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Writing and reading performance in Year 1 Australian classrooms: associations with handwriting automaticity and writing instruction

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Abstract

Theories of writing development and accumulating evidence indicate that handwriting automaticity is related to the development of effective writing skills, and that writing and reading skills are also associated with each other. However, less is known about the nature of these associations and the role of instructional factors in the early years. The present study examines: (1) the influence of handwriting automaticity in the writing and reading performance of Year 1 students, both concurrently and across time; (2) associations between students' writing and reading performance and writing instruction. The current study involved 154 children enrolled in 24 classrooms from seven government-funded primary schools in Western Australia. Handwriting automaticity and word-reading were assessed at the end of kindergarten (M_{age} = 70 months, SD = 4.37 months) and a year later at the end of Year 1 (M_{age} = 82 months, SD = 3.64 months). Child-level measures of writing quality and production as well as teacher-reported measures of writing instruction were added in Year 1. Teachers reported on amount and type of writing instruction (i.e., teaching basic skills and teaching writing processes) and amount of writing practice in their classrooms. Data analyses included multilevel modelling. Handwriting automaticity predicted writing quality and production concurrently and across time after accounting for gender and initial word-reading skills. *H*andwriting automaticity predicted reading performance across time. Writing and reading performance were associated with amount of writing practice, while teaching planning and revising were positively associated with writing performance. Implications for writing development and writing instruction are discussed.

Keywords Early education · Handwriting automaticity · Reading development · Writing development · Writing instruction

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Introduction

Writing is a powerful communication tool, historically serving human beings' unique need to perpetuate knowledge, ideas, events and emotions. In today's digital age, effective writing is critical for personal, professional and academic success, and an integral part of everyday life. Concerns about students' writing achievement have been identified across cultures and languages of instruction (Graham, 2019). In Australia, results from the 2018 National Assessment Program for Literacy and Numeracy (NAPLAN) report a continued decline in the writing performance of high-school students since 2011 (Australian Curriculum and Assessment Reporting Authority [ACARA], 2018). Research suggests that the writing difficulties students exhibit in the early years of schooling may explain the poor quality of writing in upper primary and high schools (Berninger et al., 1997; Kent, Wanzek, Petscher, Al Otaiba, & Kim, 2014).

The way we communicate our ideas into writing language has changed remarkably in recent years. Historically, learning to write referred to the practice of pen-and-paper manuscript of letters (Wollscheid, Sjaastad, & Tømte, 2016). The digital revolution in education and learning in general has resulted in the marginalisation of handwriting in some educational contexts (for a review see Wollscheid et al., 2016), instigating contradictory arguments about the importance of handwriting in today's digital world (see meta-analytical review by Feng, Lindner, Ji, & Joshi, 2017). In Australia, keyboarding has been replacing handwriting in high-stakes testing, with children's literacy skills being assessed via keyboard as early as in Year 3 (ACARA, 2018). In this context, there is an urgent need to extend knowledge about the affordances of teaching and developing handwriting skills. Since writing development is heavily shaped through instruction (Graham, 2019), it also becomes fundamental to examine the amount and types of instructional practices novice writers experience in today's classrooms to develop their writing skills and the practices that support effective writing.

Our understanding of the complexity of writing has grown in recent decades and is manifested in different empirical research supported by distinct theoretical models of writing development and its many dimensions (Bazerman et al., 2017). Merging sociocultural and cognitive perspectives of writing, the recent Writer(s)-within-Community (WWC) model of writing (Graham, 2018) explains writing development as a result of variations in contextual and individual interrelated variables, since "writing is simultaneously shaped by the community in which it takes place and the cognitive capabilities and resources of community members who create it" (p. 271). Following two primary goals, we capitalised on this tenet to investigate individual and classroom-related factors potentially facilitating the writing and reading performance of Year 1 Australian students. Our first goal was to examine relations between the handwriting automaticity of Year 1 students and their writing and reading performance concurrently and across time. A basic organising structure of the WWC model is writers and their collaborators described as "cognitive architecture, capabilities, and physical actions applied by members of the writing community" (Graham, 2018, p. 259). Acknowledging that

writing development is a consequence of individual changes (Graham, 2018), for the current study the focus was given to writing letters automatically. We focused on handwriting automaticity since it is considered "the best unique predictor of compositional fluency in elementary students" (Berninger, Abbott, Augsburger, & Garcia, 2009, p. 124), with findings from structural equation modelling showing that writing letters automatically is best described as a separate construct in early literacy acquisition (Kim, Al Otaiba, Puranik, Folsom, & Gruelich, 2014). The other organising structure of the WWC model is the writing community based on the assumption that "writing is a social activity, situated within specific contexts" that shape writing development (Graham, 2018, p. 259). Thus, our second goal was to examine classroom-related factors facilitating writing development in Year 1 Australian classrooms. Concerns about students' writing development are common across the globe, with studies indicating that students spend little time writing or being taught how to write (Graham, 2019). Since little is known about what writing instruction looks like in Australian primary classrooms (Malpique, Pino-Pasternak, & Valcan, 2017), our aim was to investigate the presence of associations between writing instruction and writing and reading performance in Year 1 Australian classrooms.

Individual-level factors predicting writing development

Empirical research examining individual-level factors of writing development is recurrently supported by two theoretical models of written expression. Both the simple-view of writing (Juel, Griffith, & Gough, 1986) and the not-so-simple view of writing (Berninger & Winn, 2006) sought to describe a multicomponent system for writing. These theoretical models of writing emphasise the role of transcription skills (e.g., handwriting, spelling, and keyboarding) as foundational skills that may constrain individual's access to higher-level processes (e.g., planning and revising) when not fluent. Empirical studies support the criticality of transcription skills showing that it uniquely predicts writing performance in the primary and middle years of schooling, accounting for approximately 25% of the variance in writing quality (Berninger & Swanson, 1994; Kent & Wanzek, 2016).

