The Relationship Between Component Skills and Writing Quality and Fluency Across Development

Purpose

Much of the extant theoretical and empirical research on writing and its' component skills has focused on a specific developmental level (e.g., elementary, secondary grades), component skill or process (e.g., transcription and writing, executive functions and writing), or type of learner (e.g., typically developing, struggling writers). Graham et al. (2012) identified a crucial need for studies in the area of writing theory that specifically address the impact of various skills to writing across the developmental spectrum. Further, Miller and McCardle (2011) highlighted the need for continued research on writing development and advocated for research not just at the earliest levels, but also for subgroups of students with academic difficulties in reading and writing. To date, there exist no empirical studies that specifically examine the relationship of multiple potential component skills of writing to quality of writing and production/fluency of text generation across the developmental span (i.e., lower elementary through secondary grades), and for students with and without disabilities. While the sheer magnitude of resources that would be required to carry out such an endeavor makes such a study unlikely, meta-analysis provides a method by which this important information from many individual studies can be summarized and quantified.

The present study sought to help further clarify and elaborate models of writing development, namely improving the understanding of how individual differences in component skills and processes relate to differences in writing quality and writing fluency ability. Further, the use of meta-analytic techniques will allow this study to compare relationships both across different grade levels and for students of differing abilities. This information has important implications for instruction and remediation of writing in the school setting. The following research questions were addressed:

1. What is the relationship between handwriting, spelling, reading, oral language, and self-regulation and writing quality and writing fluency across grades k-12?
2. Does grade level of students moderate the relationship between component skill or process and writing outcomes?
3. Do these relationships differ for students with academic difficulties (e.g., high-incidence disabilities and/or struggling readers or writers)?

Background and Context

The very act of putting language into words on paper, or writing, is a very complex task that requires considerable knowledge and cognitive effort. In their influential paper, Flower and Hayes (1980) described the writing process as follows: "As a dynamic process, writing is the act of dealing with an excessive number of simultaneous demands or constraints. Viewed this way, a writer in the act is a thinker on full-time cognitive overload" (p.33). Learning to write effectively in the early grades, often involves a focus on letter formation, basic spelling, and composing of simple descriptive and narrative texts while in the secondary grades, writing activities become more complex (e.g., writing a persuasive essay). One can hypothesize that writers across the developmental span must call upon different skills and cognitive resources in order to meet increasing demands of the writing task.

Writing has received comparatively less attention relative to the sustained efforts of researchers investigating the area of reading over the past several decades (e.g., National

Reading Panel, 2000; National Early Literacy Panel, 2008). However, theories of writing development, including the Simple View of Writing (Juel et al., 1986) and the Not-so-Simple View of Writing (Berninger & Winn, 2006), have suggested several important componential skills. Converging evidence exists supporting the role of each of these component skills hypothesized, including more rudimentary, lower-level skills such as spelling and handwriting (e.g., Graham et al., 1997), language skills allowing transformation of ideas to written language representations (e.g., Abbott & Berninger, 1993), and self-regulatory processes (e.g., Hooper et al., 2011). Furthermore, reading has demonstrated an important relationship to writing development (Abbott et al., 2010). A clear understanding of important skills contributing to writing proficiency in the early grades and beyond is important for several reasons. *First*, there has been a notable increase in expectations for writing skills, beginning in kindergarten and first grade (Common Core Standards, 2010). *Second*, previous research has demonstrated the relative intractability of writing deficits that begin early on in schooling (Juel, 1988). *Third*, most would agree that the ability to write is critical for success throughout the school years and into adulthood, where poor writing skills can have a detrimental impact in the work place (National Commission on Writing, 2004). The current state of writing skills of students in this country, where less than one-third of eighth and twelfth grade students demonstrate proficiency (NAEP, 2012), as well as research supporting the high prevalence of writing difficulties across grade levels (Hooper et al., 1993; Katusic, Colligan, Weaver, & Barbaresi, 2009; Mayes & Calhoun, 2007) highlights the importance of examining skills important to writing expression outcomes. Thus, exploration of components that influence writing development may provide possible targets for instruction, intervention, and remediation.

Method

Search Process & Coding Procedures

Prior to conducting the systematic search for potential studies, a list of search terms was generated for each component skill category (e.g., oral language) and for writing outcomes (e.g., writing quality). The search for relevant studies for this meta-analysis was conducted using Education Resources Information Center (ERIC) and PsycINFO databases. The search proceeded separately for each component skill by linking all subordinate terms in each category with OR statements and linking each category to the writing category with AND statements for a total of four separate searches. Final search parameters including limiting the search to articles published in the last 25 years (January 1, 1988 through May, 2013) as well as in peer-reviewed, English language journals. This initial search resulted in a total of 9635 potential articles.

