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ORIGINAL PAPER

Predicting teachers' research reading: A machine learning approach

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Abstract

In addition to pre- and in-service teacher education programmes, teachers' autonomous reading of content related to their work contributes significantly to their professional development. This study investigated the factors that influenced the professional reading of 10,469 language teachers in the 2018 dataset of the Programme for International Student Assessment (PISA). Two machine learning models – logistic regression and Support Vector Machines (SVM) – were used to classify light and heavy readers. Nineteen variables related to teachers, including various aspects of their life, education and instructional practices, were used as predictors for classification. The results indicate that the two models had very similar accuracy scores around 65%. Moreover, the length of the reading texts that teachers assign to their students, instruction of reading comprehension strategies, and teachers' own general reading habits were found to be the most important predictors of professional reading time.

Keywords Teacher autonomy · Teachers' professional reading · Teacher development · Logistic regression · Support vector machine (SVM) · Machine learning models

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Résumé
Prédire les lectures professionelles des enseignants : approche par l'apprentissage machine – En plus des programmes de formation initiale et continue des enseignants, le choix autonome qu'ils font des lectures liées à leur activité professionnelle favorise considérablement leur évolution professionnelle. La présente étude examine les facteurs ayant influé sur les lectures professionnelles de 10 469 professeurs de langues, à la lumière des données recueillies en 2018 dans le cadre du Programme international pour le suivi des acquis des élèves (PISA). Deux modèles d'apprentissage – celui de la régression logistique et celui des machines à vecteurs de support ou séparateurs à vaste marge (en anglais *support-vector machine,* SVM) – furent utilisés pour établir des catégories des lecteurs occasionels et des lecteurs avidus. Dix-neuf variables liées aux enseignants, entre autres différents aspects de leur vie, leur formation et leurs pratiques pédagogiques furent utilisées comme indicateurs prévisionnels pour cette classification. Les résultats indiquent une très grande similitude des scores de précision avoisinant les 65 % pour les deux modèles. En outre, la longueur des textes que les enseignants donnent à lire à leurs élèves, l'enseignement des stratégies de compréhension de la lecture et les habitudes globales de lecture des enseignants se sont révélés être les principaux indicateurs prévisionnels de leur temps de lecture professionnelle.

Introduction

Teacher professional development takes a variety of forms, and what drives teachers to grow professionally goes far beyond their formal pre- and in-service education programmes. While research reading is an important and beneficial source of teacher development, it has been under-researched for a long time. *Teachers' research reading* refers to teachers' reading of materials and research related to their profession. It is a self-directed act that teachers engage in freely based on their own needs and interests (Dikilitaş and Mumford 2019). Therefore, teachers' research reading can be closely linked to teacher autonomy.

Teacher autonomy

After *learner autonomy* was first defined by Henri Holec (1979) and later established its place in the literature, more recently researchers also directed their attention to *teacher autonomy* (Jeong and Luschei 2018). Flávia Vieira links these two autonomies, stating that

> an understanding of autonomy as a collective interest and a democratic ideal implies that in the expression "pedagogy for autonomy", *autonomy* refers to the learner *and* the teacher (Vieira 2020, pp. 144–145; italics in original).

Table 1 Dimensions of teacher autonomy, adapted from Smith (2003)

1. In relation to professional action	
A	Self-directed professional action
B	Capacity for self-directed professional action
C	Freedom from control over professional action
2. In relation to professional development	
A	Self-directed professional development
B	Capacity for self-directed professional development
C	Freedom from control over professional development

However, various researchers have different definitions of and approaches to teacher autonomy (Smith 2003). Ian McGrath (2000) introduced a two-dimensional framework of teacher autonomy consisting of (1) self-directed development and (2) freedom from external control. Inspired by McGrath's framework, Richard Smith (2003) argued for a six-dimensional framework in an attempt to resolve the definitional confusion over teacher autonomy (Table 1). Smith's framework distinguishes between teacher autonomy as a self-directed action and teacher autonomy as self-directed development, with the former referring to teachers' teaching practice and the latter pointing to teachers' learning of pedagogical knowledge and skills. This distinction can help to position the present study in the literature and clarify its theoretical as well as practical implications.