Handwriting automaticity

Despite the widespread use of technology and the current digital literacy agenda, handwriting plays a unique and fundamental role in writing development. Anecdotally described as "thinking with a pencil", handwriting involves the integration of visual-perceptual, fine and gross motor skills with cognition (Berninger et al., 2006). A growing body of research argues specific cognitive benefits of handwriting during early childhood, including brain development (James & Engelhardt, 2012), working memory (McCutchen, 2000), translation of thought-to-script (Berninger et al., 2006), and overall writing quality and production (Kim, Al Otaiba, Sidler, & Greulich, 2013). For example, studying the effects of handwriting experiences on functional brain development in preliterate children (four and five-year-olds), James

and Engelhardt (2012) found more neural activation in areas used for reading and writing after printing letters through copying than after typing them, suggesting that handwriting facilitates reading acquisition and writing development.

The importance of handwriting automaticity for developing writers is supported internationally (Berninger et al., 2009; Feng et al., 2017). Automatic letter writing has been found to be the best unique predictor of the writing skills of early developing writers (Berninger et al., 2009), theoretically supported by the notion that the translation of ideas into written text relies heavily on the writers' ability to retrieve alphabet letters in memory and produce these letter forms efficiently, legibly, and automatically (Graham, Berninger, Abbott, Abbott, and Whitaker, 1997). Students lacking handwriting automaticity have limited ability to engage in other aspects of writing, including vocabulary selection, ideation, and revision. The lack of handwriting fluency also affects students' self-efficacy and motivation for writing, constraining writing development, and ultimately academic success (Troia, Harbaugh, Shankland, Wolbers, & Lawrence, 2013). In a recent meta-analytic review investigating the role of handwriting in writing performance, Feng et al. (2017) found that handwriting automaticity consistently contributed to the writing quality and writing production of primary-school students (Years K-6) across orthographies (i.e., English, Turkish, Dutch, Korean, and Chinese). Intervention studies corroborate the relation between handwriting automaticity and writing performance, showing that handwriting instruction improves the writing quality and writing production of students from Year 1 to Year 9 (Alves et al., 2016; Berninger et al., 1997). In the Australian context, researchers have also suggested that handwriting instruction is key to promoting effective writing development. For example, Jones and Christensen (1999) assessed handwriting automaticity, reading, and writing performance of 114 Year 2 students. Handwriting automaticity explained 53% of the variance in students' story writing scores, after controlling for reading ability. In a subsequent study, Christensen (2005) found that handwriting instruction improved the writing performance of secondary-school students (Years 8–9) with low levels of handwriting automaticity.

Despite accumulating evidence showing that handwriting automaticity predicts effective writing, limited research has examined its contributions across time in kindergarten and Year 1, which is typically the period when children begin writing. In the U.S., for example, Kim et al. (2011) found that handwriting automaticity, spelling, and oral language were uniquely and positively related to the writing skills of kindergarten children. In a subsequent study looking at the shared and unique contributions of handwriting automaticity in early literacy acquisition, Kim et al. (2014) found that handwriting automaticity was moderately related but dissociable from alphabet knowledge fluency, marginally related to spelling, and not related to word reading at the end of kindergarten, presenting handwriting automaticity as a separate construct "at least during the beginning phase of literacy development" (p. 249). Findings from a similar cross-sectional study showed that handwriting automaticity added significant variance in kindergarten children's writing quality and writing production, after accounting for language, reading, and IQ (Puranik & Al Otaiba, 2012). These results suggest that handwriting automaticity plays a unique role in supporting the writing proficiency of beginning writers. However, in one of the few longitudinal studies examining writing in the early years of schooling, Kent et al.

(2014) found no relation between kindergarten students' handwriting automaticity and their writing performance one year later. Given these conflicting findings, further research is needed to examine associations between handwriting automaticity and writing performance in early childhood across time.

Associations between reading and writing

Theoretical and empirical research posits bidirectional associations between reading and writing processes. Considering the multidimensional nature of reading and writing, Fitzgerald and Shanahan (2000) proposed that both processes share knowledge (e.g., metalanguage and text attributes), cognitive systems (e.g., phonological and semantic systems, memory, and attention), and similar communication purposes. Regarding handwriting development, we know letter production builds kinaesthetic and orthographic memory that substantiates alphabet knowledge, essential cornerstones for higher-level reading skills, including comprehension and decoding (Berninger, 1999). Evidence from neuroimaging studies supports these theoretical assumptions. For example, Pugh et al. (2001) found an overlap in the activation of specific brain regions during reading and writing, and James and Engelhardt (2012) found that after handwriting experiences the brain activates networks used for reading.

Empirical research and several recent meta-analyses further show reading experiences influence writing quality and production. Kent and Wanzek's (2016) meta-analysis show that reading proficiency accounted for approximately 25% of the variance in students' writing quality across primary and secondary grades. Graham and Herbert's (2011) meta-analysis of true and quasi-experimental intervention studies reported that writing and writing instruction enhances students' reading development from Years 1–12. Graham et al. (2017) also found that reading and reading instruction strengthens the writing performance of preschool to Year 12 students.

Despite evidence supporting bidirectional associations between reading and writing (Fitzgerald & Shanahan, 2000), research shows contradictory findings in the first years of reading and writing development. When testing bidirectional associations in elementary schooling (Years 1–6), Berninger, Abbott, Abbott, Graham, and Richards (2002) found that reading had a unidirectional influence on writing quality and production in the earliest grades. Specifically, evidence indicated word reading predicted handwriting across elementary schooling. However, handwriting predicted word reading only in Year 2, suggesting asymmetrical relationships between some component skills of reading and writing. Examining longitudinal relations between reading and writing skills at the word, sentence and text levels, Ahmed et al. (2014) found stronger reading-to-writing effects in comparison to writing-to-reading effects in the early years. In contrast, longitudinal research (Kent et al., 2014) found word reading skills accounted for variation in early writing both concurrently and longitudinally in Year 1. Similar findings have also been reported with Year 3 students (Kim, Al Otaiba, & Wanzek, 2015), supporting the need to further examine associations between reading and writing in the early years.

