



Typical spelling errors of Grade 1 spellers of Polish: An exploratory study adapting the POMAS classification to the Polish orthography

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Abstract

This paper presents the adaptation of the POMAS classification of spelling errors (Silliman et al., *Developmental Neuropsychology* 29:93–123, 2006, Bahr et al., *Journal of Speech, Language & Hearing Research* 55:1587–1599, 2012; *International Journal of Bilingual Education and Bilingualism* 18:73–91, 2015) to Polish orthography. We identified the most common phonological, orthographic, and/or morphological errors committed by Polish Grade 1 spellers based on a writing-to-dictation task. Some of the error types were included in the original POMAS; some we added, following the classification rationale, to adapt the classification to the specific features of the Polish orthography. Moreover, we found that the participants made, on average, an equal number of phonological and orthographic errors, and of phonological and morphological errors. However, orthographic errors were more frequent than morphological ones. A roughly equal proportion of orthographic and phonological errors occurred in the spelling of the most difficult words. The most frequent orthographic error type was grapheme substitution, followed by final consonant devoicing, and consonant devoicing within a word errors. The most frequent phonological error type were misspellings in diacritic signs, followed by consonant deletion, vowel deletion, and epenthesis. The developed POMAS-PL version may be used by other researchers of Slavic languages, to allow for intercultural comparisons. Moreover, our analyses can be used by teachers of Polish as a first and a second language to anticipate their students' errors and to understand what knowledge the learners need to learn to spell correctly.

Keywords Spelling · Polish orthography · Grade 1 spellers · Phonological errors · Orthographic errors · Morphological errors

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Introduction

This paper focuses on spelling skills, part of more widely understood writing skills, which have not been the subject of scientific inquiry as frequently as reading has (Boulware-Gooden et al., 2015). Specifically, we looked at spelling skills in Grade 1 spellers, as learning how to write constitutes one of the most important stages of a child's development during early education (Brzezińska et al., 2012). The language of interest was Polish, a West Slavic, synthetic, inflectional language, with a semi-transparent orthography (Awramiuk, 2006). We aimed to identify and describe types of errors that could not occur in English, which, as noted by Joye et al. (2022), could provide further evidence for or against the universal nature of literacy development and difficulties as demonstrated in other, more transparent, orthographic systems. As learning how to spell requires using phonological, morphological, orthographical, and semantic knowledge (Joshi et al., 2008), we decided to adapt the POMAS classification, which defines phonological, orthographic, and morphological types of errors (Silliman et al., 2006), to the characteristics of Polish orthography. Moreover, we assessed the relationship between the Grade 1 spellers' phonological awareness and their spelling skills.

Polish orthography

Polish has a large consonant inventory, moderately high consonant–vowel ratio, complex syllable structure (Dryer & Haspelmath, 2013), and semi-transparent, semi-consistent, and semi-regular grapheme-phoneme mappings (Awramiuk, 2006). Spelling is based on four principles: phonological (most words can be written phonetically), morphological, historical, and conventional (Gajda, 1999). The phonological principle is based on grapheme-phoneme mapping, e. g. /dom/ is spelled as *dom* (a house). The morphological principle refers to a constant spelling of a given morpheme in inflected and other word-forms, regardless of the changes in pronunciation, e. g. /gat/ is spelled as *gad* (a reptile), and then as *gada*, pronounced as /gada/—an inflected form, and as *gady*, pronounced as /gadi/—a plural form. The historical principle refers to the three pairs of graphemes: *ch-h*, *ó-u*, *ź-rz*, the usage of which is based on the historical processes of the development of Polish, and which currently represent the same phoneme within a pair, e. g. graphemes *ó* and *u* both represent /u/, in, e. g. *góra* /gura/ (a mountain) and *kura* /kura/ (a hen). The conventional principle refers to usage that is fixed by convention, and not explained adequately by the phonological, morphological, and historical principles mentioned above. It concerns primarily the joint vs separate spelling of function words, e. g. particle *nie* (not) is spelled (usually) as one word with nouns, e. g. *nieszczęście* (bad luck), but as two words with verbs, e. g. *nie wiem* (I do not know). Moreover, grapheme-phoneme correspondences in Polish are more consistent than phoneme-grapheme ones (Awramiuk, 2006). This latter characteristic is typical of most alphabetic orthographies (Moll et al., 2014). Declension and conjugation (e. g. 11 conjugation groups of verbs) are used to indicate a word's syntactic function (Tokarski, 1978).

Both prefixes and suffixes are used, though suffixes occur more frequently, for 7 noun cases, tense, and aspect (Dryer & Haspelmath, 2013). Such a rich morphology might be, on the one hand, helpful for a speller, as the same affixes reoccur consistently. For example, the noun *dom*, has the following inflectional endings (underlined; zero morphemes are not shown): nominative: *dom*, genitive: *domu*, dative: *domowi*, accusative: *dom*, instrumental: *domem*, locative: *domu*, and vocative: *domie*. This shows that inflectional morphemes in Polish might be as long (or even longer), than the lexical ones. Derivational morphemes may also appear at the beginning or in the middle of words, e.g., in terms of a grammatical aspect, the perfective forms of the verb *pisać* (to write; an imperfective aspect), are *przepisać*, *zapisać*, *spisać* (all words differ semantically). Complex morphonology and inflection may facilitate spelling accuracy. For example, as the final plosives, fricatives, and affricates (but not nasals, vibrants, and approximants) in Polish words are devoiced in speech, the word *kod* (a code), is pronounced /kɔt/. However, following the morphological principle mentioned earlier, the spelling retains the final grapheme *d*, usually representing phoneme /d/ (even though, typically, grapheme *t* represents phoneme /t/, following the phonological principle). This reflects the relation of the word to its inflected forms: *kodu* /kɔdu/, *kodem* /kɔdɛm/, and the plural form: *kody* /kɔdi/, thus creating a regular orthographic principle. On the other hand, however, a rich morphology results in much longer words to be processed. A more comprehensive description of Polish can be found in Pietras and Łockiewicz (2020), and a comparison between Polish and English in Jaskulska and Łockiewicz (2017).

Spelling development in Polish

The most comprehensive psycholinguistic description of the spelling development in Polish was offered by Awramiuk and Krasowicz-Kupis (2014). The authors identified the following three stages: (1) The initial stage (the aim: familiarization with the concept and conventions of written communication, before the start of formal spelling instruction); (2) The key stage (the aim: phoneme-grapheme correspondence learning and the development of phonological, orthographic, and morphological awareness); and (3) The proficiency stage (the aim: skill automatization). The learners in our study were at the key stage, which was divided by Awramiuk and Krasowicz-Kupis (2014) into three further substages: partial and inaccurate transcription, phonetic strategy dominance, and increased orthographic and morphological awareness, which overlap with one another. Thus, during the key stage, the spellers commit both orthographic and phonological errors (though the latter term is not used in the discussed paper), while orthographic errors begin to dominate during the increased orthographic and morphological awareness stage. A classification of spelling errors into phonological and orthographic was also previously used and first advocated for Polish by Pietras (2007), who examined spelling skills of high school students with and without dyslexia. The types of spelling errors committed by Polish 10-to-14 year old spellers in an essay writing task were also described by Starz (2000). We decided to focus on younger spellers, during their key stage of learning to spell.

