



Two decennia of research on teachers' informal learning: A literature review on definitions and measures

Antoine Lecat^{a,*,1}, Yvonne Spaltman^b, Simon Beusaert^b, Isabel Raemdonck^c,
Eva Kyndt^d

^a Institute for the Analysis of Change in Contemporary and Historical Societies (IACCHOS), Place Cardinal Mercier 10 box L3.05.01, 1348, UCLouvain, Louvain-la-Neuve, Belgium

^b Department of Educational Research and Development, School of Business and Economics, Maastricht University, the Netherlands

^c Institute for the Analysis of Change in Contemporary and Historical Societies (IACCHOS), UCLouvain, Belgium

^d Department of Training and Educational Sciences, University of Antwerp, Belgium and Centre for the New Workforce, Swinburne University of Technology, Melbourne, Australia

1. Introduction

The importance of informal learning (processes) for teachers' professional development is more and more acknowledged (Jacobs & Park, 2009). As the objective of educational institutions around the globe is to sustain in providing high quality and relevant education, they have to ensure that their staff is up-to-date on the latest developments regarding technology and emerging knowledge. Akin to other occupations, teachers are also affected by the continuous and fast-paced developments within the educational field (Kyndt, Gijbels, Grosemans, & Donche, 2016). In the past, the time it took for newly gained knowledge and skills to become obsolete for teachers who had completed initial teacher education would be lengthy, however this is no longer the case (De Grip, 2015; Kyndt et al., 2016). The professional development of teachers, and the way they learn, has seen a growth in the body of literature over the past few years. Schugurensky (2015) explains that informal learning has been made widely popular only since the late 20th century. In the existing literature on informal learning, a multitude of informal learning definitions have been used interchangeably, thereby somewhat overlapping each other (Meijiuni, Cranton & Táiwò, 2015). Scholars differ in their definitional approach with regard to the features (e.g. accidental, spontaneous, implicit, self-directed) and the learning activities (e.g. reflection, trial-and-error, feedback seeking). In addition to the fact that teachers' informal learning features and learning activities differ across papers, approaches can also be different. Some scholars prefer to define teachers' informal learning based on the stimulus (e.g. Eraut, 2000, 2004), while others focus more on the type of activity (e.g. Noe, Tews, & Marand, 2013). Scholars have called for a common and exhaustive definition of informal learning (e.g. Cerasoli et al., 2018; Hoekstra, Brekelmans, Beijgaard & Korthagen, 2009b; Marsick, Volpe, & Watkins, 1999). Callanan, Cervantes, and Loomis (2011) corroborate that the definition of teachers' informal learning is dependent on the authors' interpretation of what it exactly comprises. Thus, as literature is not in unison on the definition of teachers' informal learning, a myriad of partially overlapping definitions is used (Clarke, 2005). Accordingly, a critical look at conceptualizations of informal learning is needed in order to realize an integration of the research on teachers' informal learning, allowing the distillation and unification of several definitions into one coherent understanding of teachers' informal learning. Even though informal learning might be an unconscious process and, therefore, hard to capture and measure, not having a common definition makes measuring informal learning problematic. Not to mention, it adds to the irregularity and, consequently, misalignment in the existing educational literature (e.g. Cerasoli et al., 2018).

Therefore, the purpose of this literature review is to synthesize existing literature and to give an overview of the different

* Corresponding author.

E-mail address: antoine.lecat@uclouvain.be (A. Lecat).

¹ This author is supported by an FSR grant from the UCLouvain.

approaches of teachers' informal learning and streamline this into one unified definition. Research on teachers from all educational levels (primary, secondary and higher education) is included as a broad general definition and measurement will serve as a foundation for further research. In order to develop a teachers' informal learning definition, its features must also be inventoried. Finally, this study adds to the existing literature by bringing alignment to the educational literature with regard to the definition of teachers' informal learning.

Research question 1: How can the informal learning of teachers be defined?

Furthermore, by giving an overview of the ways teachers' informal learning has been measured, a starting point for examining and developing an advice of practice and instruments for measuring informal learning is offered. As a multitude of measurement instruments for teachers' informal learning coexists, a first necessary step is to map the different ways it is measured.

Research question 2: How was informal learning measured in prior research studies?

2. Method

In order to find relevant studies and information (teachers' informal learning definitions, features and instruments), a primary search, a literature selection and analysis were completed through different phases. First, a literature search was performed within scientific databases and irrelevant literature was excluded based on several criteria. Secondly, the selected literature was critically appraised to exclude low quality studies. Thirdly, the selected studies were analyzed following Aveyard's guidelines (2014).

2.1. Literature search

The literature search should be as transparent as possible (Kyndt & Baert, 2013; Pati & Lorusso, 2018). As this review study looks into teachers' informal learning, nine scientific databases from the education field were consulted: PsycINFO, PsycARTICLES, SAGE, ERIC, JSTOR, CAIRN, SpringerLink, Taylor & Francis and Wiley Online Library (through EBSCO and LibSearch). These databases were selected on the premise that they are widely-used and internationally acknowledged. Across all of the databases, the main search term used was “informal learning”. Given the study's focus, this term was combined with either the terms “teach*”, “professor” or “tutor”. The literature search was conducted in July 2018 and resulted in 4029 search hits, presented in Table 1.

2.2. Literature selection

Articles from the literature search were then subject to exclusion criteria. In order to screen and exclude irrelevant articles, the selection process was followed step by step using the below five exclusion criteria.

- (1) Articles published before 2000 were excluded as informal learning only became increasingly popular in the late 20th century (Schugurensky, 2015). From the year 2000 onwards, studies have increasingly focused beyond the boundaries of formal learning (Bell, Tannenbaum, Ford, Noe, & Kraiger, 2017). The total articles that remained to be reviewed decreased to 3652.
- (2) In order to ensure the articles were of a certain quality, studies not published in peer-reviewed journals were excluded. This step reduced the total number of articles to 1858.
- (3) As it was essential to ensure the authors had a good understanding of the literature in order to correctly analyze the studies, papers published in languages other than English were excluded. Furthermore, double records from different databases were also deleted. This brought the total articles to 1467.
- (4) In a next step, the reading of the titles and abstracts, led to a substantial decrease in selected articles, namely 188. This selection had two main reasons: First, articles that focused on formal learning as object of study and only mentioned informal learning in the margin of the study, were deleted. Second, articles that focused on other stakeholders' informal learning, such as students and not teachers, were also deleted.

Table 1
Overview of literature search (July 2018).

Search Terms	ERIC	JSTOR	Taylor & Francis	SAGE	Wiley Online	Springer Link	Psych INFO	Psych ARTICLES
Teach* x Informal Learning	626	146	134	44	668	1134	89	1
Year Limit	513	38	132	41	605	1127	86	1
Faculty* x Informal Learning	86	2	13	8	184	449	2	0
Year Limit	66	1	13	8	177	445	2	0
Professor x Informal Learning	17	1	2	16	117	87	1	0
Year Limit	12	1	2	16	102	83	1	0
Tutor x Informal Learning	23	3	9	3	61	103	0	0
Year Limit	23	2	9	3	40	103	0	0
Total	752	152	158	71	1030	1773	92	1
+ Year Limit	614	42	156	68	924	1758	89	1
Overall Total								4029
+ Year Limit								3652

(5) Studies that focused on teachers in alternative education programs or on pre-service teachers were also eliminated. Only studies on in-service teachers were kept. Therefore, the number of articles to be assessed was brought down to a total of 43 articles.

Forty of these forty-three articles were retrieved and downloaded. Three articles were not directly accessible and, therefore, the authors of the studies were contacted through ResearchGate for a request of the full text. Since the authors did not respond, the articles could not be included in the analysis.

This review study also made use of the snowball method by scanning the reference lists of the studies by which five additional articles were identified: Grosemans, Boon, Verclairen, Dochy, and Kyndt (2015); Hoekstra et al. (2007); Hoekstra, Korthagen, Brekelmans, Beijaard & Imants (2009a); Henze, van Driel, and Verloop (2009); Lohman (2006). The additional articles were fully scanned and, consequently, included for the final step. The initial search was conducted in July 2018 and a number of months passed before a first draft of the manuscript was completed. At that time, the authors searched the literature again, using the same procedure, to see if any articles published during those months fit the criteria. Two more articles were added: Lecat, Beausaert, and Raemdonck (2018) and Zhao and Ko (2018).

This final step included scrutinizing the full texts. As a result, five articles were deleted during this phase. The first study was eliminated as it was a literature review that did not measure teachers' informal learning and used the same definition from another article in the sample. The second excluded study was focused more on the importance of teachers' informal learning rather than examining it and as such did not provide relevant information for answering the research questions of this study. The third deleted article did not make enough of a distinction between formal and informal learning as it blended it into the term professional development. The two last articles focused solely on the context in which teachers learn and work instead of studying informal learning. Ultimately, 42 articles served as a foundation for the synthetization of teachers' informal learning.