Teachers' reading of research contributes to teacher autonomy in both of the dimensions mentioned above. First, research reading is a self-directed activity that helps teachers take responsibility for their own development and become autonomous learners of the teaching profession (i.e., Dimension 2) (Dikilitaş and Mumford 2019). Second, research reading also indirectly helps teachers develop autonomy in their teaching practice (i.e., Dimension 1), as it further enables them to develop a critical view of their instruction, theoretically justify their actions, talk about their practice, and reflect on their choices and decisions (Borg 2013).

Gap in the literature and study goals

In spite of the significant role of teacher reading in teacher professional development, it has been reported that teachers do not spend much time reading about topics in their profession (Rudland and Kemp 2004). The reasons for this remain largely unclear (Broemmel et al. 2019). Given the importance of research reading in fostering teacher autonomy and the lack of sufficient knowledge about factors affecting it, the present study attempts to predict teachers' amount of reading professionally relevant materials (i.e., research reading) based on a number of personal, instructional, professional and educational factors.

Research questions

The following research questions guided the present study:

1. How accurately can teachers' research reading be predicted based on personal, instructional, professional, and educational factors using logistic regression and SVM modelling?
2. What are the most important predictors of teachers' research reading from among the available features?

Literature review

The importance of teachers' reading

Teachers' reading can be viewed as either reading professional materials related to various aspects of a teacher's work (referred to as *teachers' research reading* in this article) or engaging in any act of general reading (e.g., pleasure reading). Research shows that both types of teachers' reading can affect teachers' as well as their students' performance. Regarding teachers' research reading, Amy Broemmel et al. (2019) report that this type of reading can have an effect on student achievement, which may be due to improvements in teachers' instructional practice as a result of their own professional development. Regarding teachers' general reading, Sharon McKool and Suzanne Gespass (2009) show that teachers who spend more than half an hour per day reading various materials are more effective in teaching reading to their students.

Teachers' professional (research) reading

Interest in teachers' research reading has surged in the last decade, as it is considered to have benefits for both teachers and their students. Research reading is regarded as an important component of teacher development in general (Kotaman et al. 2018). It differs from other components of teacher development (e.g., teacher education programmes) in that research reading is self-directed; teachers thus take responsibility for their own development and become autonomous learners of the teaching profession (Reichenberg and Andreassen 2018). Some studies also indicate that professional development throughout a teacher's career can be even more important than their undergraduate studies (Harris and Sass 2009). It seems that teachers are also aware of this. Specifically, Rune Andreassen (2012) reported that Norwegian teachers consider professional self-development to be more significant than the knowledge they gain through their pre- and in-service educational programmes.

Teachers' general reading

Similar results have been found regarding the impacts of general or pleasure reading on teachers' quality of instruction and students' performance. For instance, teachers who read more tend to teach more appropriate reading strategies in their classes,

regardless of their experience level (Benevides and Peterson 2010). More importantly, teachers who are avid readers themselves tend to promote stronger reading habits among their students (Daisey 2009; Merga 2015):

> Teachers who are models of keen recreational reading can play an important role in fostering a keen love of reading in children (Merga 2016, p. 255).

Another potential reason for the relationship between teachers' reading and their students' reading could be what researchers Anthony and Mary Applegate termed the "Peter Effect" (see Applegate and Applegate 2004, p. 554), which states that teachers (like the Apostle Peter, who had no money to give to the beggar) can offer their students only what they themselves possess.

Low levels of teachers' reading

Given the importance of teachers' reading, the small amount of reading that teachers engage in can be alarming. It seems that teachers' amount of reading resembles the wider public's limited reading time (Burgess et al. 2011). The results of other studies investigating teachers' general reading suggest the same. While there may be a presupposition that most teachers are avid readers and spend large amounts of time reading, research very often suggests the opposite (Pillai 2015; Vansteelandt et al. 2017). Pre-service teachers seem no different in this regard (see, for example, Benevides and Peterson 2010). SuHua Huang and colleagues (2014) also highlight that college students studying education as their main subject read even less than college students enrolled in other disciplines.