POMAS scoring system

The POMAS (which stands for Phonological, Orthographic, and Morphological Assessment of Spelling) is an unconstrained, qualitative (providing a typology of spelling errors based on linguistic categories and specific linguistic features) system of scoring single word spelling, first proposed by Silliman et al. (2006), and developed in later works (Bahr et al., 2012, 2015). The system, based on general American English orthography, first classifies errors into either phonological or orthographic linguistic categories, which explains what happens on the phoneme/grapheme level. Additionally, the errors might be classified within more specific linguistic features as involving either a vowel, a consonant, or possibly both (the latter instance named word errors). Two examples given by Bahr et al. (2012), on p. 1592, exemplify the system as follows: misspelling the target word: *and* as *ad* would be classified as a phonological error (since a phonological element is not represented in spelling), then as a problem with a sonorant (nasal) cluster. Misspelling the target word: *tripped* as *triped* would be classified as an orthographic error (as the word phonology is preserved, even though the orthographic notation is incorrect), then as a problem with letter doubling (specifically, no doubling when required). Thus, the phonological rendition of an orthographically misspelled word is assessed as either correct or faulty based on an unconstrained approach, which uses context-free phoneme-grapheme correspondence rules. This is different from a constrained approach, which also considers positional constraints. An example given by Silliman et al. (2006) on pp. 68 and 69 illustrates the difference as follows: in an unconstrained system, misspellings of the target word *keep* as *kepe* and *kep* would be both assessed as phonologically accurate, while in a constrained system, only *kepe* would, as the final *e* denotes a long preceding vowel. Once the errors are classified as phonological or orthographic (or both; these categories are essentially mutually exclusive, as an error is considered orthographic only when it preserves phonology, but in some special instances they may overlap), their morphological plausibility is considered. This explains what happens at the word level. Thus, morphological errors overlap with the phonological and orthographic ones freely, as they represent a different level of analysis. Spelling the target word: *kissed* as *kisst* would be classified as a morphological error, specifically, as a problem with an inflected suffix (Bahr et al., 2012, p. 1592).

The POMAS classification has been already used for English (Bahr et al., 2012, 2015; O'Brien et al., 2020; Silliman et al., 2006), and adapted for Spanish (Bahr et al., 2015), Catalan (Salas, 2020), Malay, Tamil, Mandarin Chinese (O'Brien et al., 2020), and French (Joye et al., 2022). In some studies, the learners were bilingual (O'Brien et al., 2020; Salas, 2020) or belonged to clinical groups (Silliman et al., 2006). Of these studies, the learners were at a comparable educational stage as our participants, namely in Grade 1 of elementary education, in three: Bahr et al. (2012), O'Brien et al. (2020), and Joye et al. (2022). Our aim was to prepare a Polish version of the classification for reference for future intercultural comparisons, especially of the performance of writers of Slavic languages, which, as stated by O'Brien et al. (2020) would allow to identify different error types depending on a script. These authors' study demonstrated differences and similarities between languages in most

difficult aspects of language spelling, as speakers of diverse scripts: a morphosyllabic Chinese, a syllabic Tamil, and an alphabetic Malay, all differed in the proportion of phonological and morphological errors, but not in the proportion of the orthographic ones. O'Brien et al. (2020) suggested that these types could then be referred to spelling patterns that children learn either through exposure to print or systematic instruction, following Treiman and Kessler's (2014) Integration of Multiple Patterns (IMP) theory. According to this view, beginning spellers learn the spelling of entire words and of repetitive patterns, which reduces memory load. The patterns might be visually based, requiring knowledge about the shape of a letter and a probable letter order, or language based, requiring knowledge about phoneme-grapheme correspondence and morphology. For a discussion of other classification systems, see Silliman et al. (2006).

The specificity of the relationship between different types of spelling errors and their predictors

Mental lexicon stores semantic, syntactic, orthographic, and phonological information (Perfetti, 2007). Thus, phonological awareness, together with other abilities, such as rapid automatized naming, predicts the acquisition of spelling skills, in orthographies of varying grapheme-phoneme consistency (Caravolas et al., 2012; Moll et al., 2014). Predictive patterns of phonological processing, however, tend to be stronger in English (Moll et al., 2014). For example, when the contributions of phonological, orthographic, and morphological awareness to English and Russian spelling were compared, morphology and phonology contributed more to English, while morphology and orthography (but not phonology)—to Russian spelling (Boulware-Gooden et al., 2015). In addition, a meta-analysis conducted by the National Reading Panel showed that phonological awareness instruction influenced the students' spelling skills (Ehri et al., 2001).

Several studies explored whether different types of spelling errors have different predictors. Zhang et al. (2021) studied kindergarten to Grade 3 Spanish spellers, focusing on linguistic properties of the words the children were asked to spell. They found that syllable complexity was the strongest predictor of phonological errors, while orthographic difficulty a stronger predictor of orthographic errors. Van Rijthoven et al. (2021) explored the cognitive predictors of errors made by 2nd – 4th Grade Dutch spellers, and found that phonological awareness, rapid automatized naming, and semantic knowledge all correlated negatively with the frequency of phonological, morphological, and orthographic errors, and their predictive power was broadly similar across those three error categories. Moreover, Lockiewicz and Jaskulska (2016) showed that, in Polish high school learners of English as a foreign language, higher accuracy and speed of reading English words and pseudowords was associated with fewer English spelling errors of phonological as well as orthographic type. These findings suggest that deficits in cognitive skills predict the likelihood of all types of spelling errors more or less equally. The differences in the frequencies of different types of errors may result more from the parameters of the words themselves, such as their syllabic or orthographic complexity.

While spelling, even beginning learners use a variety of strategies, both phonological and non-phonological, such as knowledge of morpho-graphemic correspondences and word-specific orthographic representations (Salas, 2020). Morphological consistency supports spelling, which was demonstrated for both shallow, e. g. Spanish (Defior et al., 2008) and deep, e. g. French (Joye et al., 2022), orthographies, even though in shallow orthographies practically all words can be spelled using phonological knowledge only (Defior et al., 2008). Thus, in our study we investigated if, in a semi-transparent orthography, errors in morphologically motivated spellings will be few.