Classroom-related factors predicting writing development

Writing instruction typically begins with formal schooling (White, 2013). There is not, however, a clear picture of writing instruction in early education, with limited research examining associations between teachers' writing practices and the development of various writing skills (Coker Jr, Jennings, Farley-Ripple, & MacArthur, 2018). Research indicates that little time is devoted to writing and teaching writing in primary classrooms. Cutler and Graham (2008) found Years 1–3 teachers allocated more time teaching basic writing skills (e.g., grammar, spelling, and handwriting) than teaching writing processes (e.g., planning and revising). In the time dedicated to basic-skills instruction, teachers reported spending less time teaching handwriting (46 min) than teaching grammar usage and spelling per week (80 min and 74 min, respectively). Similar findings were reported by Dockrell, Marshall and Wyse (2016) when investigating primary-school (K-2) teachers' practices in the UK, with teachers allocating more time teaching basic writing skills (e.g., spelling and vocabulary) than teaching writing processes (e.g., planning and revising). Malpique et al. (2017) also found that kindergarten children were spending below the recommended 30 min of daily writing practice in kindergarten Australian classrooms and that teachers were spending significantly more time teaching basic writing skills, such as spelling. Statistically significant variations in the amount of writing instruction have been consistently reported across studies, and these findings have been corroborated by limited observational studies (Coker Jr et al., 2018).

Fewer studies have investigated associations between instructional quality and students' writing performance in the early years. Evidence shows that the quality of the teacher–child relationship predicts the writing performance of kindergarten and Year 1 children above and beyond individual-level predictors (Kim et al., 2013; White, 2013). Bingham, Quinn, and Gerde (2017) found that teaching higher-level strategies (i.e., composing) predicted preschool children's writing abilities over and above teaching lower-level strategies (i.e., handwriting and spelling) and that instructional practices varied significantly between teachers. These findings were limited, however, to children's name writing and invented spelling abilities. Hence, research is needed to examine associations between teaching writing practices and more complex skills associated with effective writing development, such as text composing. In one of the few studies examining such relationships in early education, Kim et al. (2013) found that instructional quality in writing and spelling was not uniquely related to Year 1 students' writing performance. The authors argue for the importance of investigating the relationship between instructional time spent on writing and children's writing performance, which was not assessed in their study. The current study examines relations between the handwriting automaticity and the writing and reading performance of Year 1 students concurrently and across time. Capitalising on the WWC model of writing (Graham, 2018) and on the tenet that writing is shaped and constraint by context, this study further examines classroom-related factors and associations between writing performance and the writing instruction that Year 1 students experience in Australian primary classrooms.

Research questions and hypotheses

The present study addressed the following research questions: (1) Does handwriting automaticity predict, both concurrently and across time, the writing performance and the reading performance of Year 1 Australian students? (2) Are there any associations between the writing performance of Year 1 Australian students and the amount of time and types of instructional practices for writing?

The WWC model presents writing and writing development shaped by an "interaction between the context in which it occurs and the mental and physical actions writers are able to apply" (Graham, 2018, p. 272). Stemming from the research previously reviewed here, our first aim was to investigate the relations between the handwriting automaticity of kindergarten children and their writing (i.e., quality and production) and reading performance (i.e., word reading) 1 year later. Cross-sectional studies show that handwriting automaticity predicts effective writing in the first years of schooling (e.g., Puranik & Al Otaiba, 2012). However, given the lack of longitudinal relationships between handwriting and writing performance in Year 1 reported by Kent et al. here reviewed (2014), we expected that handwriting would predict writing performance concurrently only. Considering findings supporting stronger reading-to-writing effects in the early years here reviewed (e.g., Berninger et al., 2002), we further hypothesised that handwriting automaticity would not make a statistically significant contribution to predict reading performance concurrently and across time. In order to assess the contributions of handwriting automaticity across time, we controlled for initial word-reading skills and gender. The first control measure was used because of the demonstrated reading and writing connections here reviewed. The second control measure was used due to gender differences typically found in writing and research indicating handwriting automaticity as an explanatory variable for gender differences in early writing (Cordeiro, Castro, & Limpo, 2018).

Situating individual-level variables associated with writing development in context is a central principle of the WWC model for writing (Graham, 2018). As previously reviewed here, international literature shows that there is still an incomplete picture of how writing is taught in primary schools, including in Australia (Malpique et al., 2017). Thus, we also examined associations between the writing instruction and the writing performance of the Year 1 Australian classrooms participating in this study. Data on students' writing practices and teachers' instructional activities is limited (Coker Jr et al., 2018). Since time is seen as a critical contributor to writing quality (Graham, 2019), we expected positive associations between writing instruction, writing practice and overall writing performance.

Method

Participants and sites

The present study was part of a larger longitudinal study investigating self-regulated learning in the early years and associations with young children's academic achievement. While all 334 government-funded primary schools within the Perth

Metropolitan Region were invited to participate in this research, the sample was recruited from the seven schools who agreed to take part. The Index of Community Socio-Educational Advantage (ICSEA), calculated based on the socio-economic status of each schools' intake area (ACARA, 2012), was used to evaluate the socio-demographic representativeness of the participating schools. Schools represented different levels of economic advantage following the ICSEA average (1000), with one below average (950), three within the average range (950–1050), and three above average (1050). Schools varied in size, with the number of primary classrooms in each school ranging from two to seven classes. Within the schools, a total of 24 teachers (all female), ranging from two to six teachers per school, agreed to participate in this study. The majority of them held a bachelor's degree (61%), 28% vocational degrees, and 6% a master's degree. Teachers varied extensively in terms of their professional experience ($M_{\text{years}} = 15.88$, $SD = 9.82$; range 3–36 years).

