 8) evaluated the implementation effect for both intensity and conformity. For this reason, the null and covariate models were repeated for these two groups without the control group.

The Null Model (model 0 in Table 8) indicated that 80.5% of the total variance in student achievement was linked to inter-individual differences while 19.5% was associated with between-class differences. In model 1, covariates at student level were included and led to a reduction in variance at the student-level of more than a third (39%) and an even more substantial reduction at the class-level (75%). Fixed effects showed that T1 reading comprehension (γ_{10} = .53; p < .001) and resources for reading available at home (γ_{20} = .15; p < .001) had positive effects on T2 reading comprehension. By contrast, grade retention (γ_{40} = −.34; p < .001) had a negative effect. Encouragement to read was no longer related to reading comprehension (γ_{30} = .05; p = .07).

Regarding implementation, model 2a showed there was a positive effect of intensity (γ_{01} = .09; p = .012) on T2 reading comprehension. Model 2b indicates that conformity—both reported (γ_{02} = −.01; p = .812) and perceived (γ_{03} = .00; p = .961)—was not associated with T2 reading comprehension. These findings provide partial support for the third hypothesis. Students whose teachers reached a higher level of intensity exhibited higher reading performances than students whose

Table 8 Multilevel analysis for reading comprehension

	Null model (model 0)		Covariates (model 1)		Intensity (model 2a)		Conformity (model 2b)	
	b (SE)	*p*	*b* (SE)	*p*	*b* (SE)	*p*	*b* (SE)	*p*
Fixed effects (level 1)								
Intercept (γ_{00})	− .03 (.07)	.640	.05 (.04)	.175	.05 (.04)	.153	.06 (.04)	.010
Initial performance (γ_{10})			.53 (.03)	< .001	.53 (.03)	< .001	.54 (.03)	< .001
Resources for reading (γ_{20})			.15 (.03)	< .001	.15 (.03)	< .001	.13 (.03)	< .001
Encouragement to read (γ_{30})			.05 (.03)	.072	.05 (.03)	.074	.06 (.03)	.016
Repeated grade (yes/no) (γ_{40})			− .34 (.07)	< .001	− .34 (.07)	< .001	− .35 (.07)	< .001
Fixed effects (level 2)								
Intensity (γ_{01})					.09 (.04)	.012	.09 (.04)	.019
Conformity reported (γ_{02})							− .01 (.04)	.812
Conformity perceived (γ_{03})							.00 (.04)	.961
Random effects								
Level 1 (ε_{ij})	.812 (.04)	< .001	.502 (.02)	< .001	.502 (.02)	< .001	.502 (.02)	< .001
Level 2 (μ_{0j})	.197 (.05)	< .001	.045 (.01)	.002	.037 (.01)	.006	.035 (.01)	.006
df change	.		4		1		2	
χ^2 change	.		549.33	.001	6.59	.020	145.84	.001

Note: *b* coefficients are standardized

teachers undertook fewer activities, regardless of the level of conformity. Introducing intensity in model 2a led to a further 6.21% reduction in variance at level 2 compared with model 1.

Discussion

The main goals of this study were (a) to test the effect of a literacy instruction program based on the explicit teaching of reading strategies, metacognition, and peer collaboration and (b) to investigate the conditions of its implementation—with particular attention paid to the role of follow-up.

Results show a positive impact of the program on students' reading performance, supporting the idea that explicitly teaching reading strategies—in combination with developing metacognition and stimulating collaboration among students—could be a promising way to foster reading comprehension among students. Indeed, students who benefit from *Lirécrire* outperform other students in reading comprehension. This result is in line with that of Sailors and Price (2015), highlighting the importance of explicit instructions in improving reading achievement. Future research could therefore focus more specifically on the explicit teaching of reading strategies as a teaching process and to understand how it affects learning.