Included studies met the following criteria: (a) included students in grades K-12 within a school setting, (b) was peer-reviewed and published in English, (c) measured skills in English language, (d) included typically developing students and/or students with mild disabilities, and (e) reported data on concurrent relationships between skills. To further ensure comprehensive search procedures, additional searching of the reference list of existing, related meta-analyses (e.g., Graham et al., 2012) was conducted which did not result in any additional articles identified. Finally, a hand search of relevant journals for 2010- 2013 was conducted to identify any additional potential studies. The specific journals searched were *Reading and Writing: An Interdisciplinary Journal* (one article located), *Reading and Writing Quarterly* (no articles), *Journal of Educational Psychology* (no articles), *Written Communication* (no articles), *Learning and Individual Differences* (one article), *Journal of School Psychology* (no articles) and *School Psychology Review* (no articles). After a review of potential articles identified from the initial

search, a total of 35 studies met criteria for the present meta-analysis. Seven studies were excluded because they reported on the same sample and construct measures as another included study and thus, a total of 28 studies are synthesized in the present study.

All studies were coded by the first author using an extensive codesheet similar to that used in the NELP (2008) meta-analysis. A random selection of 25% of studies were double-coded by a trained research assistant to ensure reliability. Initial reliability of the two raters was established through training on the coding process and then independent coding of a sample article. Inter-rater agreement of at least 90% was required before double-coding could begin. For studies that were double-coded, inter-rater agreement was 91.5%.

Analytic Procedures

Analyses were conducted by examining the *Pearson r* coefficient as the effect size between handwriting fluency, spelling, reading, oral language, and self-regulation/executive functions and writing outcomes separately. To handle potential issues of non-independence of data in the analyses, only one effect size per construct (e.g., spelling and writing quality) per sample in each study was utilized. In studies where effect sizes were reported separately by grade levels, these were treated as different samples and each was included. When multiple effect size estimates of these relationships were reported for a sample in a study (e.g., two correlation coefficients between handwriting and writing quality variables), a simple average was calculated for inclusion in the analyses. To examine the relationship between component skills/processes and writing outcomes, Pearson's r correlations were first transformed into z-scores using Fisher's z-transformation and then the variance of z was estimated. Once transformed, main effects were examined using a weighted, random-effects model for each relationship.

Heterogeneity of the effects was examined using a Q-test, and an I^2 value was also calculated. These measures capture the degree to which variability in effect sizes is beyond what can be accounted for by sampling error alone. The effects of two moderators were then tested using mixed-effects ANOVA. First, the effect of grade level was examined using ANOVA to compare the significance of the difference between effect sizes from samples with students in kindergarten through third grade, fourth through sixth grade, and seventh grade and above. Second, the effect of disability status was examined using ANOVA to determine if effect sizes significantly differed for students with high-incidence disabilities and/or students at-risk for academic difficulties in comparison to a full range sample. Comparisons were only conducted when a minimum of three studies were available per group (e.g., per grade category, student level).

Findings or Results

The corpus of literature for this review contained a total of 28 studies ranging in publication date from 1988 to 2013. The samples from these respective studies covered the full range of students from kindergarten through high school, and students from 5- 18-years old. Within these studies, there were 144 total effect sizes coded; 26 for handwriting fluency, 18 for spelling, 45 for reading, 31 for oral language, and 24 for the relationship between self-regulation variables and writing outcomes. Table 1 presents a list of included studies by component skill.

Results of the meta-analyses for each relationship between component skills and writing quality and writing fluency, as well as moderator analyses when appropriate, are presented in Tables 2-6. Under a random-effects model, the mean effect size of studies reporting the relationship between handwriting fluency and writing quality was positive and moderate in

magnitude ($r = $ .50 [.38, .61], $p < $ .001) with significant heterogeneity evident among these results ($Q = $ 234.81, $p <$ .0001). Similarly, the mean effect size between handwriting fluency and writing fluency was $r = $ .50 [.40, .58]; again, significant heterogeneity among effects was evident ($Q = $ 61.42, p < .001). This result was significant ($p < $ .001) and suggests a moderate, positive relationship. Further analyses indicated that student grade level and academic difficulties status were not moderators of these effects.