A sample of 154 children participated in both data collection points, kindergarten ($M_{age} = 70$ months, $SD = 4.37$ months; 53% female) and Year 1 ($M_{\text{age}} = 82$ months, $SD = 3.64$ months). After the first round of data collection twenty-four children dropped-out due to relocation to different schools. Twenty-four children dropped-out after kindergarten due to relocation to different schools. Given the differences in group size between those who remained (n = 154) and those who left the study (n = 24), a series of non-parametric analyses (*Mann–Whitney U*) were undertaken controlling for family-wise error. No significant differences between these two groups were identified in terms of age, writing automaticity and word reading performance. In Year 1, students represented seven schools and 24 classrooms with a range of 3–13 students per participating classroom. The ethnic distribution of the retained sample that participated at both time points was 77% Caucasian, 10% Asian-Pacific Islander, 1% Aboriginal/Torres Strait Islander, 3% African, and 9% Other (e.g., Mixed Ethnicity and unknown/not reported). Participating children belonged primarily to nuclear families formed by mother and father (88%), and the primary household language in families was English (87%). Families varied in terms of parent education and income. A small percentage (1.5%) of the parents had completed primary education only, 19.8% had completed secondary education, 29.4% completed a vocational degree, 27.2% had completed a bachelor's degree, and 22% had completed a postgraduate degree. At Year 1, 29% of the families reported earnings below the yearly income average of $77.000 (Australian Bureau of Statistics, 2015). Before participation in the study, written informed consent was obtained from each student and his/her primary guardian.

Child-level measures

Child-level measures were collected during the final school term of kindergarten (i.e., handwriting automaticity and word reading) and at the end of Year 1 (i.e., handwriting automaticity, word reading, and writing performance). The first two authors administered student assessments in a quiet location outside the classroom during the school day.

Handwriting automaticity

The alphabet writing task (Berninger & Rutberg, 1992) was used to measure students' ability to access, retrieve and write letter forms automatically and accurately. In the last term of kindergarten, children were given dotted thirds paper and asked to write all the letters of the alphabet in order in 1 min, using lower case letters. Adopting Kim et al. procedures (2011, 2015), a score of 0.5 was given for each poorly formed letter that could be recognised in context and for reversed letters. At the end of Year 1, children were given the same instruction to complete the task and they were told to begin the sequence again if time permitted. Consistent with prior research (Jones & Christensen, 1999; Kent et al., 2014), students received a score of 1.0 for each correctly formed and sequenced letter. Letters written in cursive, letters written out of order, and/or uppercase letters did not count towards children's scores. Inter-rater reliability (random 20% of data at each time point) among the two researchers who administered the task was calculated using the intraclass correlation coefficient (.98. at kindergarten and .99 at Year 1).

Reading skills

Students' reading skills were assessed using the Word Reading subtest from the Wechsler Individual Achievement Test (WIAT-II), Second Edition, Australia adaptation (Wechsler, 2007). Items were administered according to criteria provided in the test manual for start and stop points, for setting time limits, for establishing basals for continuously correct responses, and ceilings for continuously incorrect responses. The WIAT-II Word Reading subtest assesses children's pre-reading skills (e.g., phonological awareness) and decoding skills (e.g., naming letters and reading words from lists). Following standard procedures outlined in the test manual, time for administering the test depended on the accuracy of individual responses. The reported reliability coefficient of the instrument was .98 and test–retest reliability .96 (Wechsler, 2007). A trained research assistant (Psychology Graduate Student) scored this assessment following the administration manual and the first author rescored 20% of the students. Inter-rater reliability, measured by the intraclass correlation coefficient, was .99 at the end of kindergarten and Year 1. Studies testing the validity of the WIAT-II, including content, construct, and criterion-related evidence confirm that the instrument composites and subtests adequately measure each construct, with moderate to high correlations with other achievement test scores (for a review see Pelling & Burton, 2017). For the current study, word reading scores showed adequate stability over time (.566; $p < .000$) considering the expected developmental change in reading skills over a one-year period of time. As indicated in Table 1, word reading scores were positively correlated to all writing measures.

Writing skills

In the last term of Year 1, children were asked to compose a text in response to an examiner-presented prompt. Children were asked to write a story beginning with "On my way home from school, a very exciting thing happened", and they were

Table 1 Descriptive statistics and bivariate correlations for individual-level measures

Variable	M	*SD*	Min–Max	1	2	3	4	5	6	7	8	9	10	11	12	13
1. K handwriting automaticity	10.08	6.40	0–26	–												
2. K word reading	98.87	16.18	56–135	.32	–											
3. Y1 handwriting automaticity	18.80	8.71	0–42	.46	.28											
4. Y1 writing quality	2.80	1.06	0–4.86	.54	.35	.54										
5. Ideas	3.23	1.30	0–5	.44	.28	.48	.92									
6. Structure	2.40	1.25	0–5	.47	.29	.42	.87	.82								
7. Word choice	2.81	1.16	0–5	.50	.32	.50	.93	.82	.78							
8. Sentence fluency	2.89	1.25	0–5	.49	.33	.47	.93	.83	.82	.90						
9. Spelling	2.94	1.30	0–5	.56	.40	.53	.92	.77	.73	.83	.82					
10. Mechanics	1.99	1.11	0–5	.35	.17	.37	.70	.57	.50	.55	.59	.59				
11. Handwriting	3.37	1.16	0–5	.46	.32	.49	.80	.63	.59	.72	.70	.78	.47			
12. Y1 writing production	29.78	17.99	0–86	.34	.23	.44	.70	.70	.69	.72	.69	.63	.40	.41		
13. Y1 word reading	109.92	14.75	71–137	.42	.56	.33	.53	.48	.44	.50	.50	.56	.29	.45	.34	–