2.3. Critical appraisal

The quality of the 42 selected studies was evaluated using widely-used critical appraisal tools. The qualitative studies ($n = 26$) and the mixed-methods studies ($n = 5$) were scanned using the guidelines from the Critical Appraisal Skills Programme (CASP; Singh, 2013). The quantitative studies ($n = 11$) were assessed based on the CASP guidelines, with the questions used by Pluye, Gagnon, Griffiths, and Johnson-Lafleur (2009).

The general criteria that the articles had to fulfil were (1) a clear purpose of the study was mentioned; (2) an appropriate methodology, research design, and recruitment strategy, data collection was chosen to conduct the study; and (3) the results were clearly stated and rigorous. The articles were assessed and given a rating of high (more than 70% of answers are "Yes"), medium (between 40% and 70% of "Yes"), or low (less than 40% of "Yes"). Low-quality studies were excluded from the analysis.

A critical appraisal rating of low-quality means that not enough information was provided in the article to fulfill the quality criteria, not that the actual execution of the study was poor. For example, it appeared that none of the qualitative studies ($n = 26$) explicitly discussed taking into account the relationship of researcher-participant and/or potential ethical issues. Considering the relationship between researcher and participant means that the author(s) explicitly examined the effect and potential bias they might have on the study in the formulation of the research question(s) and the collection of data, recruitment of participants, and choice of location where the study took place (CASP, 2013). This was not present in most of the qualitative studies ($n = 20$). The consideration of ethical issues, referring to whether the study was clearly explained to the participants, whether confidentiality and consent were guaranteed by the author(s), or whether approval of the ethics committee were sought (CASP, 2013), was also not discussed by most of the qualitative studies ($n = 21$). This could be explained by the fact that research about teachers' informal learning does not require participant deception, hazards of confidential patient information and thus does not need ethics committee approval. After critically evaluating all qualitative studies, one study received a low-quality score. Concerning mixed-method and quantitative studies, no article received a low score. A small part ($n = 3$) of the quantitative studies and the majority ($n = 4$) of the mixed-method studies received a medium score. In the end, 41 articles remained after only including medium to high quality studies for this systematic literature review (see Appendix A, Appendix B and Appendix C).

2.4. Data analysis

For the analysis, the studies were fully read again and the features of each study were noted down. As with the literature selection and appraisal, the analysis followed a specific procedure.

The first research question of this review study is concerned with analyzing definitions of teachers' informal learning. This will then make it possible to generate a general definition of teachers' informal learning. In order to know what encompasses a teachers' informal learning definition, its features and the learning activities from which they informally learn have to be inventoried. Therefore, a (summative) content analysis was used for the coding and mapping. This way, the underlying context could be interpreted by comparing keywords and content of the studies (Torraco, 2005). Furthermore, an inductive analysis was performed to make inferences about forming a definition on teachers' informal learning.

The second research question is concerned with the measurement of informal learning. This study started by reading all the selected methods while noting down how each study set up their methodology for measuring teachers' informal learning. The various measurements were also coded and analyzed by means of a (summative) content analysis. This allowed for better insight into the variety and concurrence between the reviewed studies on which measurement method is most often used.

3. Results

This section will first give the reader an overview of all the studies selected and their characteristics. Then the first research question will be addressed by comparing definitions reported in the studies and then inventorying features of teachers' informal learning. Finally, this results section will end by looking at how teachers' informal learning has been measured in the selected studies.

3.1. Characteristics of the selected studies

There were differences among the studies with regard to the educational level where the sample of teachers taught. The majority ($n = 16$) of the reviewed studies looked solely at teachers who taught at secondary level or high school level (e.g., Aown, 2011; Bakkenes, Vermunt, & Wubbels, 2010; Henze et al., 2009; Hoekstra et al., 2007; Kang & Cheng, 2014) and 11 solely looked at teachers at tertiary level or university/college level (e.g., Gerken, Beausaert, & Segers, 2016; Harrison & McKeon, 2008; Van der Klink, Van der Heijden, Boon, & Williams van Rooij, 2014; Van Eekelen, Boshuizen, & Vermunt, 2005; Viskovic, 2005). Only one of the selected studies, Schei and Nerbø (2015), looked at teachers at kindergarten and only two of the selected studies focused solely on elementary teachers (Grosemans et al., 2015; Jurasaitė-Harbison, 2009). Ten looked at multiple educational levels such as elementary and secondary combined ($n = 7$) (e.g., Flores, 2005; Lecat et al., 2018; Tarc, 2007), secondary and tertiary combined ($n = 1$) (e.g., Springer, 2016) or even all educational levels except kindergarten ($n = 2$) (e.g., Hanraets, Hulsebosch, & de Laat, 2011; Lohman, 2005). Finally, two studies did not specify explicitly the educational level in which their study was set up (Krauss & Guat, 2008; Rehm & Notten, 2016).

The majority (twenty-two) of the studies originated from a country in Europe, mainly The Netherlands (thirteen studies; e.g. Bakkenes et al., 2010; Hoekstra & Korthagen, 2011; Van Eekelen et al., 2005), two in Belgium (Grosemans et al., 2015; Lecat et al., 2018), two in Germany (Rehm & Notten, 2016; Richter, Kunter, Klusmann, Lüdtke, & Baumert, 2011), two in the United Kingdom (Knight, Tait, & Yorke, 2006; Wilson & Demetriou, 2007), one in Portugal (Flores, 2005), one in Norway (Schei & Nerbø, 2015) and one in both Sweden and Norway (Reichenberg & Andreassen, 2018). Twelve studies originated in America: eleven in the United States (e.g. Davis, 2015; Springer, 2016; Thacker, 2017) and one in Canada (Tarc, 2007). Three studies were executed in Asia: two in Malaysia (Krauss & Guat, 2008; Rashid, 2018) and one in China (Kang & Cheng, 2014). In Oceania, two studies originated from Australia (Thomson, 2015; Thomson & Trigwell, 2018) and one from New Zealand (Viskovic, 2005). Finally, two studies were cross-cultural. One done in United States and Lithuania (Jurasaitė-Harbison, 2009) and the last one in various European countries, Israel and United States (Harrison & McKeon, 2008).

The sample of teachers in the selected studies also varied with regard to their experience level. Almost half of the selected studies, 48 percent, ($n = 20$) focused on the experienced teacher, that is, a teacher who has two or more years of teaching experience (e.g., Richter et al., 2011; Schreurs, Huveneers, & Dolmans, 2016; Thacker, 2017; Thomson & Trigwell, 2018; Van der Klink et al., 2014). The first years of the teaching career trajectory focus on getting to know the work context, forming teacher identity, and dealing with student's behaviour (Kyndt et al., 2016). And almost a quarter, 24 percent of the studies ($n = 10$) focused on both inexperienced and experienced teachers (e.g., Jones & Dexter, 2014; Thomson, 2015; Van Lankveld et al., 2016). Only 10 percent ($n = 4$) of the studies focused solely on the inexperienced teacher (Hanraets et al., 2011; Kang & Cheng, 2014; Krauss & Guat, 2008; Wilson & Demetriou, 2007). The remaining 19 percent ($n = 8$) of the studies did not specify the experience level of their teacher sample (e.g., Jurasaitė-Harbison, 2009; Knight et al., 2006; Pifer, Baker & Lundsford, 2015). Kyndt et al. (2016) looked into the differences between experienced and inexperienced teachers in their review study and found that in terms of informal learning activities undertaken they do not differ much apart from experimenting and reading. Few of the selected studies ($n = 2$) also focused on individual dispositions (e.g., Lohman, 2000, 2005) or contextual factors ($n = 8$) that influence participation of teachers in informal learning activities (e.g., Kang & Cheng, 2014; Lohman, 2000, 2003, 2005, 2006; Wilson & Demetriou, 2007).

Furthermore, the vast majority, approximately 81 percent, of the selected and reviewed studies ($n = 34$) focused on understanding the informal learning activities teachers learn (most) from (e.g., Grosemans et al., 2015; Henze et al., 2009; Knight et al., 2006). Approximately 19 percent of the articles ($n = 8$) examined, besides examining informal learning activities, factors that affected teachers' engagement in informal learning activities (e.g., Lohman, 2003; Lohman, 2005; Lohman, 2006) and seven percent of the selected articles ($n = 3$) that examined factors that affected teachers to disengage in informal learning activities (Collinson & Cook, 2004; Krauss & Guat, 2008; Lohman, 2000). Moreover, 20 percent of the studies ($n = 8$) explicitly mentioned or looked into the types of learning (using terms like dimensions, features or types) when teachers informally learn.