Even in cases where teachers are enthusiastic about reading and hold positive attitudes towards it, the amount of their reading is still limited. Nicole Rimensberger (2014) shows that there is a sharp contrast between teachers' positive attitudes towards reading and their low amounts of reading. Her qualitative data suggest that the main reasons for this discrepancy are lack of pleasure in reading and "too little time, having too much work to do or not finding the right type of book" (Rimensberger 2014, p. 5). Similarly, Matthew Sroka (2021) found that teachers tend to prioritise other personal and professional responsibilities over reading.

The same contrast seems to exist between teachers' beliefs about professional reading and the amount of time they dedicate to it. While teachers are reported to believe professional reading can enhance their instructional practice (e.g. Behrstock et al. 2009; Commeyras et al. 1997), few teachers do so regularly (Carrol and Simmons 2009). Such a mismatch may be partially due to practical factors such as time constraints (Burgess et al. 2011; Broemmel et al. 2019). Other studies have shown that many schools and teachers lack access to a large number of journals (Penuel et al. 2016) and that the technical language used in scholarly journals is inaccessible to many teachers (Gazni 2011). Accordingly, the low amount of teachers' research reading has led some scholars to argue for greater emphasis on research literacy in teacher education, comparing it with more research-oriented education in some other professions, such as nursing (Nierenberg 2017).

Methodology

This section describes the dataset we used for data collection, the participants, the data collection instruments, the preprocessing of data for use in predictive models, the variables we used as features and outcome for the models, the two machine learning models we used, and the procedures we applied to conduct our research study.

Participants, procedure and data sources

Of the 107,367 teachers who completed the language teacher questionnaire of the 2018 Programme for International Student Assessment (PISA) study, we included only 10,469 in the present study. We based our selection on the availability of information on the personal, educational, instructional, and professional data required for the present study. The subset of data we used largely resembles the complete dataset of PISA 2018 in terms of the proportion of participating countries. In both our subset and the original dataset, Spain and the United Arab Emirates (UAE) have the highest number of participating teachers at around 19% and 12%, respectively. The only considerable difference between the two datasets is the absence of teachers from Peru in the subset. Accordingly, the subset includes the data of teachers from 18 countries: Albania, Azerbaijan (Baku City only), Brazil, Chile, Chinese Taipei, the Dominican Republic, Germany, Hong Kong (China), Macao (China), Malaysia, Morocco, Panama, Portugal, the Republic of Korea, Spain, the United Arab Emirates (UAE), the United Kingdom (UK) and the United States (US). It should also be noted that the data from the language teacher questionnaire do not require any preprocessing for setting appropriate weighting as is the case with some other questionnaires in PISA datasets (OECD 2018).

Preprocessing data

Both the features (independent variables) and the outcome (dependent variable) of our research underwent some preprocessing before we fed them into machine learning algorithms. We reduced the outcome variable, which was originally a 4-point Likert scale ("less than 1 hour a week", "1–3 hours a week", "4–6 hours a week" and "more than 6 hours a week"), to two distinct categories of light readers ("less than 3 hours a week") and heavy readers ("more than 6 hours a week"). We did this for two reasons. First, such self-reported items lack precision (Rosenman et al. 2011), so the distinctions between the categories are only approximate in nature. Second, the data in their original format would be highly skewed towards higher levels of reading time, resulting in a highly unbalanced design. Unbalanced designs tend to negatively affect the performance of machine learning algorithms (Ramyachitra and Manikandan 2014).

The transformed data show a clearer distinction between the levels of research reading as well as an almost balanced distribution in the two categories. We

achieved the balanced distribution by selecting the appropriate thresholds for categorising teachers in terms of their research reading time. Other studies have used similar strategies to divide their participants into two groups of heavy and light readers. McKool and Gespass (2009), for example, compared teachers who read less than 10 minutes per day with those who read more than 30 minutes a day. In another example, Stephen Burgess et al. (2011) compared teachers who read one book or less per month (bottom third) with those who read two or more books monthly (top third), removing the middle third (i.e., those reading one to two books per month). As shown in Table 2, light readers and heavy readers constituted 43.7% and 56.3% of the data, respectively. The last preprocessing step was to scale all the features of the study to standardise them. For this purpose, the RobustScaler function in Python was used.