K kindergarten, *Y1* Year 1

All coefficients are statistically significant at the .01 level

given five minutes to complete the task. Similar 5-min prompts have been used in writing research to gauge writing performance in Year 1 (Kim et al., 2013; McMaster, Du, & Pétursdóttir, 2009). Children's writing was assessed in two different ways. First, to assess overall writing quality, we followed an analytical scoring procedure in which children's written composition was scored on seven criteria namely: ideas (e.g., development of main idea); organisation of text structure (e.g., beginning, middle, and end); word choice (e.g., interesting and specific words to convey meaning); sentence fluency (e.g., sentence-level grammar and flow); spelling; mechanics (e.g., punctuation and capitalisation); and handwriting (e.g., letter formation, neatness, and spacing). These marking criteria were adapted from the widely used 6 + 1 Traits of Writing Rubric for Primary Grades (NREL, 2011) since it was well aligned with curriculum-based judging standards for writing and creating texts in Western Australia (School Curriculum and Standards Authority [SCSA], 2017a, 2017b). The voice criterion of the original rubric was not included in the current study due to floor effects reported in previous studies using the same rubric to assess text composing in Year 1 (Kent et al., 2014; Kim et al., 2013). Scores ranged from 1 (*experimenting*) to 5 (*experienced*). The RA scored this assessment and the second author rescored 20% of the students' written texts. Before that, raters discussed the distinguishing features of each criterion and then practised using the rubric with a series of compositions that varied in overall quality. After independently scoring each practice story, raters compared their scores and resolved any differences through discussion. A score of 0 was assigned to unscorable texts in each criterion, but only two prompts were deemed unscorable in the current study (see Kim et al., 2013 for similar procedures). The writing quality score reflected the average of the seven marking criteria. Internal consistency was high for the scale, as assessed by Cronbach's alpha (0.94). Interrater reliability measured by the intraclass correlation coefficient was .88 (range = .84–.91). Second, children's written composition was assessed for the total number of words (TNW) to evaluate writing production. TNW is a widely used measure because it has been shown to predict writing quality in previous research (e.g., Graham, Hebert, Paige Sandbank, & Harris, 2016). All words that represented a spoken word were counted, regardless of spelling. Interrater reliability between the RA and the second author, who scored 20% of the texts, was .99.

Classroom-level measures

At the end of Year 1, all 24 Year 1 teachers of the 154 children completed a short survey where they were asked to indicate *the amount of time allocated for writing practice and writing instruction.* Considering the lack of validated measures to assess teachers' writing instruction in Australian contexts (Malpique et al., 2017), we conducted a review of existing surveys and scales assessing writing instruction in primary schools. Survey questions were based on two surveys examining writing instruction in American primary classrooms developed by Cutler and Graham (2008) and Gilbert and Graham (2010). To assess writing time, teachers were asked to indicate how many minutes their students spent writing and how many minutes they spent teaching writing per week. To assess types of instructional practices for

writing that students experienced, teachers were asked to indicate the amount of time they allocated to teaching basic writing skills (i.e., handwriting, spelling and grammar usage) and teaching writing processes (i.e., revising and planning strategies) in their weekly instructional practices. The reported reliability coefficient of the items examining the amount of time teaching basic skills and teaching writing processes, as assessed by Cronbach's alpha, was .84 and .85, respectively (Cutler & Graham, 2008).

Data analyses

Due to the hierarchical nature of the data, we used hierarchical linear modelling (HLM) using children (level-1) nested in classrooms (level-2) and schools (level-3). First, null models were tested to check variance at all structural levels by estimating the intraclass correlation coefficient (ICC). ICC provides the percentage of the total variance in the study outcomes that is due to different hierarchical levels, with values close to zero suggesting cluster independence. Next, fixed effects multilevel models were estimated, one for each outcome (i.e., writing quality, writing production, and word reading) to explore which variables significantly contributed to explain writing performance and reading of Year 1 students after controlling for gender and word-reading variations in kindergarten. Fixed effects models are particularly useful when level-2 sample sizes are small providing unbiased regression coefficients and higher power rates when compared to other methods (McNeish & Stapleton, 2016).

Following simulation studies, the regression coefficient estimates for these models are unbiased at level-1 even for extreme small samples of 10 level-2 units with 5 observations per unit (e.g., Łaszkiewicz, 2013). However, by choosing the most efficient multilevel strategy to account for the study's small level-2 sample size, class-level variables were not included as predictors because, by accounting for variation at level-2, these variables would require a random effects approach and a higher number of level-2 units. To that end, the estimated fixed effects multilevel models allowed to model nonindependence of data, adjusting standard errors and providing reliable statistical tests according to variance partitioning. Multilevel analysis was performed with lme4 package (Bates, Maechler, Bolker, & Walker, 2015) with p-values being estimated with lmerTest package (Kuznetsova, Brockhoff, & Christensen, 2017), both designed for R environment (R Core Team, 2017). According to Luke (2017) p value estimation using lmerTest with Kenward-Roger or Satterthwaite approximation for degrees of freedom provides p-values that are not highly sensitive and provide acceptable Type I error rates even for small samples.

Due to the small sample at each level of observation and associated power restrictions, correlations were conducted at the classroom-level to answer the second research question. Correlations between individual and classroom-level variables were performed by computing a weighted correlation of the means between groups, meaning that for each individual-level variable a weighted mean score was estimated at classroom-level. Between-level correlations addressing individual-level

composites should be interpreted at class-level. To account for non-normal distributions observed in the teacher reported data and small sample size, Kendall's tau-b non-parametric correlations were estimated.