School entry and spelling instruction in Poland

In Poland, compulsory pre-school education lasts for a year; children enter the Reception Year, which may be taught at a pre-school or at a school, in September (the beginning of the school year) of the calendar year when they turn 6 years old (Law on School Education Act, 2016). The following year, the students enter Grade 1 of compulsory school education. The school entrance may occur a year early due to a parental request (provided that a child attended a pre-school for a year prior to school admission or has received a report issued by a certified counselling centre supporting an earlier admission). Thus, the children entering Grade 1 might differ in age up to 12 months (and in rare cases, up to even 24). Pre-school curriculum does not require a systematic spelling instruction (Regulation of the Minister of National Education, 2017). Formal spelling instruction usually begins in Grade 1 of primary school, is systematic and phonics based (Awramiuk, 2006; Awramiuk & Krasowicz-Kupis, 2014). Letters and graphemes are introduced in a systematic and explicit way, as a part of an integrated literacy instruction (cf. Lorek & Wollman, 2014a).

Purpose and research questions

In our study, we aimed to:

- 1 Apply and adapt the POMAS classification to a Slavic language. Specifically, we wanted to identify spelling errors as outlined in this system which also occur in Polish, and suggest additional categories, following the classification rationale as outlined in Bahr et al. (2012) and Bahr et al. (2015), that would appear in Polish Grade 1 spellers' writing due to the specific characteristics of Polish orthography (and thus not included in the original POMAS classification).
- 2 Classify spelling errors of Grade 1 spellers of Polish into phonological and orthographic errors, identify the most common types of those, based on the features of interest, and compare their frequency, following other studies adapting the POMAS for comparative reasons. We decided to compare our results with those of Bahr et al. (2012), Joye et al. (2022), and O'Brien et al. (2020), as these studies analysed the spelling of Grade 1 spellers. These comparisons are only indirect, though. We hypothesised that the proportion of errors changes with the learners' education.

- 3 Examine morphological errors committed by Polish Grade 1 spellers. Since Polish is a synthetic, analytic language, with a rich morphology (Dryer & Haspelmath, 2013), we wanted to explore if morphological consistencies support spelling accuracy. Specifically, we hypothesized that morphological errors would be fewer than both phonological and orthographic errors (cf. Joye et al., 2022), and that learners would make a small number of errors overall.
- 4 As phonological skills are crucial for literacy development, which has been shown for many languages with different levels of transparency (Caravolas et al., 2012; Ehri et al., 2001), we wanted to add data from Polish to the already gathered evidence. In addition, we hypothesized that phonological awareness difficulties will be equally predictive of all three types of errors: phonological, orthographic, and morphological.

Materials and methods

Participants

45 Grade 1 students (64.4% girls) aged 7 years and 10 months on average ($M=94.02$, $Me=95.00$, $SD=5.05$, $Min=85.00$, $Max=101.00$ months), all monolingual speakers of Polish, participated. They attended a state primary school. A Mann–Whitney test for independent samples showed that the girls and the boys did not differ in intelligence, phonological awareness, the number, and type of committed errors. Thus, their results were examined as of a one group. The children and their parents expressed informed consent for the students to participate in the study. No child chose to withdraw.

Measures

Questionnaire

A short survey developed by the authors, to collect basic demographic information about each student (e.g.: age, gender).

Raven's coloured progressive matrices

A Polish adaptation (Szustrowa & Jaworowska, 2003) – assesses the level of non-verbal intelligence. Reliability for 7 – 9 years old children is: $r_{tt}=0.85-0.93$, $SEM=1.63-2.04$. The validity correlation with WISC test for 7–9 year old children is: $r=0.48-0.57$ (Szustrowa & Jaworowska, 2003). We used only Set A, for an approximate IQ score.

Phonological tests battery BTF IBE (Krasowicz-Kupis et al., 2015)

Assesses phonological awareness skills. Score was 1 point for every correct answer. We administered the following tasks:

- (a) Syllable deletion. A child deletes a syllable from a word, resulting in a nonword ($Max = 10$ points).
- (b) Sound deletion. A child deletes a sound from a word, resulting in another real word ($Max = 16$ points).

Discontinuation rule: three (syllable task) or four (sound tasks) consecutive errors and/or lack of answer. In calculations, we used a total composite score tapping phonological awareness ($Max = 26$ points). Reliability for 7–8;5 years old children is: $r_{tt} = 0.87–0.93$, $SEM = 0.49–0.74$. The validity correlation (Spearman's rho) with *Vocabulary Test for Children* (Koć-Januchta, 2013) ranges from $r = 0.42$ to $r = 0.49$.

A spelling task

A *spelling task* was developed by the first author for this study. The children had to write down 15 meaningful pairs of words read out loud by an examiner. Each pair was read twice, and, at the end of the task, all pairs were read again (a third reading) to allow for correctness check. The words were paired to include inflected items and facilitate comprehension. These instructions and task structure reflect the writing-to-dictation exercises commonly conducted at Polish schools and considered as the most valid and reliable tasks tapping spelling (Rocławski, 1995). Thus, the children were familiar with the procedure, as it mirrored school activities. The words for the task were selected from a primary school Grade 1 primer, commissioned by the Ministry of National Education (Lorek & Wollman, 2014a, 2014b; Lorek et al., 2014a, 2014b), to guarantee an appropriate level of difficulty, and represented a variety of phonological, orthographic, and inflectional and derivational morphological features of interest. The chosen list was designed to serve as an exploratory study of the categories of errors that may be observed when spelling in Polish. The task was piloted with 30 students with satisfactory results; out of 40 original words we selected 30 for the final version to best demonstrate the children's spelling of the features of interest. A Cronbach's alpha for accuracy, calculated on our own data ($N = 45$, main sample), was 0.88. For the reliability calculation, the coding was binary for each word (i. e. each word coded as 0 or 1 depending on whether it was spelled correctly or not). A spelling for dictation task was also used in O'Brien et al. (2020), Salas (2020), and Joye et al. (2022).

The 30 spelling items were: nouns ($n = 20$), verbs ($n = 6$), and adjectives ($n = 4$). The shortest words consisted of 4 letters, the longest – of 10 ($M = 7$ letters). In 20 (66.67%) words, the numbers of phonemes and their corresponding graphemes was identical, reflecting semi-transparency of Polish orthography, in 8 (26.67%) – there were more graphemes than phonemes, in 2 (6.67%) – more phonemes than graphemes. The shortest words consisted of 1 syllable, the longest – of 4 ($M = 2$ syllables). 9 syllable types occurred: VC, CV, CVC, CVCC, CCV, CCVC, CCCV, CCCVC, CCCVCC, 6 of which included consonant clusters, reflecting that Polish is a consonant-based

language. 19 (63.33%) words were not inflected, 11 (36.67%) words were inflected (7 nouns and 4 verbs). The task in Salas's (2020) study was of similar length: 34 words. A full list of the spelling items and their characteristics is included in the Appendix.

All tests and tasks were administered in Polish.