Features and outcome

The data collected from one of the questionnaire items on the amount of time teachers spend reading content related to their practice – "About how much time per week do you spend reading for your work (e.g., articles, magazines, books, manuals and websites) out of your classes?" – served as the outcome. As for the features, we took several categorical and continuous variables from the questionnaire, including items related to teachers' age, experience, topics covered in their teacher education programmes, amount of reading they assign to their students, use of reading strategies in their instruction, general reading habits, job satisfaction, beliefs about different aspects of language teaching, and classroom practices. In some cases, we merged the questionnaire items into a single feature if they were eliciting information on the same construct or topic, but in other cases, we avoided this integration because it would not make much sense. One example of the merged items is teachers' overall job satisfaction, consisting of 10 questionnaire items, each of which dealt with an aspect of job satisfaction (e.g., enjoying working as a teacher or thinking highly of the teaching profession). On the other hand, one example of questionnaire items that could not be merged is the ones on the inclusion of different topics in teacher education programmes, as it would not make much sense to merge, for example, "knowledge of the subject field" with "approaches to individualised learning". Moreover, in order to reduce the number of features and allow for multicollinearity among them, we ran correlations, and in cases where two or several features strongly correlated, we selected only one of them for inclusion in our analysis. Selections were mainly made based on the available literature. For example, since the variables of age and

Table 2 Frequency and percentage of data in the outcome

Research reading	Frequency	Percentage
Light readers	4,575	43.7
Heavy readers	5,894	56.3

Table 3 Features used in the logistic regression and SVM models

No.	Feature name/description
1	Age
2	Topics in teacher education programmes: knowledge and understanding of my subject field(s)
3	Topics in teacher education programmes: ICT skills for teaching
4	Topics in teacher education programmes: teaching about equity and diversity
5	The longest piece of text your students had to read for your lessons
6	Involvement in online activities: reading e-mails
7	Involvement in online activities: chatting online (e.g., on WhatsApp and Messenger)
8	Involvement in online activities: reading online news
9	Involvement in online activities: searching information online to learn about a topic
10	Involvement in online activities: taking part in online group discussions or forums
11	Involvement in online activities: Searching for practical information online (e.g., schedules, events, tips and recipes)
12	General reading habits: books on any topic
13	General reading habits: news of any type
14	Teachers' attitudes towards the importance of teaching reading
15	A group of 9 items on the occurrence of specific adaptive instruction and feedback situations in the classroom (e.g., tailoring teaching to meet students' needs, providing individual help and support, and giving students feedback)
16	A group of 7 items on teaching skills and strategies for using information on the Internet (e.g., using keywords in search engines, assessing the trustworthiness of online information, and comparing the relevance of materials on different webpages)
17	A group of 4 items on teachers' attitudes towards their education, responsibility, confidence, and capability for teaching reading comprehension
18	A group of 10 items on teachers' job satisfaction
19	A group of 11 items on teaching reading comprehension strategies and aspects (including identifying the main ideas, explaining the understanding of the text, making inferences, describing the style and structure of the text, determining the author's purpose or perspective, summarising strategies, connecting texts with prior content knowledge, monitoring comprehension, adapting the mode of reading depending on reading purposes, assessing credibility of information available on the Internet, and searching and selecting relevant information on the Internet)

experience were highly correlated, we retained only age. In total, we used 19 features. The complete list of the variables we used as features appears in Table 3.

Algorithms

We used the two machine learning classifiers of logistic regression and Support Vector Machine (SVM) for training models in this study. The former provides high interpretability, while the latter usually performs better. Being a type of generalised linear model, logistic regression is a commonly used algorithm, often as the baseline, in classification studies (Levy and O'Malley 2020). The more complex SVM model aims to find the optimum hyperplane that best separates the two groups (Fei and Zhang 2009) and works well in classification problems (Bzdok et al. 2018).