Results

Descriptive statistics and bivariate correlations among all individual-level variables are presented in Table 1. Tests of normality, including skewness and kurtosis, all fell within acceptable ranges across outcomes.

Handwriting automaticity

HLM results revealed differences, particularly between children and classrooms. Small to none variance at school level supported the decision to consider only a 2-level model with children nested within classrooms (writing quality: ICC = 75.57% for level 1, 24.43% for level 2; writing production: ICC = 81.46% for level 1, 18.54% for level 2; reading: ICC = 83.99% for level 1, 16% for level 2).

HLM results are presented in Table 2. Estimates for fixed effects indicated that handwriting automaticity positively predicted writing quality concurrently and across time. For writing production, its positive contribution existed concurrently only; while for word reading its positive contribution existed across time only. Girls outperformed boys in all writing quality indicators except mechanics (i.e., ideas: $B = -.46$, $SE = .18$, $p = .011$; structure organisation: $B = -.43$, $SE = .18$, $p = .018$; vocabulary: $B = -.38$, $SE = .15$, $p = .012$; sentence fluency: $B = -.61$, $SE = .17$, $p < .001$; spelling: $B = -.44$, $SE = .16$, $p = .008$; mechanics: $B = -.19$, $SE = .16$, $p = .250$ and handwriting: $B = -.57$, $SE = .16$, $p < .001$). Gender was not a significant predictor for word reading.

Amount and types of writing instruction

The average time spent on writing instruction and writing-related activities across classrooms in Year 1 was 250 min ($SD = 93.54$) per week. Teachers indicated that they spent an average of 71 min each week teaching writing ($SD = 25.78$; range = 30–120 min). In comparison, they reported that students spent nearly 3 h a week writing ($M = 179.28$ min, $SD = 81.63$; range = 60–360 min). Figure 1 shows the average amount of writing instruction and writing practice across the 24 classrooms and seven schools (i.e., schools A to G). It is noteworthy the large variability in the amount of time students spent writing and the amount of time spent teaching writing across classrooms and within and across schools.

Year 1 teachers reported placing considerable emphasis on teaching basic skills. Large variability was also noted in the amount of time allocated for teaching basic skills and writing processes. Teachers indicated that they spent an average of 103 min ($SD = 49.60$; range = 0–200 min) teaching spelling; 60 min ($SD = 29.82$; range = 0–129 min) teaching grammar; and 57 min ($SD = 22.94$; range = 20–90 min)

Table 2 Multilevel models: writing quality, writing production, and word reading predicted by students' handwriting automaticity (concurrently and across time)

	Writing quality			Writing production			Word reading		
	B*(SE)*	*t*	*p*	B*(SE)*	*t*	*p*	B*(SE)*	*t*	*p*
Fixed part									
K handwriting automaticity	.04(.01)	3.430	< .001***	.21(.23)	0.916	.361	.53(.17)	3.051	.003**
Y1 handwriting automaticity	.04(.01)	4.117	< .001***	.66(.17)	3.870	< .001***	.15(.13)	0.835	.405
Gender	− .43(.13)	− 3.304	.001**	− 6.53(2.60)	2.514	.013*	2.85(1.92)	1.484	.140
K word reading	.01(.001)	2.724	.007**	.10(.08)	1.265	.208	.45(.06)	7.397	< .001***
Random part									
Level-1 variance	.54			219.43			119.24		
Level-2 variance	.10			32.68			17.37		

K kindergarten, *Y1* Year 1

*$p < .05$

**$p < .01$

***$p \leq .001$

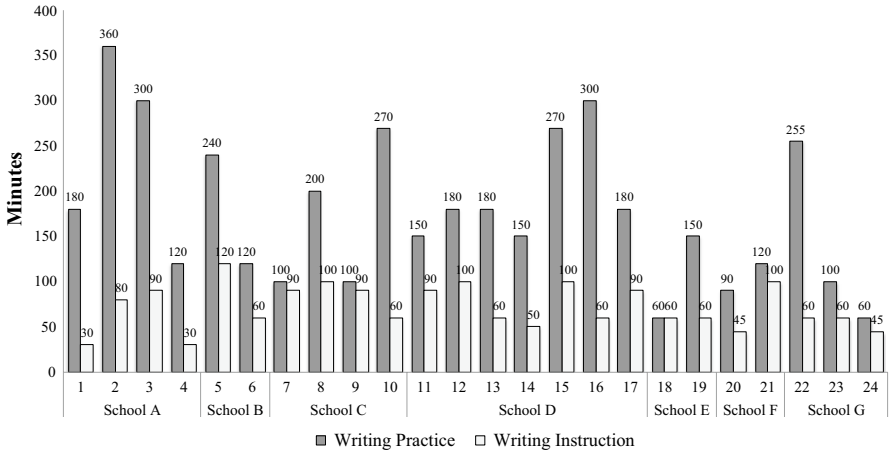

Fig. 1 Average amount of time on writing instruction and writing practice by classrooms and schools

teaching handwriting per week. In comparison, teachers reported spending 45 min ($SD = 49.60$; range = 0–180 min) teaching revising, and 47 min ($SD = 36.60$; range = 0–120 min) teaching planning strategies per week.