The effect size of *Lirécrire* at the end of the first year of implementation may be considered statistically small (Hattie 2009). However, it is consistent with the results of similar successful studies in reading (Baye et al. 2016; Borman et al. 2005; Vaughn et al. 2015). Slavin's (2008)

review showed that the mean effect size (Cohen's *d*) of instructional interventions for language arts—in secondary schools with 250 students or more—is .18. Moreover, our results are based on data collected at the end of the first year of the intervention. Another study found that the effects of an evidence-based program only become apparent at the end of the third year of its implementation (Borman et al. 2003). As Pampaka et al. (2016, p. 234) noted: "It takes time for new practices to develop and become effective, and one thus expects minimal effects in the first year of implementation of substantially new practice." Teachers need time to make mistakes, learn from these, and develop new effective practices over time (Kennedy 2016). This could also explain the small effect size of *Lirécrire*. Finally, it is important to keep in mind that the mean effect size is lowered by some teachers implementing less than 60% of the program (Durlak and DuPré 2008; Goulet 2016). Excluding data from these teachers and their classrooms increased the effect size from 0.20 to 0.31 (Cohen's *d*). Taking this into account, *Lirécrire* can have a moderate effect size (Hattie 2009) on students' performances in reading comprehension. Consequently, the effect of *Lirécrire* at the end of the first year of implementation—compared with similar literacy interventions—can be considered promising.

Regarding the effects of the follow-up intervention sessions, students from the *training + follow-up* group did not perform better than students from the *training* group, which is consistent with Troyer's findings (2017) regarding the implementation of an adolescent reading intervention. In this study, follow-up was not associated with the treatment integrity nor with students' outcomes. This lack of effect could be related to the structure of the follow-up intervention sessions we employed. In schools that received this extra support, teachers were followed three times for three hours and reported—in focus groups carried out at the end of the intervention—that they waited for these sessions to meet in order to discuss their practices with the counselor. Teachers stated that they did not really collaborate between follow-up intervention sessions, which seems to indicate that follow-up did not lead to further collaboration. Moreover, the frequency of meetings may have been too low to observe a significant effect on the reading performances of students. For example, schools participating in success for all received eight follow-up days during the school year (Borman et al. 2005). In other studies, the follow-up took the form of a weekly meeting in each school (Fixsen et al. 2005). However, closer scrutiny of the difference between experimental conditions revealed that there could be a meaningful—albeit non-significant ($p = .101$)—effect of follow-up intervention sessions with an effect size of − .32 (Cohen's *d*) compared with the training without a follow-up condition. This surprising negative result merits further investigation (Quinn and Kim 2017). Finally, the adaptation of follow-up intervention sessions to meet the specific needs of teachers according to their context could also be usefully investigated in future research. This would determine the impact of differences in session content on treatment integrity and student learning.

Other results provided partial support for the hypotheses related to treatment integrity. For instance, the intensity of implementation appears to have a significant impact on reading comprehension. Students whose teachers implemented the program with a higher level of intensity attained a higher reading comprehension score than students whose teachers showed lower levels of intensity. However, there was no effect of perceived or reported conformity on students' reading comprehension. From a theoretical point of view, these results highlight the importance of learning opportunities in improving reading comprehension. This suggests that the more a student is exposed to carefully designed reading activities, the more his or her comprehension improves, regardless of how the teacher leads these reading activities. However, the absence of a conformity effect could also be due to the measurement tool being too general and failing to capture the specific instructional practices that make a difference in reading comprehension. Classroom observations may have allowed us to collect more precise

data on implementation conformity (Resnicow et al. 1998). To address these limitations, future investigations are needed to test the relationship between conformity and students' outcomes.

Finally, it is instructive to scrutinize more closely the lack of correlation between students' perception of conformity and the conformity reported by teachers. This lack of correlation is coherent with the literature. As mentioned previously, students and teachers do not interpret learning situations from the same point of view (Kunter and Baumert 2006). Gegenfurtner (2011) assert that self-reported practices are generally overestimated compared with practices reported by a third party. Feldon (2007) also points out that there is a discrepancy between actual classroom practices and what teachers think they do. This discrepancy is notably linked to the difficulty of observing one's own practice while engaging in action. These observations invite future research to reflect on the nature and status of the data they collect according to the questions they aim to answer.

There are some limitations in this research that should be acknowledged. The first is linked to drop-out among students. Missing data analyses revealed that students in the final sample receive more encouragement to read at home and are less likely to repeat a grade than students (n = 252) who drop-out between pre- and posttests. Therefore, additional research would be useful to confirm the validity of our results. A second limitation is related to the test used to assess reading performance. Given the absence of standardized tests with strong psychometric properties in our current educational system, we relied on mandatory tests used by the Ministry of Education. Given that, the test utilized was developed by the program designers and consequently may be suboptimal in terms of assessing students' reading comprehension (Slavin 2008). Consequently, it would be worthwhile replicating the effect of *Lirécrire* with another measure of student achievement.