For the component skill of spelling, the mean effect size for the relationship to writing quality was $r = $ .54 [.45, .62], which was significantly different from 0. The mean effect for the relationship between spelling and writing fluency was also significant ($r = $ .48 [.30, .63], $p < $ .001) and moderate in strength. Significant between-study differences in effect sizes were noted for writing quality ($Q = $ 96.42, $p < $ .001) and writing fluency ($Q = $ 96.42, $p < $ .001). While there were no significant results from moderator analyses, effect size differences between samples representing the full range of abilities ($r = $ .36 [.12, .56]) and samples of students with academic difficulties ($r = $ .63 [.41, .78]) approached significance (p = .08).

The relationship between reading and writing quality was represented by a positive, moderate in strength mean effect ($r = $ .45 [.40, .49], p < .001). However, the mean effect for reading and writing fluency was somewhat weaker in magnitude ($r = $ .30 [.20, .40], p < .001). Moderator analysis revealed no significant between-group differences for students in lower versus upper elementary grades in either area. However, while the presence of academic difficulties did not moderate the reading to writing quality relationship, mean effect sizes for the reading and writing fluency relationship were significantly different ($Q_{between} = $ 4.73, $p = $ .03) between students representing the full range of abilities ($r = $ .24, 95% CI [.11, .35]) and for students with academic difficulties ($r = $ .47, 95% CI [.29, .61]).

In the area of oral language, small, yet positive relationships were evident with writing quality ($r = $ .31 [.20, .40], p < .001) and writing fluency ($r = $ .22 [.11, .33], p < .001). Significant heterogeneity was evident between effects in both areas. No significant moderators of effect size were indicated during further analyses. Finally, the mean effect for the relationship between self-regulation and writing quality was $r = $ .28 [.22, .34] and was significant. However, these effects were considered homogeneous ($Q = $ 14.17, $p = $ .17) and thus, no further analyses were conducted. The mean effect for the relationship between self-regulation and writing fluency was r = .37 [.30, .43] which was significant and suggested a moderate relationship. As effects were heterogeneous, further moderator analyses were conducted. However, no differences were evident between elementary and secondary samples.

Conclusions and Implications

The primary findings from 28 separate studies ($k = $ 144) confirmed small to moderate, significant correlations between individual component skills and student's writing quality and writing fluency. Although in most instances effect sizes were heterogeneous, in all but one analysis, no statistically significant moderator effects were found for either grade level or student ability/achievement level; the relationship between reading achievement and writing fluency was stronger for students with academic difficulties. The finding that automaticity and fluency in handwriting and spelling demonstrated moderate bivariate relationships to both quality and fluency of composition, and that such relationships were stronger in magnitude relative to other component skills, supports the perspective regarding their importance as foundational skills for the development of writing (Berninger & Winn, 2006; Juel et al., 1986). Of note however, fluency in handwriting and spelling appear to have a continuing influence on writing quality in

older students, which may be partially due presentation effects; that is, composition has shown to be judged more harshly, regardless of content, when legibility is poor and spelling errors are frequent (Graham & Hebert, 2011).

Although the specific directionality of the reading-writing relationship could not be established given the correlational nature of the research, current findings reinforce that reading and writing are related, yet not parallel in development as no more than 35% of variance in reading and writing can be accounted for by the other. The reason for the stronger influence of reading on writing fluency for those with academic difficulties may be that such students, particularly those with deficits in reading development, are more likely to have comorbid difficulties with transcription skills, particularly spelling, as is the case for students with developmental dyslexia (see Berninger et al., 2008). This may in turn, exacerbate difficulties in generating written text. Although only a small relationship was evident between self-regulation and writing outcomes, these findings do support prominent writing theories (Flower & Hayes, 1980; Berninger & Winn, 2006). Flower and Hayes (1980) describe skills related to self-regulation as analogous to the operator of a switchboard, with a primary function of allocating existing resources efficiently to the task at hand. Thus. although findings suggested a generally small direct relationship on writing outcomes, self-regulation may also influence writing proficiency indirectly through the management of multiple processes. The lack of differences in effects between grade levels stands somewhat in contrast to several theories (e.g., Bernigner & Winn, 2006) and warrants further investigation.