Classroom-level correlations were computed to examine whether or not there existed associations between writing and reading performance and writing instruction variables (see Table 3). Results showed positive correlations between the amount of writing practice, writing quality, writing production, and word reading. Positive correlations were also found between the amount of writing practice and teaching writing processes (i.e., planning and revising), with positive correlations between teaching planning strategies, writing quality, writing production, and word reading. Teaching revising strategies was also positively correlated with writing

Table 3 Correlations between writing and reading performance and writing instruction variables in Year 1

	1	2	3	4	5	6	7	8	9	10
1. Writing quality	–									
2. Writing production	.62**	–								
3. Word reading	.52**	.24**	–							
4. Writing practice	.28**	.34**	.23**	–						
5. Writing instruction	−.08	−.03	−.08	.26**	–					
6. Spelling	−.05	−.09	−.03	−.18**	.24**	–				
7. Handwriting	.16**	.18**	.18*	.01	.31**	.30**	–			
8. Grammar	−.04	.05	−.06	.01	.53**	.45**	.45**	–		
9. Revising	.06	.27*	.06	.39**	.06	−.15*	.02	.05	–	
10. Planning	.29**	.28**	.31*	.30**	.09	−.14*	.22**	.17**	.32**	–

**$p < .01$, *$p < .05$

production. Results showed positive correlations between the amount of writing instruction and teaching basic skills (i.e., spelling, handwriting, and grammar). Results further indicated a negative correlation between teaching spelling and teaching planning and between teaching spelling and revising.

Discussion

Based on data collected on a sample of students in kindergarten and Year 1, we investigated relations between the handwriting automaticity of Year 1 students and their writing and reading performance concurrently and across time. Considering the importance of situating writing in context (Graham, 2018), we also examined associations between writing instruction practices and the writing and reading performance in Year 1 Australian classrooms. Results showed that, after accounting for gender and initial word reading skills, handwriting automaticity predicted writing quality both concurrently and across time. Results further indicated that handwriting predicted Year 1 reading skills across time. In addition, associations between writing and reading performance and instructional factors suggested differences in the amount of time and type of practices Year 1 teachers allocate to promote effective writing in Australian classrooms.

Handwriting automaticity

Findings from this study confirm and extend previous studies by showing how handwriting automaticity is related to writing and reading performance in early education. As predicted, results suggested that the handwriting automaticity of Year 1 students was positively related to their writing performance, confirming findings from cross-sectional studies here reviewed (e.g., Kim et al., 2013). After accounting for gender and word reading skills in kindergarten, results indicated that handwriting automaticity predicted the quality of the texts children produced 1 year later. One could reason that the predictive association between handwriting automaticity and writing quality in Year 1 occurs via handwriting automaticity in kindergarten. In other words, strong handwriting automaticity in kindergarten facilitates faster automatic retrieval of letter forms in Year 1, which subsequently frees cognitive resources that allow children to focus on translating their ideas into writing 1 year later. These results support a developmental theory of writing (Berninger & Swanson, 1994), in which transcription skills, such as handwriting, are described as foundational skills for effective writing development. As previously reviewed here, research supports a bidirectional relationship between reading and writing (Fitzgerald & Shanahan, 2000) and stronger reading-to-writing effects in early education (Ahmed, Wagner, & Lopez, 2014). More specifically, evidence supports asymmetrical relationships between handwriting and word reading in the early years, with handwriting predicting word reading in Year 2 only (Berninger et al., 2002). As anticipated, current results corroborate the absence of a relation between handwriting automaticity and word reading in Year 1. Contrary to expectations, results

indicated that handwriting automaticity and word reading in kindergarten predicted word reading across time, suggesting that being able to write letters quickly and effortlessly in kindergarten facilitates pre-reading and decoding skills 1 year later. Experimental research is needed to confirm these findings and systematically evaluate potential explanatory mechanism of writing-to-reading effects over time in the early years.

In the present study, results showed a significant proportion of variability in Year 1 students' writing and reading performance associated with classroom variables. After accounting for the effects of gender and initial word reading skills, variance components results for the random intercepts model indicated that nearly 25% of the variability in writing quality was attributable to classroom-related factors. Results further indicated that 18.5% and 16% of the variability in students' writing production and word reading skills were attributable to classroom-related factors, respectively. The low power at the classroom level did not allow us to compute random slope models to examine the predictive value of classroom-related variables. However, these findings help making the case that variance in writing and reading performance is likely to be explained by other factors than initial variance among writers alone, supporting the WWC model of writing and the principle that writing development is a result of variations in contextual and individual variables (Graham, 2018). Research investigating the variance in children's writing performance associated with classroom variables is limited. This study is, to our knowledge, the first examining associations between writing performance and instructional time for writing in Year 1 Australian classrooms.

Writing instruction

As noted previously, international research shows little time is devoted to teaching writing in primary classrooms (Graham, 2019). As predicted, findings from our study showed that Year 1 students spent, on average, less than the recommended 50 min of daily writing practices (Graham, McKeown, Kiuhara, & Harris, 2012). Teachers indicated their students spent about 179 min engaged in writing activities and that they were allocating about 71 min on writing instruction per week. Similar findings were reported in a study in Australian kindergarten classrooms (Malpique et al., 2017) and corroborate international research suggesting that the teaching of writing vary rather noticeably across classrooms (Coker Jr et al., 2016; Kim et al., 2013). Large variability was reported in the amount of time students spent writing and in the amount of writing instruction occurring across Year 1 classrooms and within primary schools, ranging from 30 to 120 min per week. Variation was also noticeable in the teaching of basic writing skills and in the teaching of writing processes across classrooms. Providing adequate time for students to write is an essential element of effective writing development (Graham, 2019; Rietdijk, van Weijen, Janssen, van den Bergh, & Rijlaarsdam, 2018). This will enable students to have more opportunities to develop their writing skills and feel more confident when facing a writing task, allowing teachers with more opportunities to identify writing difficulties at the outset and subsequently respond to students' differences and needs (Graham, Bollinger et al., 2012).