3.2. Teachers' informal learning definitions

The problem with the construct of teachers' informal learning is that up until now no general definition has been established. As a consequence, the selected studies differed in their idea of what teachers' informal learning encompassed. For instance, some authors mainly identified the informal learning of teachers as the conscious or unconscious decision to engage in learning activities that ultimately lead to a modification in either behaviour or cognition (Hoekstra et al., 2007; Hoekstra, Korthagen et al., 2009a; Hoekstra, Brekelmans et al., 2009b). They take into account that teachers' informal learning is not merely behavioural and cognitive, but also motivational and emotional in nature. Schei and Nerbø (2015), similar to the studies by Hoekstra et al. (2007, 2009a, 2009b), defined informal learning as learning that is not undertaken in a systematic manner. However, they add that informal learning predominantly takes place in everyday (work) situations. They contend that informal learning happens haphazardly and often by chance rather than planned with a predetermined agenda. Furthermore, Schei and Nerbø (2015) include in their definition that the objective of

engagement in informal learning activities is to acquire and use new skills and knowledge. Lohman (2000, 2003, 2005, 2006) shares the perspective of Schei and Nerbø (2015) that the end goal of informal learning is to obtain new skills and professional knowledge. However, different from the definition by Schei and Nerbø (2015), is that Lohman (2000, 2003, 2005, 2006) defines informal learning as a feature of workplace learning which encompasses learning activities consciously initiated by employees in the workplace. In accordance with Hoekstra et al. (2007, 2009a, 2009b), Lohman (2005) states that learning from informal activities requires effort by the individual in physical, cognitive, and emotional terms. Another example is that of Jurasaitė-Harbison (2009): she is more general in defining informal learning as she defines it as the unplanned or spontaneous learning that can be developed from multiple sources and in multiple contexts. Jurasaitė-Harbison (2009) emphasizes that a community of practice and the interaction between individuals within that community of practice is a valuable working environment and motivator for engaging in informal learning. The definition of informal learning used by Grosemans et al. (2015) has similarities and differences to the abovementioned definitions. Similarities include that individuals do not systematically engage in informal learning activities and arises often from daily work situations, activities, and routines. Furthermore, Grosemans et al. (2015) argue, as informal learning takes place spontaneously and mostly unconsciously, it is not clear what the exact learning outcomes will be. These authors expect individuals engaging in informal learning to develop their professional knowledge and skills. However, they differ from other authors in terms of making explicit that informal learning occurs both on an individual and collectively level.

In sum, some of the definitions correspond to informal learning taking place in everyday work situations, consciously initiated by teachers. Others have the outcome of spontaneously and unconsciously advancing professional knowledge and skills. Other definitions highlighted the aspects of informal learning being emotional, physical, and cognitive in nature. Nevertheless, the definitions are only partly overlapping as none of the definitions are identical in terms of features mentioned.

3.3. Features of teachers' informal learning

The features of informal learning were also inventoried. Approximately 40 percent ($n = 17$) of the selected studies specifically mentioned the features of teachers' informal learning. The results are depicted in Table 2. As can be viewed, the features of informal learning are diverse and sometimes even opposite. For instance, the reviewed studies are not in accordance whether informal learning of teachers is planned or unplanned. A couple of the selected studies mentioned that the informal learning of teachers is intentional, or planned ($n = 6$). Features that are worded differently but could be placed in this group are: deliberate ($n = 3$) and situated ($n = 1$). These features grouped together view informal learning as being an activity that is intentionally engaged in. Some studies also mentioned that informal learning is unintentional, or unplanned ($n = 5$). Features that have overlap are accidental learning ($n = 1$), incidental learning ($n = 1$), implicit learning ($n = 2$) spontaneous learning ($n = 2$), reactive learning ($n = 2$), and unpredicted learning ($n = 1$). These features grouped together view informal learning as happening unintentionally and rather by chance. The individual is not consciously aware that he or she is informally learning. Moreover, some of the selected studies ($n = 5$), mentioned that informal learning of teachers is self-directed, meaning that the learning is under the individual teachers' control rather than controlled by others. Closely related to the feature 'self-directed', Thacker (2075) described informal learning as being 'self-guided'. Even though a different term is used, there is no difference between its meaning and that of 'self-directed'. Two studies also mentioned that informal learning is 'unstructured', which means that there is no systematic support for informal learning in place. Furthermore, Wilson and Demetriou (2007) suggest that informal learning is 'experiential' and should rather be viewed as learning while doing or experiencing. The emphasis is placed on the consciousness level by focusing on the level of intention or planning or lack thereof. In sum, a myriad of terms is used to describe the features of teachers' informal learning. When grouped together, the most often mentioned features are self-directed learning ($n = 6$), unintentional learning ($n = 15$), or intentional learning ($n = 10$).

Table 2
Features of teachers' informal learning.

Features	Author(s)
Accidental (1)	Schei and Nerbø (2015)
Deliberate (4)	Jurasaitė-Harbison (2009); Hoekstra et al. (2007); Lecat et al. (2018); Wilson and Demetriou (2007)
Experiential (1)	Wilson and Demetriou (2007)
Implicit (2)	Hoekstra, Brekelmans et al. (2009b); Wilson and Demetriou (2007)
Incidental (1)	Viskovic (2005)
Independent (1)	Jones and Dexter (2014)
Intentional (2)	Knight et al. (2006); Kwakman (2003)
Non-linear (1)	Van Eekelen et al. (2005)
Planned (3)	Bakkenes et al., 2010; Van Eekelen et al. (2005); Wilson and Demetriou (2007)
Reactive (2)	Hoekstra et al. (2007); Wilson and Demetriou (2007)
Self-directed (5)	Aown (2011); Hoekstra, Brekelmans et al. (2009b); Kwakman (2003); Lohman (2003); Van Eekelen et al. (2005)
Self-guided (1)	Thacker (2017)
Situated (2)	Harrison and McKeon (2008); Viskovic (2005)
Spontaneous (2)	Grosemans et al. (2015); Jurasaitė-Harbison (2009)
Unintentional (1)	Knight et al. (2006)
Unplanned (4)	Lecat et al. (2018); Schei and Nerbø (2015); Van Eekelen et al. (2005); Wilson and Demetriou (2007)
Unpredicted (1)	Flores (2005)
Unstructured (2)	Grosemans et al. (2015); Schei and Nerbø (2015)

4. Measurement of teachers' informal learning

4.1. Inventory

This section looks at how the informal learning of teachers has been measured. The inventory phase identified 102 non-unique measurements of informal learning (by counting all measurements in the studies), which resulted in 32 unique instruments (by counting the number of different instruments). Most of the studies ($n = 30$) made use of a combination of measurements. Content analysis identified six categories in which the types of measurements of teachers' informal learning go.

The first category concerns the use of case studies, either multiple or single. A total of 11 studies used a case study research design. The second category concerns the use of interview for measuring informal learning, which was used in the majority of the studies ($n = 37$). The methods ranged from semi-structured ($n = 20$) for the majority to group interviews ($n = 1$), follow-up interviews ($n = 1$), electronic interviews ($n = 1$) and telephone interviews ($n = 1$). The third category concerns the use of a questionnaire or survey ($n = 23$). Measurements in this category range from the use of (online) questionnaires ($n = 19$) to post-interview surveys ($n = 1$) and COACTIV study ($n = 1$). The COACTIV study was a part of the German extension of the 2003 European PISA (Programme for International Student Assessment). The fourth category concerns on site measurements. In some studies, researchers visited and observed teachers in schools ($n = 9$) or took field notes ($n = 4$). Recordings of lessons ($n = 3$), supervision meetings ($n = 1$) and researchers' impression ($n = 1$) were also analyzed to gain information. The fifth category comprised seven studies that made use of an approach using written reports that build on the participants' perspective. Some studies used digital logs ($n = 1$), written reports via emails ($n = 2$), Facebook timeline ($n = 1$), electronic diaries ($n = 1$), or looked at Twitter data of participants ($n = 2$). Lastly, in the sixth category, researchers reviewed schools documents (project materials or institutional policy; $n = 2$) or lessons preparation ($n = 1$). They also used a storyline method ($n = 1$), pre-interview request sheet ($n = 1$). The storyline method is built on a teacher's representation of a series of experiences or events (vertical axis on 5-point scale in the one from Henze et al., 2009) and plotted in time on the horizontal axis. This method is not in the fifth category because it is not based on written reports. The results of the content analysis are depicted in Table 3.