Analyses

After selecting the appropriate features and conducting the necessary preprocessing as described above, we first split the dataset into a training and test (hold-out) set with a ratio of 5:1. Then, using 10-fold cross-validation, we further divided the training set into a new training set and a validation set to find the best hyperparameters for the models. We then used the discovered hyperparameters to train the model one more time on the original training set. We used the final model on the hold-out set to report the performance of the models and other evaluation metrics. It should be noted that the same training, validation, and hold-out sets were used for both algorithms to make the comparison between the performance of the two models as fair as possible.

The best hyperparameters we found from the cross-validation procedure described above for the two models are as follows. We found the three best hyperparameters of solver ("newton-cg", "lbfgs", and "liblinear"), penalty ("none", "l1", "l2", and "elasticnet"), and C (a real number) for logistic regression to be newton-cg, l2, and 0.5, respectively. For the SVM model, we found the best three hyperparameters of kernel ("rbf", "linear", and "poly"), C (1, 10, and 100) and gamma (0.1, 0.01, and 0.001) to be "rbf", 100, and 0.001, respectively.

Results

How accurately can teachers' research reading be predicted from personal, instructional, professional and educational factors using logistic regression and SVM?

Regarding the first research question guiding our study, the logistic regression and SVM models showed very similar performance in correctly predicting the amount of teachers' research reading on all evaluation metrics, with the SVM model being around 1% more accurate than the logistic regression, as shown in Table 5. Since we used a relatively balanced design in this study, the weighted average estimates for precision, recall, and F1-score were similar to the macro average ones. Given their performance similarity, we chose logistic regression for this research problem and dataset due to its higher interpretability advantage. Moreover, SVM is computationally far more expensive, especially when finding the best hyperparameters using grid search and cross-validation. A detailed comparison of the two models is presented in Figure 1 and Table 4. In addition, the confusion matrices for the SVM and logistic regression models are provided in Tables 5 and 6, respectively.

Figure 1 shows the ROC curves for the baseline of 0.5, which represents random guessing, alongside the logistic regression and SVM models. The two curves are very similar, with the same ROC AUC of 0.70, indicating that the two models performed similarly.

The confusion matrix for the SVM model as shown in Table 5, compared with the confusion matrix for the logistic regression as shown in Table 6, indicates that while the two models performed similarly, there was a slight difference in predicting

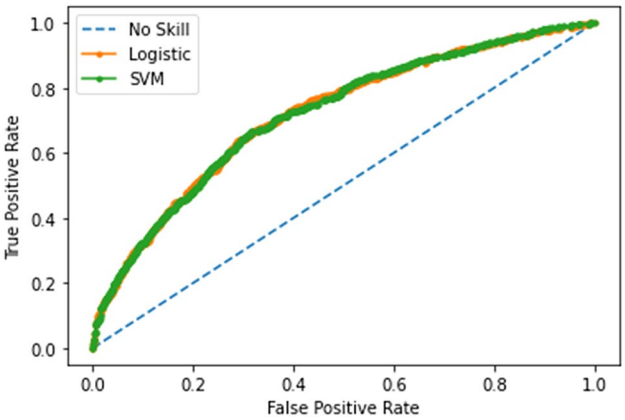

Fig. 1 ROC curves for the logistic regression and SVM models

Table 4 Results of the evaluation metrics for the logistic regression and SVM models

	Accuracy (hold-out set)	Accuracy (training set)	Precision (macro/ weighted avg.)	Recall (macro/ weighted avg.)	F1-score (macro/ weighted avg.)
Logistic regression	0.64	0.66	0.64/0.64	0.63/0.64	0.63/0.64
SVM	0.65	0.66	0.64/0.64	0.63/0.65	0.64/0.64

Table 5 Confusion matrix for the SVM model

		Predicted evaluation metrics					
		Low	High	Total	Precision	Recall	F1-score
True	Low	481	434	915	0.61	0.53	0.57
	High	303	876	1,179	0.67	0.74	0.70
	Total	784	1,310	2,094			

Table 6 Confusion matrix for the logistic regression model

		Predicted evaluation metrics					
		Low	High	Total	Precision	Recall	F1-score
True	Low	471	444	915	0.61	0.51	0.56
	High	300	879	1,179	0.66	0.75	0.70
	Total	771	1,323	2,094			

light versus heavy readers. Having made 481 correct predictions for light readers (versus the 471 correct predictions made by the logistic regression model), the SVM model had a slightly better F1-score (around 1%) in predicting light readers.