Future perspectives and practical implications

To conclude, our results appear to support Rowan and Miller's (2007) findings: a structured approach may be effective in improving teaching practices and student achievement. However, the results did not show that including follow-up sessions increased the effectiveness of this approach. Finally, the results also indicated that a certain level of intensity seems to be necessary to impact student learning. These findings have potential implications for education and for research.

Although the results of the present study provide several indicators with regard to instructional change processes and improving learning, they also highlight the complexity of supporting teachers in implementing new practices and raise questions that merit future research. Supporting teachers through follow-up sessions may be a way to improve teaching practices, but it does not appear to be sufficient in itself. Therefore, future research could explore the frequency of follow-up sessions to highlight how often and when these sessions are the most useful. Researchers might also wish to examine the content of follow-up sessions and determine which kind of discussion has the potential to improve teaching practices and what these discussions should be about (Dellisse & Galandin press; Horn and Little 2010; Kennedy 2019; Little 2006).

Furthermore, previous studies draw attention to several factors—such as teacher self-efficacy beliefs or school principal support—that may also influence the implementation process (Durlak and DuPré 2008). Including these factors in analyses may help to elucidate their effect on student outcomes and the effectiveness of implemented practices. We contend that it is important to pursue such investigations to better understand how teachers put innovations and reforms into practice.

Finally, this study also raises questions for practitioners. The present findings showed that the explicit teaching of reading strategies combined with metacognitive questions and peer

collaboration has the potential to improve students' reading comprehension. However, is it the combination of all of these practices or only some of them that are effective? It may be useful in future research to differentiate these teaching practices in order to identify their respective contribution to students' learning (Dunlosky et al. 2013). The results also highlighted the importance of creating sufficient learning opportunities for students to improve their reading comprehension, whatever the conformity to specific program requirements. But does conformity—which refers to the quality with which practices are implemented—really not matter? Understanding the role of conformity should also be investigated in future research.

To conclude, the results of the present study invite scholars to go beyond the question of what works in education and investigate who it works for, through what means, and in what circumstances (Hanley et al. 2016).

Acknowledgments We particularly thank Marielle Wyns (Coordinator) and AlexandraVanguchte, Elena Pazsto, Elisabeth Freymann, Elise Van de Velde, Emilie Van Lierde, Emilie Vermeulen, Julie Verschueren, Manon Rolin, Marylène Willocq, Sophie Brasseur, Céline Heylens, Isabelle Henry, Estelle Bidin, and Lucile Lhoste (Langage Arts students) for their help during data collection and correction sessions.

Funding The current research was supported by grants from the *Fondation Louvain* and the *Fondation de la Recherche Scientifique* FRS-FNRS (F 6/40/5 - FRESH/FC - 12690).

Appendix

Table 9 Correlation matrix

		1	2	3	4	5	6	7	8	9	10
Student level											
Final performance	1	1.00									
Initial performance	2	.64***	1.00								
Resources for reading	3	.36***	.32***	1.00							
Encouragement to read at home	4	.25***	.20***	.39***	1.00						
Grade retention (yes/no)	5	.32***	.27***	.26***	.18***	1.00					
Classroom level											
No program vs. program (C1)	6						1.00				
Training vs. training + follow-up (C2)	7						.01	1.00			
Intensity	8						.	− .03	1.00		
Conformity reported	9						.01	.06	.23	1.00	
Conformity perceived	10						.44***	.08	.31*	.16	1.00

*$p < .05$; **$p < .01$; ***$p < .001$

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Sébastien Dellisse. PhD student in education sciences at UCLouvain.

Current themes of research:

His research interests are program implementation, teaching improvement through professional development, and teaching practices.

Most relevant publications in the field of Psychology of Education:

Penneman, J., De Croix, S., Dellisse, S., Dufays, J.-L., Dumay, X., Durpiez, V., Galand, B., Wyns, M. (2016). « Outils didactiques et changement pédagogique: analyse longitudinale de l'appropriation de l'outil Lirécrire pour apprendre par des enseignants du secondaire », in Revue française de pédagogie, n°197, pp. 79–98.

Xavier Dumay. Professor of education at UC Louvain.

Current themes of research:

His research interest lies in the globalization of education, the regulation of educational systems, labor markets for teachers, and changing forms of education. He has published extensively on issues related to educational policy, educational organizations, and comparative education. His work has appeared a.o. in the American Journal of Education, British Educational research Journal, British Journal of Educational Studies, Comparative Education, Comparative Education Review.