As mentioned before, 30 studies used a combination of measurements (e.g. Aown, 2011; Collinson & Cook, 2004; Hanraets et al., 2011; Tarc, 2007). Often, the combination involved a case study or survey combined with semi-structured interviews (Schei & Nerbø, 2015; Rashid, 2018; Kang & Cheng, 2014; Hoekstra, Korthagen et al., 2009a). However, additional measurements were undertaken such as on-site observations ($n = 9$), taking field notes ($n = 4$), or recordings of lessons and/or meetings ($n = 5$). Several studies ($n = 11$) relied only on one measure, predominantly the use of surveys (e.g. Hoekstra, Korthagen et al., 2009a; Hoekstra, Brekelmans et al., 2009b; Krauss & Guat, 2008; Richter et al., 2011; Springer, 2016; Van der Klink et al., 2014). Table 4 show a ranking of the most used measurements.

4.2. Description

It became apparent that the most used way of measuring informal learning was through semi-structured interview as nearly half of the studies ($n = 20$) made use of this measurement. Not all studies specified the guidelines for the interviews (e.g., Flores, 2005; Grosemans et al., 2015; Schreurs et al., 2016). Furthermore, most authors did not indicate the questions they asked during semi-structured interviews (e.g. Lohman, 2000; Wilson & Demetriou, 2007) but sometimes general information is given, such as "(interviews) examine further the ways in which teachers learn in the workplace" (Flores, 2005, p. 488) or "(the interview) explored the informal learning activities of the teacher" (Grosemans et al., 2015, p. 154). Only four articles included semi-structured interview guide (Hanraets et al., 2011; Lohman, 2003; Schei & Nerbø, 2015; Van Lankveld et al., 2016). Given these general information and interview guides, typical questions aim to retrieve which learning activities are done by teachers (e.g. Hanraets et al., 2011; Van Eekelen et al., 2005), for instance "the teachers were asked to give examples of situations or activities from which they had learned something" (Van Eekelen et al., 2005, p. 454). Others questions were about sources of learning, for instance "Primary questions concerned sources of information for learning about technology integration" (e.g. Jones & Dexter, 2014, p. 373) or about their professional development experiences, for instance "The interview guide covered the following areas: (1) educational background; (2) professional development experiences; (3) reflections on teaching; (4) conceptions about EFL (English as a Foreign Language) learning and teaching; (5) comments on the environment of teaching" (e.g. Kang & Cheng, 2014, p. 173).

Some authors elaborated their approach during interviews by also taking into account learning from critical incidents, the work itself, or the organization of work (e.g. Lohman, 2003; Schei & Nerbø, 2015). Van Eekelen et al. (2005) not only looked into activities or situations the teachers had informally learnt from, but also looked into how they individually defined informal learning ("the teachers were asked how they would define learning and what learning goals (if any) they had for the following two months.", p.454). Harrison and McKeon (2008) specifically asked five experiences during the first year of their new work.

The second most used measurement was through (online) questionnaires or surveys ($n = 19$) accounting for the measurement of 46 percent of all studies included in this review. While the guidelines for the surveys were rarely discussed explicitly, most of the studies made use of surveys where teachers indicated the learning activities they undertook and learned most from (e.g., Henze et al., 2009; Springer, 2016; Tarc, 2007). In studies using questionnaires, the smallest number of items is 10, on a 5-point Likert scale, to measure 4 dimensions of social informal learning (Gerken et al., 2016). These dimensions are (1) feedback seeking from supervisor, (2) feedback seeking from colleagues, (3) external information seeking and (4) help seeking. The biggest number is 61 items, on a 4-point Likert scale to measure 4 dimensions of teachers' professional learning (Flores, 2005). These dimensions are (1) the nature and scope or professional learning, (2) processes and contexts of learning, (3) factors influencing teachers' professional development and

Table 3
Measurement of informal learning.

Case study	Interviews	(Online) Survey	On site	Personal reports	Others
Multiple Case Studies (8)	Semi-structured Interviews (20)	Questionnaire (12)	Observations/visits (9)	Written Reports via Email (2)	Reviewing documents (2)
Single Case Study (3)	Open interviews (5) Interview (non-specified) (4)	Survey (7) Questionnaire to Pupils about Teacher (2)	Field Notes (4) Recording of lessons (3)	Twitter Data (Tweets) (2) Facebook Timeline (1)	Pre-interview request sheet (1) Storyline method (1)
	Focus Group (3)	Pre-interview Survey (1)	Recording of supervision meetings (1)	Electronic Diary Study (1)	Reviewing of planning and lesson materials (1)
	Follow-up Interviews (2)	Post-interview survey (1)	Recording of researcher impression after interview (1)	Digital Logs (1)	
	Group interview (1) Electronic interview (1) Telephone interview (1)	COACTIV study (1)			

Table 4
Ranking of teachers' informal learning measurement.

Type of Measurement Used		Number of Studies	Percentage
1	Semi-structured Interviews	20	49%
2	Questionnaire/survey	19	46%
3	Observations/visits	9	22%
4	Multiple Case Study	8	20%
5	Open Interviews	5	12%
6–8	Interviews (non-specified)	4	10%
	Diary study	4	10%
	Field Notes	4	10%
	Single Case Study	3	7%
9–11	Focus Group	3	7%
	Recording of lessons	3	7%

(4) school culture and leadership. The study using the most dimensions is the one from [Lecat et al. \(2018\)](#) in which social informal learning is assessed on basis of 6 dimensions, each with 5 items. These dimensions are (1) feedback seeking frequency, (2) help seeking frequency, (3) information seeking frequency, (4) feedback use, (5) help use and (6) information use. Two articles did not report the exact number of items ([Grosemans et al., 2015](#); [Springer, 2016](#)) but refer to a validated questionnaire and indicate they have added some items.

Not all questionnaires are based on self-reports by teachers. [Hoekstra and Korthagen \(2011\)](#) made use of a different information sources, for instance teachers and students' perceptions when measuring teachers' informal learning. In this study, pupils filled out a survey before –and after their teacher completed the questionnaire. The rationale for doing so, [Hoekstra and Korthagen \(2011\)](#) state, is that research showed that the judgment of pupils demonstrated to be trustworthy when measuring teachers' behaviour. While this does not take into account possible negative teacher-student relationships and does not capture teachers' learning as a whole, it provides an external perspective on teachers' progress through engagement in informal learning activities.

The third most used measurement was on site observations or visits ($n = 9$), that is about 22% of the selected studies. Schools visits and observations are made to gain information about unconscious (or unremembered) informal learning activities. It also can lead to a better understanding of participants' workplaces and the settings for informal learning. For instance, [Lohman \(2003\)](#) used in site visits to confirm findings from interviews, in order to enhance the credibility of what she found. Schei and Nerbo conducted all interviews on site in order to have a better view of the work settings so to add information to complete their data.

4.3. Strengths and weaknesses

Currently, no best practice is established for the measurement of informal learning, the approaches as depicted in [Table 4](#) each have their strengths and weaknesses for measuring teachers' informal learning. Below the three most used methods for measuring teachers' informal learning are discussed in detail.

First of all, measuring teachers informal learning using semi-structured interviews has the advantage of both having a pre-determined set of questions to help teacher to remember their learning activities and the flexibility of approach to questioning teachers' informal learning to let them finely express how they learn. However, as there is more room for supplementary questions to ask and reacting on chat teachers said, it becomes more difficult to compare the interviews with each other as answers or even questions can diverge ([Kothari, 2003](#)). Another drawback on this approach is that it is more time consuming for teachers to answer and for researchers in terms of conducting the interviews and transcribing the unstructured responses. As a result, studies using semi-structured interviews have both less participants than other research designs and because of the time needed, the teachers' participation rate is lower than for instance a study asking them to answer online whenever they want. Despite these weaknesses, semi-structured interviews allow researchers to go more into detail and in a more exploratory way than for instance using a structured interviews or a survey with an imposed definition of informal learning and a limited freedom in the questions and directions ([Kothari, 2003](#)). Therefore, with regard to capturing informal learning activities or processes, some may not come directly to mind and interviews allows to go back on questions and make it easier to explain again. Furthermore, in-depth questions can be spontaneously generated throughout the interview.

Secondly, the approach of measuring informal learning through (online) questionnaire has been used by 44 percent ($n = 18$) of the selected studies. The strength of using surveys as a measurement tool for teachers' informal learning is that it is cost-effective in terms of time and money for the participants ([Kothari, 2003](#)). Furthermore, a higher percentage of teachers can be reached by sending the questionnaire to the schools principals or via social media. However, teachers who learn the least informally may think they have nothing to say and, consequently, this may cause a bias as only those participants respond who have learned informally ([Kothari, 2003](#)). As a certain percentage and proportion has to be reached in order to be representative for the teacher population within the respective educational levels, and then allowing generalization, this method is likely to be one of the slowest methods ([Kothari, 2003](#)). Furthermore, another drawback of sending questionnaires to teachers is that the individual dispositions or emotions of teachers on the spot cannot be taken into account as there is no face-to-face encounter with the researcher. Multiple researchers have made use of (online) surveys, however, only one researcher ([Collinson & Cook, 2004](#)) has made use of both a pre-interview survey and post-interview survey in addition to augment teachers' impressions and opinion with statistical scores. This way, the

increase of a teacher's knowledge base on a particular subject as a result of engaging in informal learning behaviour can be measured through the use of benchmarks and repeated questionnaires or surveys.