Procedure

All children completed two parts of the test – a group one (a spelling task and *Raven's Coloured Progressive Matrices*; testing time was approximately 50 min) and an individual one (*Phonological Tests Battery*; testing time was approximately 5 min). The test administration was conducted by the second author only, and the classification of errors by the first author only, to avoid examiner variability. The assessment was conducted at a school, at the end of the school year during the second semester (within one month: May), to ensure appropriate practice in spelling: approximately 8 months, starting in September. The study was conducted in accordance with the Declaration of Helsinki, and the research protocol was approved by the Ethics Board for Research Projects at the Institute of Psychology, University of Gdansk, Poland, decision no. 3/2019, dated: 26.03.2019.

Qualitative analyses

To evaluate the spelling errors, we used the POMAS classification developed by Ruth H. Bahr and Elaine R. Silliman; we received a full version of it from Ruth H. Bahr on 7th of December 2021, upon e-mail request. To conduct the evaluation, we modified the original classification due to the specific characteristics of Polish by adding 8 new types of errors to develop the Polish version of the POMAS (the POMAS-PL). Subsequently, the orthographic grapheme substitution error was further divided into grapheme substitutions considering only consonantal pairs: *h* and *ch*, *ż* and *rz*, and vowel pair: *ó* and *u*, as these orthographic errors are commonly considered as most difficult for Polish spellers, even adults. Thus, 10 extra categories were created. The introduced types, their definitions, and examples are presented in Table 1. Moreover, certain error types were not observed (e.g., silent letter omissions, long vs. short vowel errors), due to the characteristics of Polish orthography. Each time there was an ambiguity if the misspelling represented one or two errors (a rare case in severely distorted words), it was treated and counted as one error. In multiple cases, students made more than one error within one word; thus, the total number of errors committed by a learner could exceed the total number of spelling words. For a detailed explanation of the rules of classification, please see Sect. "[The description of the Polish adaptation of POMAS: POMAS-PL, and our adaptation of its principles, using data from our sample](#)", and consult Silliman et al. (2006).

Quantitative analyses

When comparing the median number of committed types of errors, Wilcoxon signed-rank test and the Friedman test were used. To investigate the relationship between

Table 1 Types of errors added to the POMAS classification due to the characteristics of Polish orthography

Error types and their definitions	Target	Error
Word level		
Diacritic sign-the lack of or an unnecessarily added diacritic sign	<i>stońce</i>	<i>stonce</i>
Consonant level		
Substitution of graphemes <i>h</i> and <i>ch</i> (sound /x/)	<i>chleba</i>	<i>hleba</i>
Substitution of graphemes <i>ż</i> and <i>rz</i> (sound /ʒ/)	<i>krzew</i>	<i>kżew</i>
Consonant devoicing within a word	<i>babcia</i>	<i>bapcia</i>
Final consonant devoicing	<i>krzew</i>	<i>krzef</i>
Palatalisation-soft consonants: alveolar-palatal fricatives, affricates, and nasals are spelled without a diacritic sign and with an extra <i>i</i> letter	<i>gość</i>	<i>gosici</i>
Vowel level		
Substitution of graphemes <i>ó</i> and <i>u</i> (sound /u/)	<i>hulajnoga</i>	<i>hólajnoga</i>
Substitution of graphemes representing nasal vowels	<i>dźwięk</i>	<i>dźwienk</i>
Substitution of graphemes <i>ł</i> and <i>u</i> (sound /w/)	<i>autobusem</i>	<i>altobusem</i>

Diacritic signs are used for both consonants and vowels

the study variables, partial correlation coefficients were calculated, with distributions transformed where appropriate using Blom's formula. To explore the specificity of the correlation between phonological awareness and different error types we used a Steiger's Z test for testing the statistical significance of the difference between two dependent correlations (Hoerger, 2013). To interpret the practical significance levels of correlation coefficients we used AlWahaibi et al.'s (2020) approach.

Results

The description of the Polish adaptation of POMAS: POMAS-PL, and our adaptation of its principles, using data from our sample

Following the examples given in Bahr et al. (2012), if in the Polish sample the word *narodowy* was spelled as *narotowy*, this error would be first classified as a phonological error, since the pronunciation of the distorted word would change from the original one /narɔɔɔvi/ to /narɔɔvi/. This error would then be scored as a consonant-level error, since one consonant: /d/ was replaced with another one: /t/, and, finally, as an error in voicing, since a voiced consonant was replaced with its voiceless equivalent. If the word *pracuje* was spelled as *pracóje*, this error would be first classified as an orthographic error, since the pronunciation of the distorted word would not change from the original one; the orthographic notation would, however, be faulty (actually, no Polish word is spelled this way, though the word final string *-óje* is rare, but does occur, e. g. *dwóje*). This error would then be scored as a vowel-level error, since the replacement considered the vowel pair *u-ó*, and, finally, as an error in grapheme substitution: a specific case of *u-ó* grapheme substitution. In addition

to these errors, which did not overlap with one another, a separate category of morphological errors was identified. These errors overlapped with either phonological or orthographic errors. A morphological error would be scored if a learner made an error within roots, inflectional and derivational suffixes, and within prefixes. For example, if the word *pracuje* was spelled as *pracóje*, this error would be classified as a morphological error; specifically, a difficulty with a derivational suffix. *Uje* is a verb suffix denoting 3rd person, singular, present tense. There is an orthographic rule explicitly stating that this suffix is always spelled with the letter *u* to represent the /u/ sound. If the word *bukszpanu* was spelled as *bukszpan*, this error would be classified as a morphological error; specifically, a difficulty with an inflectional suffix, which is missing. In the phrase: *krzew bukszpanu* the first word is in the Nominative Case, and the second: in the Genitive Case, the ending of which would be: *u*. If the word *popłynąć* was spelled as *plłynąć*, this error would be classified as a morphological error; specifically, a missing prefix *po*. This omission would change the aspect of the verb (from the perfective to the imperfective). Thus, the knowledge of morphology should additionally support the correct spellings in these cases.

Accuracy of single Polish word spelling – qualitative results

No student spelled all the words correctly; the accuracy varied from 17.00% correct (1 learner) to 93.00% correct (2 learners). Despite this, only 3 students (7.00%) made no attempt to spell a word/words ($Max=3$ words omitted by a student). The descriptive statistics for spelling accuracy are presented in Table 2.