Most relevant publications in the field of Psychology of Education:

Dupriez, V., Dumay, X., & Vause, A. (2008). How do school systems manage pupils' heterogeneity? *Comparative Education Review*, *52* (2), 245–273.

Dumay, X. (2009) Origins and consequences of schools' organizational culture for student achievement. *Educational Administration Quarterly*, *45* (4), 523–555.

Dumay, X., & Dupriez, V. (2008). Does the school composition effect matter? Evidence from Belgian data. *British Journal of Educational Studies*, *56* (4), 440–477.

Dupriez, V, & Dumay, X. (2006). Inequalities in school systems: effect of school structure or of society structure? *Comparative Education*, *42* (02), 243–260.

Benoit Galand. Professor of education at UC Louvain.

Current themes of research:

His current themes of research and research interest are motivation and engagement in learning, violence and bullying at school, and teaching practices.

Most relevant publications in the field of Psychology of Education:

Galand, B., Frenay, M. & Raucent, B. (2012). *Effectiveness of problem-based learning in engineering education: a comparative study on three levels of knowledge structure. International Journal of Engineering Education*, 28 (4), 939–947.

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Vincent Dupriez. Professor of education at the Université catholique de Louvain.

Current themes of research:

His academic work concerns the field of educational policy and school administration. His recent work has focused on the new modes of school governance and their impact on teachers.

Most relevant publications in the field of Psychology of Education:

Cattonar B., Dupriez V. (in press). Recomposition des professionnalités et de la division du travail enseignant en contexte d'accountability réflexive. Le cas des professionnels de l'éducation en Belgique francophone. *Education et Sociétés*.

Gonzalez, A. & Dupriez, V. (2017). Acceso a las universidades selectivas en Chile: ¿pueden las estrategias institucionales de los establecimientos secundarios atenuar el peso del capital cultural?. *Revista Complutense de Educacion*, 28(3), 947–964.

Dupriez, V., Delvaux, B. and Lothaire, S. (2016), Teacher shortage and attrition: why do they leave? *British Educational Research Journal*, 42 (1), 21–39.

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Dupriez, V., Monseur, C., Van Campenhoudt, M. & Lafontaine, D. (2012). Social inequalities of post-secondary educational aspirations: influence of social background, school composition and institutional context. *European Educational Research Journal, 11(4),* 504–519.

Jean-Louis Dufays. Doctor in Philosophy and Literature. After 14 years of combining secondary education and university research, he has been a professor at UCLouvain since 1996, where he teaches literature theory and the didactics of French.

Current themes of research:

His research focuses on reading, stereotyping, the genres of poetry, life storytelling, comedy and song, as well as the analysis of teaching practices and their effects.

Most relevant publications in the field of Psychology of Education:

Dufays, J.-L. (2010). *Stéréotype et lecture. Essai sur la réception littéraire* (2e édition). Berne: Peter Lang.

Dufays, J.-L., Gemenne, L., Ledur, D. (2005). *Pour une lecture littéraire: Histoire, théories, pistes pour la classe*. Louvain-la-Neuve: De Boeck Supérieur. doi:10.3917/dbu.dufay.2005.01.

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Dufays, J.-L., & Plane, S. (2009). *L'écriture de fiction en classe de français*. Namur: Presses Universitaires de Namur.

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Dufays, J.-L, & Servais, P. (2013). *Publier en sciences humaines. Quels enjeux, quelles modalités, quels supports, quelle diffusion*? Louvain-la-Neuve, Academia.

Dufays, J.-L, & Daunay, B. (2014). *Didactique du français: du côté des élèves. Comprendre les discours et les pratiques des apprenants*. Bruxelles: De Boeck.

Dufays, J.-L, Brunel, M., Emery-Bruneau, J., Dezutter, O., & Falardeau, E. (2017). *L'enseignement et l'apprentissage de la lecture aux différents niveaux de la scolarité*. Namur, Presses universitaires de Namur.

Dufays, J.-L, Denizot, N., & Louichon, B. (2019). *Approches didactiques de la littérature*. Namur, Presses universitaires de Namur.

Liesje Coertjens. Professor on Assessment for Learning at the University of Louvain.

Current themes of research:

Her research interests include student learning and (peer-assessment of) performance assessment. More specifically, she investigates the efficiency and reliability of rubrics rating and comparative judgment.