Relative to other outcomes, oral language showed the weakest relationship to writing, accounting for less than 10% of variance in both writing quality and fluency. The results stand somewhat in contrast to the importance placed on oral language by Juel and colleagues' (1986), in their simple view of writing, as one of two key components for proficient writing in the elementary grades. There is an important caveat however; oral language, as represented by both expressive and receptive language ability as well as knowledge of grammatical conventions of language, may represent only one aspect of ideation noted by Juel et al. (1986). Ideation in a broader sense may involve a more active and recursive process of planning, ongoing evaluation, and revision (Bereiter & Scardamalia, 1987; these processes were not specifically captured in the studies utilized in this meta-analysis.

Several limitations must be considered when interpreting these results. The studies reviewed examined these skills within English writing systems and thus, it is possible that such relationships may differ in other language systems. We were also only able to locate three studies that specifically measured and reported the relationship between one or more component skill and writing quality and/or fluency for samples of students in Grades 7-12 and only one involved a sample representing the full range of student abilities (Best, 2011). It is clear that future research examining these relationships at the secondary level is warranted and would help create a clearer picture of influences on writing quality and fluency and identify potential targets for instruction. Of the 144 total effect sizes examined across the five component skills in this study, approximately 25% ($k = 37$) involved students with academic difficulties; these effects came from only seven studies. Further, none involved students with specific learning disabilities. More information on this population is needed in order to devise appropriate instructional programs. In this study, only bivariate relationships were considered. Future studies should look to examine multivariate findings in order to synthesize relations between multiple components skills and writing outcomes.

Appendix A – References

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Appendix B - Tables and Figures

Table 1

Study Characteristics

Study	N	Grade/Age Level	Type of Sample	Component Skill
Abbott & Berninger (1993)	600 (100/grade)	1st-6th	Full Range	RDG, OL
Abbott, Berninger, & Fayol (2010)	128	1st-2nd	Full Range	HW, SP, RDG
	113	6th-7th	Full Range	HW, SP, RDG
Berninger et al. (2001)	102	6:10-13:2 years	Academic Difficulties	HW, SP, RDG
Best, Miller, & Naglieri (2011)	250	5:0-5:11 years	Full Range	SR
	330	6:0-6:11 years	Full Range	SR
	329	7:0-7:11 years	Full Range	SR
	356	8:0-9:11 years	Full Range	SR
	284	10:0-11:11 years	Full Range	SR
	158	12:0-13:11 years	Full Range	SR
	163	14-15:11 years	Full Range	SR
	168	16:-17:11 years	Full Range	SR
Bourke & Adams (2003)	60	6:6-7:5 years	Full Range	SR

Study	N	Grade/Age Level	Type of Sample	Component Skill
Connelly, Gee, & Walsh (2007)	48	5th-6th	Full Range	HW
DeBono et al. (2012)	97	13:0-18:0 years	Academic Difficulties	RDG, OL, SR
Dockrell, Lindsay, & Connelly (2009)	58	11th grade	Academic Difficulties	HW, SP, RDG, OL
Freed, Adams, & Lockton (2011)	59	6:0-10:8 years	Academic Difficulties	RDG
	12	6:1-10:10 years	Academic Difficulties	RDG
Graham et al. (1997)	600 (100/grade)	1st-6th	Full Range	HW, SP
Hooper et al. (2011)	205	1st	Full Range	HW, SP, RDG, OL, SR
Jones & Christensen (1999): Study 1	114	1st	Full Range	HW, RDG
Juel (1988)	54	1st-4th	Full Range	RDG
Kim et al. (2011)	242	Kindergarten	Full Range	HW, SP, RDG, OL
Mackie & Dockrell (2004)	11	9:8-12:3 years	Academic Difficulties	RDG, OL
	11	10:0-12:3 years	Full Range	RDG, OL
	11	6:0-9:8 years	Full Range	RDG, OL
McCutchen et al. (1994)	117	3rd-4th	Full Range	SR
	93	7th-8th	Full Range	SR

Study	N	Grade/Age Level	Type of Sample	Component Skill
Medwell, Strand, & Wray (2009)	198	6th	Full Range	HW
Mehta et al. (2005)	712	4th	Full Range	SP, RDG
Nagy et al. (2003)	97	4th	Academic Difficulties	SP, RDG, SR
Olinghouse & Graham (2009)	32	2nd	Full Range	HW, RDG
	32	4th	Full Range	HW, RDG
Olinghouse (2008)	120	3rd	Full Range	HW, RDG, OL
Olson et al. (2013)	540	8:0-18:0 years	Full Range	HW, SP, RDG, OL
Swanson & Berninger (1996a)	300 (100/grade)	4th-6th	Full Range	SR
Swanson & Berninger (1996b): Study 1	50	5th	Full Range	RDG, SR
Thomson et al. (2005)	209	6:1-17:6	Academic Difficulties	HW, SP, RDG, SR
Vanderberg & Swanson (2007)	160	10th	Full Range	SR
Wagner et al. (2011)	98	1st	Full Range	HW
	88	4th	Full Range	
Williams & Larkin (2012)	64	8:9-11:9	Full Range	SP, RDG, OL, SR