Table 2 Descriptive statistics in the group

Variables	<i>M</i>	<i>Me</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>SKE</i>	<i>K</i>
Intelligence	9.76	10.00	1.09	7.00	12.00	-0.37	0.63
Phonological awareness	17.82	17.00	5.41	4.00	26.00	-0.34	-0.37
Number of words spelled							
Correctly	17.93	19.00	6.59	5.00	28.00	-0.14	-1.21
Incorrectly	11.93	11.00	6.40	2.00	23.00	0.08	-1.29
No answer	0.13	0.00	0.55	0.00	3.00	4.43	20.01
Number of errors							
Phonological	8.84	7.00	8.36	0.00	36.00	1.59	2.85
Orthographic	8.40	8.00	4.83	0.00	19.00	0.20	0.70
Morphological	6.51	6.00	3.41	0.00	13.00	0.21	-1.63
Number of errors							
Word level	2.16	2.00	1.92	0.00	9.00	1.35	2.58
Consonant level	9.18	7.00	7.01	0.00	33.00	1.13	1.57
Vowel level	5.91	6.00	3.82	0.00	13.00	0.31	-1.02
Total	17.22	15.00	11.92	2.00	51.00	0.82	0.26

$n=45$. Morphological errors overlap with phonological and orthographic ones. The perfect score for the number of words spelled was 30.00. Intelligence shows *Raven's Coloured Progressive Matrices* raw scores for Set A

In all the most difficult words to spell (words which had fewer than 50.00% of correct spellings out of 45 maximum correct) taken together, there was a roughly equal proportion of orthographic and phonological errors; examples of these errors are presented in Table 3. When individual words were analysed separately, in *podróżować* (to travel), *żółta* (yellow), and *elfów* (of elves) orthographic errors were dominant, and in *dźwięk* (a sound), *popłynąć* (to take a cruise), *bukszpanu* (of a boxwood), and *perkusji* (of drums)—phonological ones. Specifically, in all words both types of errors occurred, except for: *chór* (a choir; only orthographic errors), *gość* (a guest), *świeci* (it shines), *statkiem* (a ship), *kromka* (a slice), *narodowy* (national) (only phonological errors). Spearman's rank order correlation showed no link between the length of the words, as measured with the number of phonemes, and the number of either orthographic ($r = -0.110$, $p = 0.562$) or phonological ($r = 0.293$, $p = 0.116$) errors. Qualitatively, the two most difficult words consisted of only 1 syllable. The specific types of errors included (target words given in brackets), among others, grapheme substitution (including of grapheme pairs: 1. *ó* and *u*: **perkósji* (*perkusji*), 2. *h* and *ch*: **hur* (*chór*), 3. *ż* and *rz*: **rzułta* (*żółta*)), and of graphemes representing nasal vowels: **dźwienk* (*dźwięk*), consonant devoicing, both within a word: **elwów* (*elfów*), and at the end of it: **elfuf* (*elfów*), voicing: **pukszpanu* (*bukszpanu*), problems with diacritic signs: **zrułta* (*żółta*), epenthesis: **dzywic* (*dźwięk*), letter reversal: **zrułta* (*żółta*), palatalization: **dziwięk* (*dźwięk*), consonant and vowel deletion: **podóźować* (*podróżować*), **perkusj* (*perkusji*), vowel error: **bukszpana* (*bukszpanu*), cluster reduction: **żółta* (*żółta*), consonant error: **bukszfanu* (*bukszpanu*), stoppings: **eltów* (*elfów*), etc., which represent the most frequent types of errors, that more than 25% of Grade 1 spellers committed (see Table 4). *Ó-u*, *rz-ż*, and *h-ch* grapheme pairs reflect the historical principle of the Polish orthography,

Table 3 Most difficult words to spell and examples of phonological and orthographic errors

Target word	Percent of correct spellings	Number of errors		Total errors	Examples of errors	
		Orthographic	Phonological		Orthographic	Phonological
<i>chór</i>	13	60	0	60	<i>hur</i>	NA
<i>dźwięk</i>	22	15	44	59	<i>dźwienk</i>	<i>dziwięk, dzywic</i>
<i>podróżować</i>	22	41	27	68	<i>podróźzować</i>	<i>podóźować</i>
<i>popłynąć</i>	38	6	40	46	<i>popłynać</i>	<i>popłunąć, poplyność</i>
<i>żółta</i>	38	28	9	37	<i>rzułta</i>	<i>zrułta, żółta</i>
<i>bukszpanu</i>	40	15	30	45	<i>bukrzpanu</i>	<i>bukszpana, pukszpanu</i>
<i>elfów</i>	49	27	7	34	<i>elfuf</i>	<i>elwów, eltów</i>
<i>perkusji</i>	49	3	24	27	<i>perkósji</i>	<i>perkusi, perkusj</i>
Total		195	181	376		

Examples include only actual errors made by students; however, in some cases spelling was slightly corrected if no word in a category included only an orthographic or a phonological error; this was done for clarity. All words in the table were spelled correctly in fewer than 50.00% cases. The frequency of cut-off point was chosen to best present the character of difficulties

Table 4 Most frequent phonological and orthographic errors by linguistic feature and proportion of students who made this type of error

Feature		Level	Type
Ó and u grapheme substitution	154 (.89)	Vowel	Orthographic
H and ch grapheme substitution	65 (.80)	Consonant	Orthographic
Diacritic sign	46 (.69)	Word	Phonological
Ż and rz grapheme substitution	55 (.64)	Consonant	Orthographic
Consonant deletion	41 (.56)	Consonant	Phonological
Vowel deletion	49 (.53)	Vowel	Phonological
Epenthesis	41 (.51)	Word	Phonological
Palatalisation	56 (.51)	Consonant	Phonological
Final consonant devoicing	35 (.47)	Consonant	Orthographic
Consonant devoicing within a word	24 (.40)	Consonant	Orthographic
Nasal vowel grapheme substitution	22 (.40)	Vowel	Orthographic
Vowel error	29 (.40)	Vowel	Phonological
Consonant error	38 (.36)	Consonant	Phonological
Voicing	25 (.31)	Consonant	Phonological
Cluster reduction	22 (.27)	Consonant	Phonological
Ł and u grapheme substitution	12 (.27)	Consonant	Orthographic
Inflectional suffix	54 (.58)	NA	Morphological
Derivational suffix	25 (.40)	NA	Morphological

The raw number of errors committed within the entire sample given, with the proportion of students who made this type of error in brackets. The table includes only these types of errors that were made by at least 25% of Grade 1 spellers. The frequency of cut-off point was chosen to best present the character of difficulties. Morphological errors overlap with phonological and orthographic ones; thus, they were placed separately at the bottom of the table. Ł and u grapheme substitution appears when the diphthong /aw/ is represented in writing as *au*, e. g. *autobusem*

and, in contemporary Polish, each member of those pairs always represents the same phoneme. Thus, faulty spelling almost exclusively results in orthographic errors. In total, of the 10 orthographic types of errors found in Polish misspellings, 2 also occurred in English. Of the 18 phonological types of errors found in Polish misspellings, 16 also occurred in English.