Thirdly, teachers case studies were also often used as a measurement for informal learning, as 27 percent ($n = 11$) of the selected articles made use of a multiple case study ($n = 8$) or a single case study ($n = 3$). While case studies offer the best approach to go in-depth on the informal learning processes of teachers, it is difficult to create a case study that suits all subjects while at the same time be able to generalize the findings to a larger group. The abovementioned ways – interviews, surveys, and case studies, have been frequently used to measure teachers' informal learning. One issue of concern remains that, as informal learning is often believed to be a highly unconscious process, informal learning for participants might be hard to pinpoint and, consequently, hard to measure. Then participants may report the most conscious learning activities but these may not be the most frequently used.

Lastly, in 22 percent ($n = 9$) of the selected studies, researchers made visits or observations in schools. The strength of this research method, is that it allows to directly check the accuracy of the data through the observed participant. Observation enhances the reliability of the learning behaviours reported. It allows to see unconscious learning activities that teachers are not aware of and also avoids desirability biases. These are strengths are not found in self-report measures. The main weakness is the time the observations take and the necessity of having two or more analysts in order to ensure inter-judge reliability (Stigler, Gallimore, & Hiebert, 2000).

5. Conclusion and discussion

Even though the body of literature on teacher learning increased over the past few years, the existing research and theory on teacher learning has been dealing with a lack of clarity surrounding the concept informal learning (Clarke, 2005; Hoekstra et al., 2007; Schugurensky, 2015). Informal learning is still often viewed by existing literature as a global category containing what does not refer to formal learning or is mistakenly used as a synonym for workplace learning. Consequently, literature to date has been unsuccessful in constructing a comprehensive definition for teachers' informal learning.

The first purpose of this study was to generate a theoretical framework and streamline this into a general definition of informal learning of teachers.

5.1. How can the informal learning of teachers be defined?

Based on the preceding analysis and results, it became clear that teachers' informal learning takes different forms. With regard to the features of learning it was found to be 'self-directed', 'intentional', and 'unintentional'. As a result, after reviewing the selected studies and considering the dimensions and features of informal learning activities, this study proposes the following definition on teachers' informal learning as:

"The learning of teachers by intentionally or unintentionally engaging in individual or collective, interactive or non-interactive, and instructive or self-directed activities that enhances the professional development of knowledge and skills. This learning can be deliberate or implicit. These activities include, but are not limited to, the activities of reflecting; reading; interacting and collaborating with colleagues; feedback giving and receiving; and the sharing of experiences and ideas."

The significance of the proposed definition is that it acknowledges and takes into consideration the different activities teachers prefer to undertake and the features of informal learning, thereby accounting for a more complete picture on teachers' informal learning. While this definition is non-conclusive, it serves as a starting point for alignment and the furthering of the educational literature on teachers' informal learning.

The second aim of the study was to map the ways informal learning of teachers has been measured in the past.

5.2. How was informal learning measured?

This review study mapped the measurements of the selected studies. We will give advice on measurements use and suggest some alternative innovative methods.

It was found that most studies make use of qualitative approach when researching teachers' informal learning. Furthermore, in qualitative approach, semi-structured interviews with teachers were the most used. This technique has strength and weakness. First of all, according to Diefenbach (2009), it allows more methodological freedom and creativity, especially when the concept, like informal learning, can be vague or can be interpreted by teachers. In this sense, face-to-face interviews allows the researchers to reformulate the research question, specify what the concepts really mean and what it encompasses. In this study, we suggest that, given the complex nature of informal learning, a combination of semi-structured interviews, questionnaires and observations are a good way to capture teachers' informal learning, but it can be completed with other more innovative methods.

Since semi-structured interviews provide a structured set of open-ended questions, which i.a. could include what learning means for an individual (Van Eekelen et al., 2005), which informal learning activities an individual undertakes and what the inhibitors and motivators are to engage in informal learning. Furthermore, by making use of benchmarks measured through repeated surveys or questionnaires, including a pre- and post-questionnaire, both for the teacher him/herself, as in the study by Collinson and Cook (2004) and his/her students, as in the study by Hoekstra and Korthagen (2011) people's impressions and opinions on a particular subject can be measured at different points in time. This is in line with the findings of the literature review by Kyndt et al. (2016) who found and stated that a mixed-method approach is most suitable in capturing teachers' informal learning.

Interviews and questionnaires can give a good overall view on teachers' learning activities and what is important to them. However, these research methods assume that teachers are mostly conscious of their informal learning. Measuring informal learning most allow to measure implicit learning as well. Direct observation as the third most used measurement method in the selected studies, can add a more objective view on interactions, learning contexts, working alone time, the variety of working tasks and behaviors that offer opportunities for informal learning. Moreover, video observation to assess teachers learning activities can more easily capture the complexity of interactions that can be submitted to the analysis of several researchers and enhance inter-judge reliability (Stigler et al., 2000). The benefits of the video observation include obtaining a record of small group interactions generally not doable with an observer (Borko, Jacobs, Eiteljorg, & Pittman, 2008). However, observation mainly focus on social informal learning and does not take into account individual learning, for instance learning by reflection.

The current measurement approaches in the literature like the one discussed above can benefit from other more objective and innovative options. These alternative measurement methods can be used in addition to the existing instruments to help capturing teachers' informal learning, especially by taking into account the social dimension and the context in teachers' informal learning. For instance, socio-metric badges and social network analysis are two methods that can be added to the more commonly used instruments to increase the social learning activities remembered by teachers. Socio-metric badges are key-sized devices worn by teachers to measure interactions and discussion time (Kim, McFee, Olguin, Waber, & Pentland, 2012). It can bring a unique perspective of teachers' social informal learning. These devices make a continuous data collection easier even as teachers move throughout the day and its interactions (coffee break, lunch discussions, shared-space interactions, etc.). This information, reported to teachers, can help them to remember the various discussions they had and the colleagues to whom they seek feedback, help or information. Another additional method is social network analysis, a methodological approach designed to systematically map teachers' network configuration *ex nihilo* (Coburn & Russell, 2008). This network information can track all interactions between teachers, and help them to report all social learning activities they had (Carrington, Scott & Wasserman, 2005).

5.2.1. Limitations and future research

This literature review considered informal learning definitions, features and ways of measurement. This review study attempted to consider numerous aspects that informal learning of teachers comprises but also has some limitations. Accordingly, suggestions and directions for future research on informal learning are made.

First, this review combines studies from various countries and diverse educational systems. Nawab (2011) showed that teacher's workplace and informal learning can vary across different countries and so can, in this sense, definitions and measures. Future research can make cross-cultural comparisons. This literature review focused on peer-reviewed articles that studied "informal learning" of teachers (keywords: "teach*", "professor" or "tutor"). We did not search for specific subtypes of informal learning, such as implicit, reactive or deliberative informal learning. However, when looking into the instruments used to measure informal learning (Table 4), it looks like mostly interviews and questionnaires are used to measure informal learning. Both self-report methods are relevant to measure deliberate informal learning, but less convenient for measuring implicit informal learning. Other methods like diaries, daily mobile-phone logs or objective measures like socio-metric badges have to our knowledge been used in other contexts then education for measuring informal learning. We believe the table gives a good overview of the state-of-the-art literature, given our broad search terms, however, searching explicitly for specific subtypes of informal learning, such as implicit learning, might be relevant to confirm our finding that mostly deliberate informal learning of teachers is measured and not implicit informal learning. A future literature review can search studies from different sources and collect published and unpublished papers.

Moreover, even though this study took an all-encompassing approach and tried to grasp the concept of teachers' informal learning, the definition was based upon the information and findings available in selected studies and, therefore, remains inconclusive. Hodkinson and Hodkinson (2005) claim that the nature of learning interacts with, among others, personal dispositions and the practice and culture at the workplace. This also became apparent in the additional topics discussed in the selected studies, since these separate aspects of informal learning were already investigated. For instance, constraints and promoters for engaging in informal learning activities as well as contextual factors were mentioned in the selected studies (Hoekstra et al., 2007; Krauss & Guat, 2008; Lohman, 2000; Wilson & Demetriou, 2007). Not only the way of learning but also the preference of undertaking informal learning activities differ between individuals. Consequently, a recommendation for future research is to – based on the theoretical framework provided above – extend and research the literature incorporating antecedents, individual preferences, personality traits, individual activity paths and consequences of informal learning in order to gain a more exhaustive notion of what encompasses teachers' informal learning.