Current findings suggested Year 1 Australian teachers may be prioritising the teaching of basic skills over the teaching of writing processes. These results corroborate similar findings in primary classrooms where more time on phonic activities related to spelling was included in teachers' writing instruction (Dockrell et al., 2016; Malpique et al., 2017). This may be problematic since research with primary students (Graham, Bollinger et al., 2012) suggests that writing instruction in early education should include the teaching of basic writing skills and the teaching of writing processes in the same instructional protocol. Considering the variability in the amount of time for writing and teaching writing, findings from the present study suggested a lack of uniformity in writing instruction in Australian primary classrooms, with potential consequences on students' writing development. Simultaneously, these findings corroborate the WWC model (Graham, 2018) and the premise that there is variability across writing communities and within writing communities in which writing is developed, potentially associated with community members' knowledge, beliefs and values about writing (Graham, 2019). Experimental studies are clearly needed to examine the extent to which variability in time for writing and teaching writing is explained by teachers' beliefs and knowledge about writing instruction.

In the present study, we examined associations between writing and reading performance, amount of writing practice, and amount and type of writing instruction in Year 1. Results showed statistically significant positive associations between the amount of writing practice and both writing and reading performance. In a meta-analysis examining writing instruction in Years 2–6, Graham, McKeown et al. (2012) reported that increasing the time students wrote improved writing quality. As previously reviewed here, research shows that increasing time spent on writing has a positive effect on primary students' reading outcomes (Graham & Herbert, 2011). Current findings corroborate the importance of writing practice to promote effective writing and support the theoretical view of reading-to-writing connections in early education. Our results showed, however, that the amount of writing instruction was not significantly related to students' writing performance. These results corroborate Coker et al. findings (2018) showing no direct relationship between the amount of writing instruction and students' writing achievement in Year 1. Taken together, these findings substantiate the stand that "time alone is not sufficient to ensure that students receive strong writing instruction" (Graham, 2019, p. 288). It is not necessarily the time spent on teaching writing that matters most but what teachers do and what students do in the allocated time for writing. Results further showed that the amount of writing instruction was positively associated with teaching basic writing skills, suggesting that teachers who allocated more time to explicitly teaching writing would focus more on teaching basic skills. On the other hand, the amount of writing practice was positively associated with planning and revising,

suggesting that teachers who provided more time for writing in their classrooms would more often engage students in higher-level writing processes. Given the bidirectional nature of correlations, we have to contemplate the possibility of students' writing performance affecting teachers' time allocation for instruction and practice. For instance, teachers of more able writers may have allocated more time for independent practice while scaffolding higher-level processes. By the same token, teachers' focus on basic skills may have been triggered by cohort-level difficulties in

transcription processes. Experimental designs are needed to identify casual mechanisms. While current findings provide insights into potential ways that instructional factors may be associated with writing performance, much more work is needed to understand the ways that individual and classroom-related factors may interact to facilitate development.

Limitations and future research

The present study has a number of limitations that need to be taken into account when interpreting findings. First, the relatively small number of classrooms did not allow us the use of more sophisticated statistical multilevel models (e.g., random slopes models) to examine the predictive value of classroom-related factors in students' writing and reading performance. To that end, only fixed effects multilevel models were performed to provide reliable regression coefficient estimates and unbiased standard errors. Moreover, the estimated weighted correlations of the means between groups performed for our individual and classroom-related variables can only be informative at classroom-related, not allowing to perform generalisations at student-level. In addition, although our sample varied in terms of education and income it was less diverse in terms of ethnicity. Thus, generalizing the findings to other populations should be done cautiously. Future research with larger samples is clearly needed to examine classroom-level predictors of writing and reading performance in early education, including overall classroom quality. Second, we did not include any measures to examine children's reading comprehension skills. Similar word reading measures as the WIAT-II Word Reading subtest have been used in studies with this age group (e.g., Coker Jr et al., 2018). Including a measure of reading comprehension, however, would have allowed us to reach a more comprehensive view of writing-to-reading connections in early education. Moreover, considering that handwriting is just one component of early writing development (Berninger & Winn, 2006), research is needed to examine a larger set of individual-level predictors of writing development, including spelling and keyboarding, and relations with classroom-related practices. Such research is clearly needed to provide a more comprehensive understanding of how "writing is simultaneously shaped by variability within a writing community and individual differences" (Graham, 2018, p. 275). Third, despite assessing several aspects of writing, including quality and production, this data was drawn from only one writing sample collected at the end of Year 1. Including multiple samples of students' writing could have increased measurement reliability. Finally, the use of self-reports rather than direct observation to assess writing instruction means that findings must be treated cautiously. Teachers' responses may have been influenced by the difficulty of estimating time allocated for specific practices. However, we reasoned that surveying teachers after collecting child-level measures would increase the likelihood of teachers reporting their actual classroom practices, being less likely to plan writing instruction with our questions in mind (Malpique et al., 2017). Teachers' reports and overall findings are well aligned with findings from observational research in early education (Coker Jr et al., 2018). Additional research including interviews, direct observation, or a

combination of the two is needed to provide a more precise estimate of the amount of writing and writing instruction, as well as a more comprehensive understanding of the nature of instructional practices that promote effective writing development in early education.

Conclusions and implications for theory and practice

In the present study, individual and classroom-related factors were used to examine the writing performance of Year 1 Australian students. Reinforcing extant literature highlighting the importance of handwriting automaticity for developing writers (Berninger et al., 2009; Feng et al., 2017), current results offer preliminary evidence on the role that handwriting automaticity plays in young children's writing and reading outcomes. These findings solidify writing-to-reading connections in early development. Furthermore, the current study extends knowledge on the relations between students' writing and reading performance and instructional practices for writing, suggesting specific associations with students' writing performance in Year 1. While further validation is necessary, these findings help provide additional evidence to understand writing development in context in early education.

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