Accuracy of single Polish word spelling – quantitative results

A Friedman's ANOVA demonstrated differences in the number of orthographic, phonological, and morphological errors: $\chi^2(2)=11.545$, $p=0.003$. Post hoc analysis with Wilcoxon signed-rank tests was conducted with a Bonferroni correction applied, resulting in a significance level set at $p<0.017$. Median number of orthographic, phonological, morphological errors were 8.00 (*Min.*=5.00 to *Max.*=12.00), 7.00 (2.50 to 12.00) and 6.00 (4.00 to 8.50), respectively. The Grade 1 spellers committed an equal number of phonological and orthographic errors ($Z=-0.631$, $p=0.540$), and of phonological and morphological errors ($Z=-1.110$,

$p=0.540$). However, the learners made more orthographic than morphological errors ($Z=-4.871$, $p\leq 0.001$). A Friedman's ANOVA demonstrated a statistically significant difference between the number of word-, vowel-, and consonant-level errors, $\chi^2(2)=64.422$, $p\leq 0.001$. Post hoc analysis with Wilcoxon signed-rank tests was conducted with a Bonferroni correction applied, resulting in a significance level set at $p<0.017$. Median number of word-, vowel-, and consonant-level errors were 2.00 (1.00 to 3.00), 6.00 (3.00 to 9.50) and 7.00 (4.00 to 14.00), respectively. The Grade 1 spellers made fewer word-level than vowel-level ($Z=-5.422$, $p\leq 0.001$, $r=0.81$) and consonant level ($Z=-5.658$, $p\leq 0.001$, $r=0.84$) errors. Vowel-level errors were less frequent than consonant-level errors ($Z=-4.707$, $p\leq 0.001$, $r=0.70$).

Phonological awareness and the frequency of types of spelling errors

A partial correlation (Table 5) was conducted to determine the relationship between phonological awareness and the number of different types of spelling errors, whilst controlling for age.

Phonological awareness showed moderate to strong (range from -0.48 to -0.72) negative correlations with all types of spelling errors. However, since chronological age also correlated moderately to strongly with all variables under study (except for nonverbal IQ), controlling for age attenuated phonological awareness – spelling

Table 5 Partial correlations between study variables whilst controlling for age

Control variables	Variable	Age	PA	NV IQ	Number of errors:		
					Word	Consonant	
None ^a	PA	.64**					
	NV IQ	.02	.09				
	Number of errors	Orthographic	-.61**	-.60**	-.03		
		Phonological	-.66**	-.61**	.06		
		Morphological	-.55**	-.53**	.00		
		Word	-.60**	-.48**	.07		
		Consonant	-.56**	-.58**	.02	.68**	
		Vowel	-.64**	-.72**	.02	.70**	.84**
Age	NV IQ		.09				
	Number of errors	Orthographic		-.35*	-.02		
		Phonological		-.32*	.10		
		Morphological		-.29	.02		
		Word		-.16	.10		
		Consonant		-.35*	.04	.52**	
		Vowel		-.53**	.05	.51**	.76**

^aPearson zero-order correlations. Partial Correlations. ** $p\leq .01$; * $p\leq .05$; $N=45$; PA=Phonological Awareness, NV IQ=Nonverbal IQ. Correlation co-efficient between orthographic and phonological errors was .675** with no controlling for age, and .462** with controlling for age. Positive correlations between overlapping types of errors are not included. Normal transformation using Blom's formula was used where appropriate

correlations substantially. Those partial correlations emerged as moderate (range from -0.32 to -0.53) for most types of spelling errors, except for morphological and word-level spelling errors, where they were weak (below -0.30) and no longer statistically significant, indicating that age had influence in controlling for these latter relationships – older learners committed fewer morphological and word-level errors. In addition, the types of errors correlated with each other positively and strongly without (range from 0.68 to 0.84) and moderately to strongly with controlling for age (range from 0.51 to 0.76).

A Steiger's Z test showed that phonological awareness did not correlate significantly more strongly with the number of phonological errors as compared with the number of orthographic errors ($Z_h = -0.20, p = 0.840$), or morphological errors ($Z_h = -0.17, p = 0.868$). Moreover, phonological awareness did not correlate significantly more strongly with the number of orthographic errors as compared with the number of morphological errors ($Z_h = -0.69, p = 0.492$).

Discussion

A quantitative analysis of error types in the adaptation of the POMAS – POMAS-PL

Similarly to Joye et al. (2022), Salas (2020), O'Brien et al. (2020), Bahr et al. (2015) we found that spelling errors that we identified in our sample could be classified as either phonological, orthographic, and/or morphological ones, following the principles outlined in the original POMAS (Bahr et al., 2012; Bahr et al., 2015; Silliman et al., 2006). This also included types of errors unique for Polish. In total, in our sample, of the 18 phonological types of errors found in Polish misspellings, 16 also occurred in English. Of the ten orthographic types of errors found in Polish misspellings, two also occurred in English. A slightly bigger overlap was found by Bahr et al. (2015), as of the nine orthographic types of errors found in Spanish misspellings, four also occurred in English; however, in an older group of students. We attribute the substantial overlap between the phonological type of errors to the fact that both in Polish and in English phoneme-to-grapheme mapping is key to accurate spelling, and for both languages, phonics is the most efficient method of instruction in an integrated literacy course (see for Polish: Awramiuk, 2006; Awramiuk & Krasowicz-Kupis, 2014; see for English: Fletcher et al., 2018; National Reading Panel (US), National Institute of Child Health, & Human Development (US), 2000). We attribute the minimal overlap between the orthographic types of errors to the substantial differences between Polish and English orthography rules (cf. Jaskulska & Łockiewicz, 2017).

A qualitative analysis of error types in the adaptation of the POMAS—POMAS-PL

A qualitative analysis of types of errors within the three categories revealed that among the orthographic errors the most frequent type was grapheme substitution of the pairs: *ch-h*, *ó-u*, *ż-rz*, phonologically plausible, following Joye et al.'s

(2022) terminology. These were followed with final consonant devoicing, consonant devoicing within a word, and nasal vowel grapheme substitution errors, also all phonologically plausible. All these types of errors were added to the original POMAS for the Polish version. Phonologically plausible grapheme substitutions, though of different specific types, were also frequent in French (Joye et al., 2022). Grapheme substitutions were also reported for Polish spellers by Awramiuk and Krasowicz-Kupis (2014).

As most of Polish words can be spelled based on phoneme-grapheme mapping only (Gajda, 1999), a situation in which word-specific knowledge stored in mental lexicon (Moll et al., 2014; O'Brien et al., 2020), and knowledge of orthographic rules and morpho-graphemic rules produce orthographically correct spellings (O'Brien et al., 2020) seem to be most challenging for Polish beginning spellers. The participants in our study also replaced other consonants and vowels with one another. 27.00% of students replaced grapheme *au* with *at*, following pronunciation /aw/—in practically all cases, /w/ is spelled as *t* in Polish. This shows the learners' faulty use of statistical learning – applying a productive rule in a word which is an exception to it (Treiman & Kessler, 2014). Letter reversal identified in Tamil (O'Brien et al., 2020) and errors with diacritic signs identified in French (Joye et al., 2022) appeared also in our sample; we classified these, however, as phonological errors, which demonstrated differences in orthographic rules between languages and likely reflecting a language-based difficulty (cf. Treiman & Kessler, 2014),