This review study also provided an overview of the measurements of informal learning. A typology of most used ways of measuring informal learning was developed and the strengths and weaknesses of the most used measurements discussed. To date, no research has been done as to what might be the best order to measure informal learning. This review study suggests that a multi-source design is appropriate by including semi-structured interviews, questionnaires and observations conducted at regular intervals to measure the learning activities of an individual on a particular subject and more innovative and objective methods, such as socio-metric badges and social network analysis. A recommendation for future research is to investigate whether the use of a full range of methods is an effective tool to capture teachers' informal learning. One point of interest could be to examine whether quantitative data collection indeed has to be done before the qualitative data collection or that a different order is also appropriate. Another point of interest is to determine where the best cost-benefit ratio can be found among the multitude of possible measurement methods.

Finally, another limitation of this literature review is that it focused on teachers' informal learning without linking it to the development of their professional identity, although scholars showed that teachers' learning often leads to changes in their identity (Van Veen, Slegers, Bergen, & Klaassen, 2001). Furthermore, according to Geijssels and Meijers (2005), teachers' identity development

can also be seen as a learning process, which makes it relevant to the topic of teachers' informal learning. They argue that teachers' learning and identity should be discussed as an individual sense-making process as well as a social-cognitive construction of new meanings. Consequently, a recommendation for future research is to link teachers' learning, in formal and informal learning contexts, to teachers' identity development, given their interwovenness

Acknowledgement

I'm supported by an FSR grant from the UCLouvain (University of Louvain-la-Neuve in Belgium). That's the typical (public) "Belgian Fund for Scientific Research". I have no conflict of interest to declare.

Appendix

Appendix A Critical Appraisal of Selected Qualitative Studies

Author(s)	Did the study clearly state the aim of the research?	Did the study choose an appropriate qualitative methodology?	Did the study choose the appropriate research design to address the aim of the research?	Did the study use an appropriate recruitment strategy to address the aim of the research?	Did the study collect the data in such a way that it addressed the research issue/aim?	Did the study adequately consider the relationship between researcher and participant(s)?	Did the study consider ethical issues?	Did the study do a sufficiently rigorous data analysis?	Does the study present a clear statement of findings?	Final Rating
Aown (2011)	Y	Y	Y	Y	Y	Y	N	Y	Y	High
Collinson and Cook (2004)	Y	Y	Y	Y	Y	Y	N	Y	Y	High
Davis (2015)	Y	Y	Y	Y	Y	N	Y	Y	Y	High
Hanraets et al. (2011)	Y	Y	Y	Y	Y	N	N	Y	Y	High
Harrison and McKeon (2008)	Y	Y	Y	N	Y	N	N	Y	Y	Medium
Henze et al. (2009)	Y	Y	Y	Y	Y	Y	N	Y	Y	High
Hoekstra et al. (2007)	Y	Y	Y	Y	Y	N	N	Y	Y	High
Hoekstra, Kort-hagen et al. (2009a)	Y	Y	Y	Y	Y	N	N	Y	Y	High
Hoekstra and Korthagen (-2011)	Y	Y	Y	Y	Y	N	N	Y	Y	High
Jones and Dexter (2014)	Y	Y	Y	Y	Y	N	N	Y	Y	High
Jurasaitė-Harbi-son (2009)	Y	Y	Y	Y	Y	N	N	Y	Y	High
Kang and Cheng (2014)	Y	Y	Y	Y	Y	Y	N	Y	Y	High
Knight et al. (2006)	N	Y	Y	N	Y	N	N	N	Y	Medium
Lohman (2000)	Y	Y	Y	Y	Y	N	N	Y	Y	High
Lohman (2003)	Y	Y	Y	Y	Y	N	N	Y	Y	High
McPherson, Budge, and Lemon (2015)	N	Y	N	N	Y	N	N	N	N	Low
Rashid (2018)	Y	Y	Y	Y	Y	N	Y	Y	Y	High
Schei and Nerbo (2015)	Y	Y	Y	Y	Y	N	Y	Y	Y	High
Schreurs et al. (2016)	Y	Y	Y	Y	Y	N	Y	Y	Y	High
Tarc (2007)	Y	Y	Y	N	Y	N	N	Y	Y	Medium
Thacker (2017)	Y	Y	Y	Y	Y	N	N	Y	Y	High
Thomson (2015)	Y	Y	Y	Y	Y	N	Y	Y	Y	High
Thomson & Triggwell (2018)	Y	Y	Y	N	Y	N	N	Y	Y	Medium

Van Eekelen et al. (2005)	Y	Y	Y	Y	Y	Y	N	Y	Y	High
Van Lankveld et al. (2016)	Y	Y	Y	Y	Y	Y	N	Y	Y	High
Viskovic (2005)	Y	Y	Y	N	Y	N	N	Y	Y	Medium

Abbreviations: Y (Yes), N (No).

Criteria met: < 4 Low.

Criteria met: 4–6 Medium.

Criteria met: > 6 High.

Appendix B. Critical Appraisal of Selected Quantitative Studies

Author(s)	Did the study clearly state the aim of the research?	Did the study choose an appropriate quantitative methodology?	Did the study use an appropriate recruitment strategy to address the aim of the research?	Did the study make use appropriate sampling and sample?*	Did the study justify the measurements (validity and standards)?*	Did the study control for confounding variables?*	Did the study clearly state the findings?	Did the study produce results that are generalizable to the source population?	Rating
Gerken et al. (2016)	Y	Y	Y	Y	Y	Y	Y	Y	High
Hoekstra, Brekelmans et al. (2009b)	Y	Y	Y	Y	Y	Y	Y	Y	High
Van der Klink et al. (2014)	Y	Y	Y	Y	Y	Y	Y	Y	High
Krauss and Guat (2008)	Y	N	Y	N	Y	N	Y	Y	Medium
Lecat et al. (2018)	Y	Y	Y	N	Y	N	Y	N	Medium
Lohman (2005)	Y	Y	Y	Y	Y	Y	Y	Y	High
Lohman (2006)	Y	Y	Y	Y	Y	Y	Y	Y	High
Rehm and Notten (2016)	Y	N	Y	N	N	N	Y	Y	Medium
Reichenberg and Andreassen (2018)	Y	Y	Y	Y	Y	N	Y	Y	High
Richter et al. (2011)	Y	Y	Y	Y	Y	Y	Y	Y	High
Springer (2016)	Y	N	Y	Y	N	N	Y	Y	Medium

Abbreviations: Y (Yes), N (No).

Criteria met: < 4 Low.

Criteria met: 4–5 Medium.

Criteria met: > 5 High.

* Extra criteria based on the study by [Pluye et al. \(2009\)](#).

Appendix C. Critical Appraisal of Selected Mixed-Method Studies

Author(s)	Did the study clearly state the aim of the research?	Did the study justify the use of a mixed-method design?	Did the study use a combination of qualitative and quantitative data collection techniques or procedures?	Did the study use an appropriate recruitment strategy to address the aim of the research?	Did the study collect the data in such a way that it addressed the research issue/aim?	Did the study adequately consider the relationship between researcher and participant(s)?	Did the study consider ethical issues?	Did the study do a sufficiently rigorous data analysis?	Did the study integrate the qualitative and quantitative data or results*?	Did the study clearly state the findings?	Rating
Bakkernes et al., 2010	Y	N	Y	Y	Y	N	N	Y	Y	Y	High
Flores (2005)	Y	N	Y	Y	Y	N	N	Y	Y	Y	Medium
Grosemans et al. (2015)	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	High
Kwakman (2003)	Y	N	Y	Y	Y	N	N	Y	Y	Y	Medium
Pifer, Baker, and Lunsford (2015)	Y	N	Y	Y	Y	N	N	Y	Y	Y	Medium

Abbreviations: Y (Yes), N (No).

Criteria met: < 4 low.

Criteria met: 4–5 medium.

Criteria met: > 6 high.

* Extra criteria based on the study by Pluye et al. (2009).