What are the most important predictors of teachers' research reading from among the available features?

Regarding our second research question, Figure 2 shows the most important features in the logistic regression model, and Table 7 provides the importance score and odds ratio of each feature in the logistic regression model.

As can be seen in Figure 2 and Table 7, teacher instruction of different reading comprehension strategies had the highest predictive power in the logistic regression model. Of almost equal predictive power is the length of reading texts that teachers assigned to their students. The next two almost equally significant features are how teachers read books and news in general. As for inverse relationships, we found Online Activities 2 (i.e., chatting online) to have the strongest negative correlation with research reading.

Discussion

The most significant feature of the regression model was the instruction and use of reading comprehension strategies. In a similar study, Burgess et al. (2011) examined the association between teachers' best practice techniques and their amount of reading. Although they could find significant relationships for only two of their many techniques, they state that other studies have reported more significant relationships. The main reason for the differing results of Burgess et al. (ibid.) could be that they used teachers' amount of leisure reading, while the present study investigated research reading time.

Another aspect of reading instruction is the length of texts that teachers assign their students to read, which was found to be almost as important a feature as the instruction of reading comprehension strategies. This relationship between teachers' and their students' reading behaviour may be explained through the Peter Effect mentioned above (i.e., teachers cannot give their students what they do not possess themselves; Applegate et al. 2014). Therefore, teachers who read a lot tend to assign longer reading texts to their students. This finding is also consistent with a number of other studies mentioned above that have found a relationship between teachers' amount of reading and their classroom practice, especially reading instruction (McKool and Gespass 2009).

These two findings (i.e., teachers' use of reading strategies in the classroom and the importance of the amount of reading teachers assign) further suggest a link between teachers' research reading and their teaching practice. This may also imply that research reading can serve as a type of teacher self-development through improving their knowledge. As Deborah McCutchen et al. (2002) have shown, teacher knowledge can inform and shape practice in several ways. A teacher's knowledge of content and pedagogy can help them teach the content more effectively, develop better lesson plans, foster teacher reflections on practice, improve teacher-student interactions, and so forth (Walshaw 2012). This can be also viewed at the level of teacher education research and the discussion of knowledge mobilisation (KM), i.e.,