Among the phonological errors that we identified the most frequent type were misspellings in diacritic signs (discussed in detail in the previous paragraph), followed by consonant deletion, vowel deletion, epenthesis, problems with palatalization, and vowel errors. Of these, only epenthesis overlaps with all other studies, for English (Bahr et al., 2012), French (Joye et al., 2022), and Tamil (O'Brien et al., 2020) orthography. Letter deletion was also reported for spellers of Polish by Awramiuk and Krasowicz-Kupis (2014). However, in French, a high frequency of phoneme substitution was observed (Joye et al., 2022). For an example of differences, English learners struggled with long vowels (Bahr et al., 2012). This was not an issue in our group, as Polish vowels are not differentiated in terms of length. Moreover, in English (Bahr et al., 2012), most frequent consonantal errors concerned reversals and sonorant cluster reduction. In Polish, we found that while 56.00% of learners deleted a consonant when located not in a consonantal cluster, only 27.00% reduced a consonantal cluster. This shows that the learners were aware of long sequences of consonants in Polish, which are typically occurring patterns (Treiman & Kessler, 2014). In our sample, 26 (87%) out of 30 words had a consonant cluster, including three shortest 4-letter words, which reflects the characteristics of Polish orthography (Dryer & Haspelmath, 2013). In fact, Grade 1 spellers of Polish made fewer word-level than vowel-level and consonant level errors, and fewer vowel-level errors than consonant-level errors. This was expected, as Polish is a consonantal language (Dryer & Haspelmath, 2013), and the 30 words we used for our spelling task consisted of 124 (63.59%) consonants and 71 (36.41%) vowels.

Spelling accuracy in Grade 1 spellers of Polish—a comparison of the number of phonological, orthographic, and morphological errors

We found that in a writing-to-dictation task the Grade 1 spellers of Polish made, on average, an equal number of phonological and orthographic errors, and of phonological and morphological errors. However, orthographic errors were more frequent than morphological ones. Generally, in our sample errors in morphologically motivated spellings were the least frequent. These findings are similar to the proportions given by O'Brien et al. (2020) for Malay, a transparent alphabetic orthography with almost perfect phoneme-grapheme correspondences, so more transparent than Polish is. 128 Grade 1 spellers made an equal number of phonological and orthographic errors; both types were more frequent than the morphological ones. Our results are different to the proportions given by Bahr et al. (2012) for American English, an opaque orthography. 100 Grade 1 spellers made more orthographic (52.00%) than phonological (26.00%), and more phonological than morphological (7.00%) errors. Similarly, orthographic errors (61.67%) were also more frequent than phonological ones (19.63%), which were slightly more frequent than morphological ones (16.83%) in a dictation task written by 32 Grade 1 spellers of an opaque French (Joye et al., 2022); in this study the categories of errors had been classified with no overlap. These inter-language indirect comparisons suggest a different proportion of types of errors made by Grade 1 spellers depending on the consistency of phoneme-grapheme correspondences: an equal number of orthographic and phonological errors in more transparent, and a higher number of orthographic errors as compared with phonological ones in less transparent orthographies. As O'Brien et al. (2020) concluded, the characteristics and constraints of a script result in spellers relying in a varied extent on a specific representational code. Interestingly, 119 Grade 1 spellers of Tamil, a transparent alphasyllabary, made more phonological than graphemic-orthographic errors, and 321 Grade 1 spellers of non-alphabetic morphosyllabic Mandarin Chinese made an equal number of different types of errors, using a script with simplified hanzi characters (O'Brien et al., 2020). More data from other languages based on the POMAS classification is, therefore, needed, to draw conclusions about the universality of the proportions of errors.

In our sample, a roughly equal proportion of orthographic and phonological errors occurred in the spelling of the most difficult words. Some words included only one type of error, and some several across all three categories, which is consistent with O'Brien et al.'s (2020) observation that spellers use different types of knowledge depending on the word spelled. Grade 1 spellers of Polish in our study relied on both phoneme-grapheme correspondences, word-specific orthographic representations, and knowledge of orthographic rules and morpho-graphemic rules, all listed by O'Brien et al. (2020), and had been developing their knowledge of repeatable patterns within words, as suggested in the IMP theory (Treiman & Kessler, 2014). An equal proportion of phonological and orthographic errors would also suggest that our participants did not yet, as a group, reach the final substage of the key stage of spelling acquisition in Polish as proposed by Awramiuk and Krasowicz-Kupis (2014).

Morphological consistency supporting spelling in Polish

In our study, no Grade 1 speller of Polish spelled all the words correctly; the accuracy varied from 17.00% correct (1 learner) to 93.00% correct (2 learners). Such a wide skill gap, despite the same age and educational level, was expected, as differences in L1 skill between learners occur early in elementary school (Sparks et al., 2009). Nevertheless, almost all students attempted to spell all given words, similarly to Malay and Chinese learners (O'Brien et al., 2020). On average, in a spelling-to-dictation task our participants correctly spelled 18 words out of 30, demonstrating 60.00% of accuracy, which is almost twice as high accuracy as for Grade 1 spellers of French: 5.5 words out of 17, which equals 32.35% (Joye et al., 2022). In fact, our participants appeared to make a rather fast progress in learning how to spell within a year into spelling instruction, as they succeed in spelling many words phonologically correctly, including polysyllabic words and words of low frequency, such as *perkusji*, *bukszpanu*, *hymn*.

Looking at the morphological errors that our participants committed, errors in inflectional suffixes were most frequent, followed by errors in derivational suffixes (58.00% and 40.00% of Grade 1 spellers made them, respectively). These could have been either phonological or orthographic. A comparable proportion was noticed in French (Joye et al., 2022), as inflectional morphology was more difficult than derivational one for Grade 1 spellers, a trend that we also observed, even that in Joye et al.'s (2022) study three categories of errors did not overlap. The authors interpreted a very low rate of errors in derivational morphemes as evidence that derivational morphology supports spelling in French due to its consistency. In our sample, even though derivational errors were rarer than inflectional ones when suffixes were investigated, they were still quite common, as some students also made errors in prefixes. The latter errors were rare (only 13.00% of students made them), so we assume that prefixes (all of them derivational) facilitate spelling in Grade 1 Polish learners. Such a conclusion cannot be reached about suffixes, as Grade 1 spellers misspelled even highly repeatable grammatical cases endings, such as *ów* and *ji*. Inflections were also challenging for English Grade 1 spellers (Bahr et al., 2012), even though English has a simple inflectional system.

Finally, we found no link between the length of words, as measured with the number of phonemes, and the number of either orthographic or phonological errors. Qualitatively, the two most difficult words consisted of only 1 syllable. This finding contradicts Awramiuk and Krasowicz-Kupis (2014) suggestion that the longer a Polish word is, the more frequent errors are. We deduce that, since most words in Polish can be spelled based on an either phonological or morphological principle, the word difficulty might depend more on the necessity of applying historical and/or conventional principles to spell it correctly (cf. Gajda, 1999) rather than the length of the word itself. The latter two principles are often associated with exceptions and depend more on word memorizing, limiting generalisations (cf. Treiman & Kessler, 2014). In conclusion, our hypothesis about the supportive role of morphological consistency for spelling accuracy was only partially confirmed.