Most relevant publications in the field of Psychology of Education:

Kyndt, Eva, Donche, Vincent, Coertjens, Liesje, van Daal, Tine, Gijbels, David, & Van Petegem, Peter (2018). Does self-efficacy contribute to the development of students' motivation across the transition from secondary to higher education?. *European Journal of Psychology of Education*, *34*(2), 457–478. doi:10.1007/s10212-018-0389-6

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Coertjens, Liesje (2018). The relation between cognitive and metacognitive processing: building bridges between the SRL, MDL, and SAL domains. *British Journal of Educational Psychology*, *88*, 138–151. doi:10.1111/bjep.12214

Grosemans, Ilke, Coertjens, Liesje, & Kyndt, Eva (2018). Work-related learning in the transition from higher education to work: The role of the development of self-efficacy and achievement goals. *British Journal of Educational Psychology*. doi:10.1111/bjep.12258

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van Daal, Tine, Lesterhuis, Marije, Coertjens, Liesje, van de Kamp, Marie-Thérèse, Donche, Vincent, & De Maeyer, Sven (2017). The complexity of assessing student work using comparative judgment: the moderating role of decision accuracy. *Frontiers in Education*, *2*, doi:10.3389/feduc.2017.00044

Coertjens, Liesje, Vanthournout, Gert, Lindblom-Ylänne, Sari, & Postareff, Liisa (2016). Understanding individual differences in approaches to learning across courses: a mixed method approach. *Learning and Individual Differences: Journal of Psychology and Education*, *51*, 69–80. doi:10.1016/j.lindif.2016.07.003

Séverine De Croix. Doctor in Philosophy and Literature.

Current themes of research:

Her research interests and current themes of research are didactics of reading and writing from kindergarten to upper secondary school, in particular addressing learning difficulties and preventing educational inequalities. She has also interest in teacher training and professional development.

Most relevant publications in the field of Psychology of Education:

De Croix, S., Penneman, J, Wyns, M. (2018), Lirécrire pour apprendre. Comprendre les textes informatifs, Louvain-la-Neuve, Presses universitaires de Louvain.

De Croix, S., Penneman, J, Wyns, M. (2017), « Concevoir un outil didactique pour enseigner la lecture des textes informatifs au début du secondaire: élaborer une planification didactique », in Brunel, M., Dezutter, O., Dufays, J.-L., Emery-Bruneau, J., Falardeau, É. (dir.), La progression dans l'enseignement de la lecture, Namur, Presses universitaires de Namur, 217–245.

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De Croix, S., Ledur, D. (2017), « Quelle place accorder aux écritures de la réception dans le contexte de la formation initiale? Du comportement de futurs enseignants face à des médiations de la lecture à l'élaboration de dispositifs de formation », in Le Goff, FR., Fourtanier, M.-J. (dir.), Les formes plurielles des écritures de la réception, Namur, Presses universitaires de Namur, 111–126.

De Croix, S., Ledur, D. (2016), Nouvelles lectures en JEux. Comprendre les difficultés de lecture et accompagner les lecteurs adolescents, Bruxelles, CECAFOC - Fonds social européen.

Penneman, J., De Croix, S., Dellisse, S., Dufays, J.-L., Dumay, X., Durpiez, V., Galand, B., Wyns, M. (2016). « Outils didactiques et changement pédagogique: analyse longitudinale de l'appropriation de l'outil Lirécrire pour apprendre par des enseignants du secondaire », in Revue française de pédagogie, n°197, pp. 79–98.

De Croix, S., Penneman, J. (2016), « Lire un dossier de documents à visée informative et y circuler: un objet enseignable au début du secondaire? », in Recherches en Éducation, n°25, 93–105.

Jessica Penneman. Doctor in Philosophy and Literature.

Current themes of research:

Her research interests and current themes of research are implementation of new teaching practices, teaching improvement, and teacher professional development.

Most relevant publications in the field of Psychology of Education:

Penneman, J., (à paraitre). Entre formation et accompagnement des enseignants: comment la circulation des savoirs didactiques s'effectue-t-elle et avec quels effets sur les compétences des élèves, les pratiques professionnelles des enseignants et les pratiques de formation des chercheurs?*Revue des HEP.*

Penneman, J., De Croix, S., Dellisse, S., Dufays, J.-L., Dumay, X., Dupriez, V., Galand, B. & Wyns, M. (2018). Outils didactiques et changement pédagogique: analyse longitudinale de l'appropriation de l'outil *Lirécrire* par des enseignants du secondaire. *Revue française de pédagogie,* n° 197*,* 79–98.

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