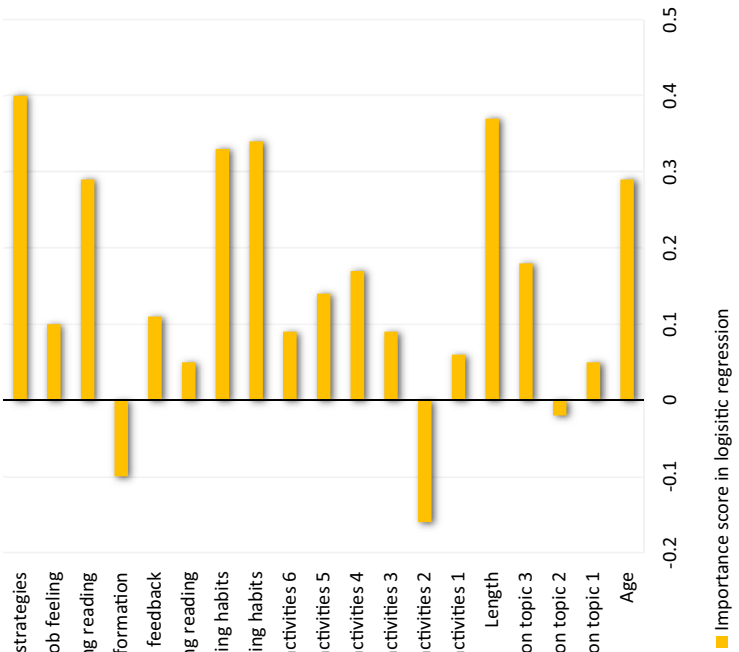

Fig. 2 Feature importance in the logistic regression model

Table 7 Feature importance and odds ratios in the logistic regression model

No.	Feature	Importance score	Odds ratio
1	Age	0.29	1.34
2	Teacher education programme topics 1	0.05	1.05
3	Teacher education programme topics 2	–0.02	0.98
4	Teacher education programme topics 3	0.18	1.20
5	Length of reading assignment	0.37	1.45
6	Online activities 1	0.06	1.06
7	Online activities 2	–0.16	0.85
8	Online activities 3	0.09	1.09
9	Online activities 4	0.17	1.18
10	Online activities 5	0.14	1.15
11	Online activities 6	0.09	1.09
12	General book reading habits	0.34	1.40
13	General news reading habits	0.33	1.39
14	Importance of teaching reading	0.05	1.05
15	Adaptive instruction and feedback	0.11	1.12
16	Teaching strategies for using online information	–0.10	0.90
17	Attitudes towards teaching reading	0.29	1.34
18	Job feeling	0.10	1.10
19	Teaching reading comprehension strategies	0.40	1.49

> the process by which knowledge is transferred from its originating community – often a research community – to other communities, which are often policy or practice communities (Cain et al. 2016, p. 529).

The results of the present study are in line with those of Georgeta Ion and Romita Iucu, who found that teachers' "reading about research findings in journals" is one of several "useful strategies that facilitated research utilisation in practice" (Ion and Iucu 2016, p. 602). However, not all the knowledge teachers gain through reading research can be directly transferred to practice (Borg 2015; Davoodi and Yousefpoori-Naeim 2014).

We found the next two equally significant factors predicting research reading to be teachers' habits of reading general books as well as news. This is an interesting finding, as the relationship between teachers' professional and personal reading has been neglected by previous studies. While professional reading is indeed different from personal reading in various aspects, the former can be seen as rooted in the latter in the sense that professional reading follows general reading. The alarming issue of low rates of professional reading reported in the literature (e.g., Rudland and Kemp 2004) may be primarily due to the unsatisfactory general reading habits of teachers rather than their professional reading *per se.* When investigating professional reading, general reading habits should receive similar attention comparable to other professional factors, such as teachers' experience or education. As the results of our study indicate, teachers who have stronger habits of reading books and news

on any topic are generally better professional readers as well. This suggests that the many reasons reported in the literature for teachers' low levels of general or pleasure reading may also apply to professional reading.

After the four salient features of the logistic regression model (as discussed above), we found the variable of age to be one of the strongest predictors of teachers' research reading. This relationship has been shown to be significant in other studies as well. Monica Reichenberg and Rune Andreassen (2018), for example, found that older teachers generally spend more time reading various sorts of materials, including fiction, nonfiction, and newspapers. Similar trends have been also found among professionals other than teachers (Berg and Chyung 2008). In a similar vein, other studies have shown that more experienced teachers read more professional materials (Broemmel et al. 2019), which also supports our own finding in the present study, as more experienced teachers tend to be older. As explained in the methodology section, we observed a strong direct relationship between age and experience among the teachers who participated in PISA 2018, and in order to resolve multicollinearity, we removed the variable of experience from the list of predictors. The significant effect of age on research reading may also be linked to time availability. As discussed in the literature review, lack of time has frequently been reported as a major reason for teachers' limited engagement in reading. Older teachers may have more free time for reading compared to their younger colleagues, who may be busy with children and familial responsibilities.

Finally, we found an inverse relationship between chatting online and research reading. Although the relationship is not as strong as that of other major predictors, such as teaching reading strategies or the length of reading assignments, it still stands out, as chatting online is the only online activity in the set of six online activities that is inversely related to professional reading (see Table 3 for a list of the online activities). This could be due to the disadvantages of using instant messaging applications such as WhatsApp, as also reported by other studies (see Yılmazsoy et al. 2020 for a literature review). Chatting online can be addictive and time-consuming, cause distractions, and lead to eye strain and sleep disorders (Dietz and Henrich 2014; Gon and Rawekar 2017; Yeboah and Ewur 2014), all of which have a limiting effect on reading time. Online activity may also give teachers the false impression that they do not need to read research because they receive large amounts of multimedia content on various topics, including the teaching profession. Such multimedia materials are usually more appealing compared to reading text. Nevertheless, the main drawback of such information circulated on social media is its low factual reliability (Shahzad et al. 2023).