Phonological awareness and spelling in polish Grade 1 spellers

We found that specific (age controlled) negative correlations between phonological awareness and spelling errors were only moderate for most types of errors; they were weak and non-significant for morphological and word- level errors. We controlled for age as phonological awareness develops with age (Krasowicz-Kupis, 2004), and, in our study, these two variables correlated strongly. The relationship between phonological awareness and spelling errors was an expected result, as phonological processing contributes to the development of literacy skills (Caravolas et al., 2012; Ehri et al., 2001; Moll et al., 2014). Percentages of phonological, orthographic, and morphological errors also all correlated negatively with phonological awareness in van Rijthoven et al.'s (2021) study. Moreover, our results agree with other research that suggests that phonological awareness contributes to spelling more in more opaque languages (Moll et al., 2014). Polish, however, is less transparent for spelling than for reading (Awramiuk, 2006), which might explain these results.

We found that the correlations between phonological awareness and the frequency of phonological, orthographic, and morphological spelling errors were equally strong. Similarly, in Dutch spellers (van Rijthoven et al., 2021; we did the calculations using the Steiger Z test and data from Table 2 ourselves, since such calculations are not presented and interpreted in the paper) phonological awareness did not correlate significantly more strongly with the number of phonological errors as compared with the number of orthographic errors, or morphological errors, showing that phonological awareness is generally equally linked with all three types of spelling errors, as predicted. However, phonological awareness correlated significantly more strongly with the number of morphological errors as compared with the number of orthographic errors ($Z_h = -2.24$, $p = 0.025$). In that study, though, the POMAS was not used, which might explain this difference when compared to our results, as error classification rules differed.

Limitations

We used a writing-for-dictation task as a measure of spelling accuracy. Such an approach allowed us to avoid students spelling only (or mostly) words they were most familiar with, and to examine all key features of interest. In future studies, we intend to examine spelling skills of older students, using the classification developed in this study, and employing it in both a writing-for-dictation and a narrative task, which would allow a more thorough analysis of morphological errors and text production. In addition, we would like to add an orthographic awareness, morphological awareness, and lexical tasks, to investigate if they would contribute more to orthographic and morphological accuracy in spelling than phonological awareness does.

Educational implications

Our study has clear educational implications, as it directs teachers' attention to the most difficult aspects of Polish spelling system and orthography in a group of spellers, who are at a key stage of literacy acquisition. The adapted POMAS-PL

classification allows to predict both potential errors in students' writing (as suggested by Bahr et al., 2015) and the type of knowledge needed to facilitate correct spelling (as suggested by Joye et al., 2022). For example, to facilitate the correct spelling of final consonants, the teachers can employ in their instruction the knowledge about the phonology of Polish and derivational and inflectional morphology patterns. They can also predict a student spelling *krzew* as *krzef*, following the pronunciation, and choosing a grapheme more frequently representing a phoneme /f/. With that understanding the teachers could facilitate the correct spelling by explicitly and systematically teaching this pattern and rule to their students, and not attribute the error to, say, phonological processing deficits. These strategies should be implemented as early as in Grade 1 of literacy instruction. In addition, the knowledge of these mechanisms could also help the teachers' work in cases when English L2, Polish L1 speakers learn to spell in second and third languages, as they can commit some errors due to linguistic transfer and employing the rules of Polish spelling to English (Sparks et al., 2009).

Conclusions

This paper presents the adaptation of the POMAS classification to the characteristics of Polish orthography. We identified the most common spelling errors committed by Polish Grade 1 spellers based on a writing-to-dictation task designed to involve all potentially challenging features of interest. The errors, both overlapping with the errors originally described for English and uniquely occurring in Polish, were classified using the rationale outlined in Bahr et al. (2012), which resulted in the POMAS-PL version. We hope that our classification will be used by other researchers of Slavic languages, to allow for intercultural comparisons. Moreover, our analyses can be used by teachers of Polish as a first and a second language to anticipate their students' errors and to understand what knowledge the learners need to learn to spell correctly.

Appendix

The list of target words.

Pair	Target word	IPA transcription	Number of		Syllable structure	Word type	If inflected
			Sounds	Letters			
1	chór	xur	3	4	<CVC>	noun	no
	kolegów	kɔlɛguf	7	7	<CV> <CV> <CVC>	noun	yes
2	królowa	krulova	7	7	<CCV> <CV> <CV>	noun	no
	elfów	elfuf	5	5	<VC> <CVC>	noun	yes
3	dźwięk	dźvjɛnk	6	6	<CCCVCC>	noun	no
	perkusji	perkusji	8	8	<CVC> <CV> <CCV>	noun	yes
4	malutki	malutci	7	7	<CV> <CV> <CCV>	adj	no
	kundelek	kundelek	8	8	<CVC> <CV> <CVC>	noun	no
5	drzwi	dʒvi	4	5	<CCCV>	noun	no
	skrzypią	skʃipjɔ	7	8	<CCCV> <CCV>	verb	yes
6	krzew	kʃɛf	4	5	<CCVC>	noun	no
	bukszpanu	bukʃpanu	8	9	<CVCC> <CV> <CV>	noun	yes
7	przyszedł	pfjɛdw	7	9	<CCV> <CVCC>	verb	yes
	gość	gocɛ	4	4	<CVCC>	noun	no
8	babcia	bapɕa	5	6	<CVC> <CV>	noun	no
	pracuje	prafɕuje	7	7	<CCV> <CV> <CV>	verb	yes
9	świeci	ɕfɛci	6	6	<CCCV> <CV>	verb	yes
	słońce	swonɕɛ	7	6	<CCVC> <CCV>	noun	no
10	podróżować	podruʒvatɕ	10	10	<CV> <CCV> <CV> <CVC>	verb	no
	autobusem	awtobusem	9	9	<VC> <CV> <CV> <CVC>	noun	yes
11	popłynąć	popwɛnɔɕɛ	9	8	<CV> <CCV> <CVCC>	verb	no
	statkiem	statkɛm	8	8	<CCV> <CCCVC>	noun	yes
12	straż	straf	5	5	<CCCVC>	noun	no
	pożarna	poʒarna	7	7	<CV> <CVC> <CV>	adj	no

Pair	Target word	IPA transcription	Number of		Syllable structure	Word type	If inflected
			Sounds	Letters			
13	zóŭta	ʒuwta	5	5	<CVC> <CV>	adj	no
	hulajnoga	xulajnoga	9	9	<CV> <CVC> <CV> <CV>	noun	no
14	kromka	kromka	6	6	<CCVC> <CV>	noun	no
	chleba	xleba	5	6	<CCV> <CV>	noun	yes
15	hymn	ximn	4	4	<CVCC>	noun	no
	narodowy	narodovi	8	8	<CV> <CV> <CV> <CV>	adj	no

adj. denotes adjective

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Conflict of interest The authors declare no conflict of interest.

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