References

- Aown, N. M. (2011). A place for informal learning in teaching about religion: The story of an experienced non-Muslim teacher and her learning about Islam. *Teaching and Teacher Education*, 27(8), 1255–1264. <https://doi.org/10.1016/j.tate.2011.07.005>.
- Aveyard, H. (2014). *Doing a literature review in health and social care: A practical guide* (2nd ed.). UK: McGraw-Hill Education.
- Bakkenes, I., Vermunt, J. D., & Wubbels, T. (2010). Teacher learning in the context of educational innovation: Learning activities and learning outcomes of experienced teachers. *Learning and Instruction*, 20(6), 533–548. <https://doi.org/10.1016/j.learninstruc.2009.09.001>.
- Bell, B. S., Tannenbaum, S. I., Ford, J. K., Noe, R. A., & Kraiger, K. (2017). 100 years of training and development research: What we know and where we should go. *Journal of Applied Psychology*, 102(3), 305. <https://doi.org/10.1037/apl0000142.supp>.
- Borko, H., Jacobs, J., Eiteljorg, E., & Pittman, M. E. (2008). Video as a tool for fostering productive discussions in mathematics professional development. *Teaching and Teacher Education*, 24(2), 417–436. <https://doi.org/10.1016/j.tate.2006.11.012>.
- Callanan, M., Cervantes, C., & Loomis, M. (2011). Informal learning. *Wiley Interdisciplinary Reviews: Cognitive Science*, 2(6), 646–655. <https://doi.org/10.1002/wcs.143>.
- Carrington, P. J., Scott, J., & Wasserman, S. (Vol. Eds.), (2005). *Models and methods in social network analysis: Vol. 28* Cambridge University Press.
- Cerasoli, C., Alliger, G., Donsbach, J., Mathieu, J., Tannenbaum, S., & Orvis, K. (2018). Antecedents and outcomes of informal learning behaviors: A meta-analysis. *Journal of Business and Psychology*, 33(2), 203–230. <https://doi.org/10.21236/ada607502>.
- Clarke, N. (2005). Workplace learning environment and its relationship with learning outcomes in healthcare organizations. *Human Resource Development International*, 8, 185–205. <https://doi.org/10.1080/13678860500100228>.
- Coburn, C. E., & Russell, J. L. (2008). District policy and teachers' social networks. *Educational Evaluation and Policy Analysis*, 30(3), 203–235. <https://doi.org/10.3102/0162373708321829>.
- Collinson, V., & Cook, T. (2004). Learning to share, sharing to learn: Fostering organizational learning through teachers' dissemination of knowledge. *Journal of Educational Administration*, 42(3), 312–332. <https://doi.org/10.1108/09578230410534658>.
- Davis, K. (2015). Teachers' perceptions of Twitter for professional development. *Disability & Rehabilitation*, 37(17), 1551–1558. <https://doi.org/10.3109/09638288.2015.1052576>.
- De Grip, A. (2015). The importance of informal learning at work. *IZA World of Labor*, 162, 1–10. <https://doi.org/10.15185/izawol.162>.
- Diefenbach, T. (2009). Are case studies more than sophisticated storytelling? Methodological problems of qualitative empirical research mainly based on semi-structured interviews. *Quality and Quantity*, 43(6), 875–894. <https://doi.org/10.1007/s11335-008-9164-0>.
- Eraut, M. (2000). Non-formal learning and tacit knowledge in professional work. *British Journal of Educational Psychology*, 70(1), 113–136. <https://doi.org/10.1348/000709900158001>.
- Eraut, M. (2004). Informal learning in the workplace. *Studies in Continuing Education*, 26(2), 247–273. <https://doi.org/10.1080/158037042000225245>.
- Flores, M. A. (2005). How do teachers learn in the workplace? Findings from an empirical study carried out in Portugal. *Journal of In-Service Education*, 31(3), 485–508. <https://doi.org/10.1080/13674580500200491>.
- Geijsel, F., & Meijers, F. (2005). Identity learning: The core process of educational change. *Educational Studies*, 31(4), 419–430. https://doi.org/10.1007/1-4020-4453-4_17.
- Gerken, M., Beusaert, S., & Segers, M. (2016). Working on professional development of faculty staff in higher education: Investigating the relationship between social informal learning activities and employability. *Human Resource Development International*, 19(2), 135–151. <https://doi.org/10.1080/13678868.2015.1116241>.
- Grosemans, I., Boon, A., Verclairen, C., Dochy, F., & Kyndt, E. (2015). Informal learning of primary school teachers: Considering the role of teaching experience and school culture. *Teaching and Teacher Education*, 47, 151–161. <https://doi.org/10.1016/j.tate.2014.12.011>.
- Hanraets, I., Hulsebosch, J., & de Laat, M. (2011). Experiences of pioneers facilitating teacher networks for professional development. *Educational Media International*, 48(2), 85–99. <https://doi.org/10.1080/09523987.2011.576513>.
- Harrison, J., & McKeon, F. (2008). The formal and situated learning of beginning teacher educators in England: Identifying characteristics for successful induction in the transition from workplace in schools to workplace in higher education. *European Journal of Teacher Education*, 31(2), 151–168. <https://doi.org/10.1080/02619760802000131>.
- Henze, I., van Driel, J. H., & Verloop, N. (2009). Experienced science teachers' learning in the context of educational innovation. *Journal of Teacher Education*, 60(2), 184–199. <https://doi.org/10.1177/0022487108329275>.
- Hodkinson, H., & Hodkinson, P. (2005). Improving schoolteachers' workplace learning. *Research Papers in Education*, 20(2), 109–131. <https://doi.org/10.1080/02671520500077921>.
- Hoekstra, A., Beijaard, D., Brekelmans, M., & Korthagen, F. (2007). Experienced teachers' informal learning from classroom teaching. *Teachers and Teaching: Theory and Practice*, 13(2), 191–208. <https://doi.org/10.1080/13540600601152546>.
- Hoekstra, A., Brekelmans, M., Beijaard, D., & Korthagen, F. (2009b). Experienced teachers' informal learning: Learning activities and changes in behavior and cognition. *Teaching and Teacher Education*, 25(5), 663–673. <https://doi.org/10.1016/j.tate.2008.12.007>.
- Hoekstra, A., & Korthagen, F. (2011). Teacher learning in a context of educational change: Informal learning versus systematically supported learning. *Journal of Teacher Education*, 62(1), 76–92. <https://doi.org/10.1177/0022487110382917>.
- Hoekstra, A., Korthagen, F., Brekelmans, M., Beijaard, D., & Imants, J. (2009a). Experienced teachers' informal workplace learning and perceptions of workplace conditions. *Journal of Workplace Learning*, 21(4), 276–298. <https://doi.org/10.1108/13665620910954193>.
- Jacobs, R. L., & Park, Y. (2009). A proposed conceptual framework of workplace learning: Implications for theory development and research in human resource development. *Human Resource Development Review*, 8(2), 133–150. <https://doi.org/10.1177/1534484309334269>.
- Jones, W. M., & Dexter, S. (2014). How teachers learn: The roles of formal, informal, and independent learning. *Educational Technology Research & Development*, 62(3), 367–384. <https://doi.org/10.1007/s11423-014-9337-6>.
- Jurasaitė-Harbisson, E. (2009). Teachers' workplace learning within informal contexts of school cultures in the United States and Lithuania. *Journal of Workplace Learning*, 21(4), 299–321. <https://doi.org/10.1108/13665620910954201>.
- Kang, Y., & Cheng, X. (2014). Teacher learning in the workplace: A study of the relationship between a novice EFL teacher's classroom practices and cognition development. *Language Teaching Research*, 18(2), 169–186. <https://doi.org/10.1177/1362168813505939>.
- Kim, T., McFee, E., Olguin, D. O., Waber, B., & Pentland, A. S. (2012). Sociometric badges: Using sensor technology to capture new forms of collaboration. *Journal of Organizational Behavior*, 33(3), 412–427. <https://doi.org/10.1002/job.1776>.
- Knight, P., Tait, J., & Yorke, M. (2006). The professional learning of teachers in higher education. *Studies in Higher Education*, 31, 319–339. <https://doi.org/10.1080/03075070600680786>.
- Kothari, C. R. (2003). *Research methodology. Methods and techniques* (2nd ed.). New Delhi, India: New Age International Limited.
- Krauss, S. E., & Guat, K. A. (2008). An exploration of factors influencing workplace learning among novice teachers in Malaysia. *Human Resource Development International*, 11(4), 417–426. <https://doi.org/10.1080/13678860802261660>.
- Kwakman, K. (2003). Factors affecting teachers' participation in professional learning activities. *Teaching and Teacher Education*, 19(2), 149–170. [https://doi.org/10.1016/S0742-051X\(02\)00101-4](https://doi.org/10.1016/S0742-051X(02)00101-4).
- Kyndt, E., & Baert, H. (2013). Antecedents of employees' involvement in work-related learning: A systematic review. *Review of Educational Research*, 83(2), 273–313. <https://doi.org/10.3102/0034654313478021>.
- Kyndt, E., Gijbels, D., Grosemans, I., & Donche, V. (2016). Teachers' everyday professional development: Mapping informal learning activities, antecedents, and learning outcomes. *Review of Educational Research*, 86(4), 1111–1150. <https://doi.org/10.3102/0034654315627864>.
- Lecat, A., Beusaert, S., & Raemdonck, I. (2018). On the relation between teachers' (in)formal learning and innovative working behavior: The mediating role of employability. *Vocations and Learning*, 11(3), 529–554. <https://doi.org/10.1007/s12186-018-9199-x>.
- Lohman, M. C. (2000). Environmental inhibitors to informal learning in the workplace: A case study of public school teachers. *Adult Education Quarterly*, 50(2), 83–101. <https://doi.org/10.1177/07417130022086928>.