Limitations and future work

This study has several limitations. First, self-reported data collected through questionnaires pose a limitation on interpreting the results. However, the convergence across different studies could be a sign that the results are reliable (Broemmel et al. 2019). Future studies could employ a variety of measurement instruments to mitigate this limitation. Second, several important variables were not included, as there

were no relevant items for these variables in the PISA questionnaire. These include teachers' attitudes towards research and reading research, reading atmosphere in the teacher's family, teachers' content and pedagogical knowledge, and membership/attendance in professional book clubs. Future studies could incorporate these variables into their instruments and use direct measures of teaching practice as a continuation of this line of research. Third, the model performance was modest, which implies that more complex models are needed to capture the relationship between the features (i.e., predictors) and the response (i.e., outcome) variable. Future studies should include more predictors and more complex models to mitigate this issue. Finally, our selection of individual participants as well as countries from the large dataset of PISA 2018 was based on the availability of data for the variables of interest. Since the present study used a large number of variables as features, and a lot of data for different variables were missing for different countries, it was not possible to narrow down the research to a single country or add countries as a layer of analysis. With the next run of PISA, future studies could replicate this study, hopefully with sufficient data collected from teachers of individual countries to make either country-specific or multilevel modelling analyses possible.

Conclusion and implications

Despite the significance of reading research materials for teacher development in general, and teacher autonomy in particular, the reasons for the reportedly low amount of research reading among teachers are largely unknown. Thus, the present study investigated the factors affecting teachers' reading of research related to their profession. We utilised machine learning algorithms to predict the amount of teachers' research reading using 19 features. We found the amount of reading that teachers assign to their students, the use of reading comprehension strategies in their instruction, their habits of reading general books and news, and, to a lesser degree, their age to be associated with their professional reading in the logistic regression model.

The most significant finding of our study was the association between teachers' research reading and their classroom practice through the assignment of reading materials as well as teachers' instruction of reading comprehension strategies. This finding implies that the merits of teachers' professional reading out of teacher development programmes as a kind of self-development strategy should not be underestimated. It is also important to note that, although self-development strategies generally require smaller investments than other professional development programmes, teachers' research reading should not be left unsupported. As argued by Mark Rickinson (2003), teachers may need help locating the relevant research studies and understanding the research language. Similarly, Neale Rudland and Coral Kemp (2004) and Asher Shkedi (1998) also state that many teachers refrain from reading research because they find it irrelevant and theoretical. This problem is partially due to the lack of teacher training on how to read and use research findings (Hood 2003). That is also why a greater focus on research literacy in initial teacher education is often recommended.

Teacher education not only includes the formal programme teachers are required to complete, but also involves different stakeholders, including policymakers, teacher education programme developers, schools, and even researchers. All these stakeholders play a role in continued teacher development. Policymakers and programme designers should incorporate a research component in teacher education programmes. This component can cover a wide range of activities and skills from asking teachers to learn research methodology and conduct research (usually in the form of action research) to simply reading research studies (Flores 2016). Some countries, such as Portugal (Flores 2018), go even further and require teachers to complete a graduate programme with either compulsory or optional research courses. Graduate studies can facilitate research utilisation and knowledge mobilisation by helping teachers link academic research to their teaching practice (Ion and Iucu 2016). While many schools consider fostering research beyond their responsibilities (Witherow 2011), they should be encouraged to reinforce research-oriented teacher education by promoting research activities. Clive Dimmock (2016) believes that schools should be centres for conducting research. This can mean teachers conducting research on their own in their classes as well as collaborating with researchers in academic research studies (Barkhuizen 2021). Similarly, researchers should strengthen their professional bonds with teachers, especially if they want their work to have an impact on practice (Sato and Loewen 2022). Only when these, and other relevant conditions are met, are teachers likely to engage in more research reading.

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