- Lohman, M. C. (2003). Work situations triggering participation in informal learning in the workplace: A case study of public school teachers. *Performance Improvement Quarterly*, 16(1), 40–54. <https://doi.org/10.1111/j.1937-8327.2003.tb00271.x>.
- Lohman, M. C. (2005). A survey of factors influencing the engagement of two professional groups in informal workplace learning activities. *Human Resource Development Quarterly*, 16(4), 501–527. <https://doi.org/10.1002/hrdq.1153>.
- Lohman, M. C. (2006). Factors influencing teachers' engagement in informal learning activities. *Journal of Workplace Learning*, 18(3), 141–156. <https://doi.org/10.1108/13665620610654577>.
- Marsick, V. J., Volpe, M., & Watkins, K. E. (1999). Theory and practice of informal learning in the knowledge era. *Advances in Developing Human Resources*, 1(3), 80–95. <https://doi.org/10.1177/152342239900100309>.
- McPherson, M., Budge, K., & Lemon, N. (2015). New practices in doing academic development: Twitter as an informal learning space. *International Journal for Academic Development*, 20(2), 126–136. <https://doi.org/10.1080/1360144x.2015.1029485>.
- Meijiuni, O., Cranton, P., & Taiwo, O. (Eds.). (2015). *Measuring and analyzing informal learning in the digital age (Advances in higher education and professional development (AHEPD) book series)*. Hershey, PA: Information Science Reference.
- Nawab, A. (2011). Workplace learning in Pakistani schools: A myth or reality. *Journal of Workplace Learning*, 23, 421–434. <https://doi.org/10.1108/13665621111162954>.
- Noe, R. A., Tews, M. J., & Marand, A. D. (2013). Individual differences and informal learning in the workplace. *Journal of Vocational Behavior*, 83(3), 327–335. <https://doi.org/10.1016/j.jvb.2013.06.009>.
- Pati, D., & Lorusso, L. N. (2018). How to write a systematic review of the literature. *HERD: Health Environments Research & Design Journal*, 11(1), 15–30. <https://doi.org/10.1177/1937586717747384>.
- Pifer, M. J., Baker, V. L., & Lunsford, L. G. (2015). Academic departments as networks of informal learning: Faculty development at liberal arts colleges. *International Journal for Academic Development*, 20(2), 178–192. <https://doi.org/10.1080/1360144x.2015.1028065>.
- Pluye, P., Gagnon, M. P., Griffiths, F., & Johnson-Lafleur, J. (2009). A scoring system for appraising mixed methods research, and concomitantly appraising qualitative, quantitative and mixed methods primary studies in mixed studies reviews. *International Journal of Nursing Studies*, 46(4), 529–546. <https://doi.org/10.1016/j.ijnurstu.2009.01.009>.
- Rashid, R. (2018). Dialogic reflection for professional development through conversations on a social networking site. *Reflective Practice*, 19(1), 105–117. <https://doi.org/10.1080/14623943.2017.1379385>.
- Rehm, M., & Notten, A. (2016). Twitter as an informal learning space for teachers!? The role of social capital in twitter conversations among teachers. *Teaching and Teacher Education*, 60, 215–223. <https://doi.org/10.1016/j.tate.2016.08.015>.
- Reichenberg, M., & Andreassen, R. (2018). Comparing Swedish and Norwegian teachers' professional development: How human capital and social capital factor into teachers' reading habits. *Reading Psychology*, 39(5), 442–467. <https://doi.org/10.1080/02702711.2018.1464530>.
- Richter, D., Kunter, M., Klusmann, U., Lüdtke, O., & Baumert, J. (2011). Professional development across the teaching career: Teachers' uptake of formal and informal learning opportunities. *Teaching and Teacher Education*, 27(1), 116–126. <https://doi.org/10.1016/j.tate.2010.07.008>.
- Schei, V., & Nerbo, I. (2015). The invisible learning ceiling: Informal learning among preschool teachers and assistants in a Norwegian kindergarten. *Human Resource Development Quarterly*, 26(3), 299–328. <https://doi.org/10.1002/hrdq.21213>.
- Schreurs, M. L., Huveneers, W., & Dolmans, D. (2016). Communities of teaching practice in the workplace: Evaluation of a faculty development programme. *Medical Teacher*, 38(8), 808–814. <https://doi.org/10.3109/0142159x.2015.1112892>.
- Schugurensky, D. (2015). On informal learning, informal teaching, and informal education: Addressing conceptual, methodological, institutional, and pedagogical issues. *Measuring and analyzing informal learning in the digital age* (pp. 18–36). IGI Global. <https://doi.org/10.4018/978-1-4666-8265-8.ch002>.
- Singh, J. (2013). Critical appraisal skills programme. *Journal of Pharmacology and Pharmacotherapeutics*, 4(1), 76. <https://doi.org/10.4103/0976-500x.107697>.
- Springer, D. G. (2016). Teaching popular music: Investigating music educators' perceptions and preparation. *International Journal of Music Education*, 34(4), 403–415. <https://doi.org/10.1177/0255761415619068>.
- Stigler, J. W., Gallimore, R., & Hiebert, J. (2000). Using video surveys to compare classrooms and teaching across cultures: Examples and lessons from the TIMSS video studies. *Educational Psychologist*, 35(2), 87–100. https://doi.org/10.1207/S15326985EP3502_3.
- Tarc, P. (2007). Informal learning in 'Performative' times: Insights from empirical research on Canadian teachers' work and learning. *The Canadian Journal for the Study of Adult Education*, 20(2), 71–86.
- Thacker, E. S. (2017). "PD is where teachers are learning!" high school social studies teachers' formal and informal professional learning. *Journal of Social Studies Research*, 41(1), 37–52. <https://doi.org/10.1016/j.jssr.2015.10.001>.
- Thomson, K. (2015). Informal conversations about teaching and their relationship to a formal development program: Learning opportunities for novice and mid-career academics. *International Journal for Academic Development*, 20(2), 137–149. <https://doi.org/10.1080/1360144x.2015.1028066>.
- Thomson, K. E., & Trigwell, K. R. (2018). The role of informal conversations in developing university teaching? *Studies in Higher Education*, 43(9), 1536–1547. <https://doi.org/10.1080/03075079.2016.1265498>.
- Torraco, R. J. (2005). Writing integrative literature reviews: Guidelines and examples. *Human Resource Development Review*, 4(3), 356–367. <https://doi.org/10.1177/1534484305278283>.
- Van Eekelen, I. M., Boshuizen, H. P. A., & Vermunt, J. D. (2005). Self-regulation in higher education teacher learning. *Higher Education*, 50(3), 447–471. <https://doi.org/10.1007/s10734-004-6362-0>.
- Van Lankveld, T., Schoonenboom, J., Kusurkar, R., Beishuizen, J., Croiset, G., & Volman, M. (2016). Informal teacher communities enhancing the professional development of medical teachers: A qualitative study. *BMC Medical Education*, 16(1), 109. <https://doi.org/10.1186/s12909-016-0632-2>.
- Van Veen, K., Sleegers, P., Bergen, T., & Klaassen, C. (2001). Professional orientations of secondary school teachers towards their work. *Teaching and Teacher Education*, 17, 175–194. [https://doi.org/10.1016/S0742-051X\(00\)00050-0](https://doi.org/10.1016/S0742-051X(00)00050-0).
- Van der Klink, M., Van der Heijden, B., Boon, J., & Williams van Rooij, S. (2014). Exploring the contribution of formal and informal learning to academic staff member employability: A Dutch perspective. *Career Development International*, 19(3), 337–356. <https://doi.org/10.1108/cdi-03-2013-0030>.
- Viskovic, A. R. (2005). Community of practice as a framework for supporting tertiary teachers' informal workplace learning. *Journal of Vocational Education and Training*, 57(3), 389–410. <https://doi.org/10.1080/13636820500200293>.
- Wilson, E., & Demetriou, H. (2007). New teacher learning: Substantive knowledge and contextual factors. *Curriculum Journal*, 18(3), 213–229. <https://doi.org/10.1080/09585170701589710>.
- Zhao, Y., & Ko, J. (2018). Workplace learning in the professional development of vocational education teachers. *Studia Paedagogica*, 23(2), 43–58. <https://doi.org/10.5817/sp2018-2-4>.