Note: RDG = Reading; OL = Oral Language; HW = Handwriting fluency; SP = Spelling; SR = Self-regulation

Table 2

Random-effects and moderator analysis results for handwriting fluency

Writing Quality					Writing Fluency				
Descriptive Statistics		Homogeneity			Descriptive Statistics		Homogeneity		
Mean ES [95% C.I.]	*k*	*Q*	*p-value*	*I²*	*Mean ES [95% C.I.]*	*k*	*Q*	*p-value*	*I²*
.50 [.38, .61]	16	234.81	< . 001	93.6	.50 [.40, .58]	10	61.42	< .001	85.3

Moderator Analysis: *Grade Level*

	Q	*df*	*p-value*	*Mean ES (95% CI)*	*k*		*Q*	*df*	*p-value*	*Mean ES (95% CI)*	*k*
Between	3.47	1	.06			Between					
K-3	7.73	5	.17	.63 [.43, .77]	6	K-3					
4-6	.77	3	.86	.30 [-.05, .58]	4	4-6					

Moderator Analysis: Student Ability

	Q	*df*	*p-value*	*Mean ES (95% CI)*	*k*		*Q*	*df*	*p-value*	*Mean ES (95% CI)*	*k*
Between	.00	1	.98			Between					
Full Range	15.54	12	.21	.50 [.36, .62]	13	Full Range					
Academic Difficulties	.08	2	.96	.50 [.17, .73]	3	Academic Difficulties					

Note. K = number of studies; CI = confidence interval.

Table 3

Random-effects and moderator analysis results for spelling

| | Writing Quality | | | | | Writing Fluency | | | | |
| | Descriptive Statistics | | Homogeneity | | | Descriptive Statistics | | Homogeneity | | |
Mean ES [95% C.I.]	k	Q	p-value	I^2		Mean ES [95% C.I.]	k	Q	p-value	I^2
.54 [.45, .62]	11	96.43	< .001	89.6		.48 [.30, .63]	7	122.10	< .001	95.1

Moderator Analysis: *Grade Level*

	Q	df	p-value	Mean ES (95% CI)	k		Q	df	p-value	Mean ES (95% CI)	k
Between	.16	1	.69			Between					
K-3	1.32	2	.52	.52 [.24, .72]	3	K-3					
4-6	1.51	2	.47	.45 [.15, .67]	3	4-6					

Moderator Analysis: Student Ability

	Q	df	p-value	Mean ES (95% CI)	k		Q	df	p-value	Mean ES (95% CI)	k
Between	.44	1	.51			Between	3.14	1	.08		
Full Range	5.82	6	.44	.52 [.40, .62]	8	Full Range	3.06	5	.63	.36 [.12, .56]	4
Academic Difficulties	1.98	3	.58	.58 [.42, .64]	3	SWD/At-Risk	.41	4	.36	.63 [.41, .78]	3

Note. K = number of studies; CI = confidence interval.

Table 4

Random-effects and moderator analysis results for reading achievement

Writing Quality						Writing Fluency					
Descriptive Statistics			Homogeneity			Descriptive Statistics			Homogeneity		
Mean ES [95% C.I.]		k	Q	p-value	I^2	Mean ES [95% C.I.]		k	Q	p-value	I^2
.45 [.40, .49]		27	60.00	< .001	56.7	.30 [.20, .40]		18	89.51	< .001	81.0

Moderator Analysis: *Grade Level*

	Q	df	p-value	Mean ES (95% CI)	k		Q	df	p-value	Mean ES (95% CI)	k
Between	1.53	1	.22			Between	.44	1	.51		
K-3	6.73	7	.46	.47 [.41, .53]	8	K-3	1.78	4	.78	.26 [.13, .38]	5
4-6	4.36	5	.50	.42 [.35, .48]	6	4-6	5.08	3	.17	.19 [.04, .34]	4

Moderator Analysis: Student Ability

	Q	df	p-value	Mean ES (95% CI)	k		Q	df	p-value	Mean ES (95% CI)	k
Between	.11	1	.74			Between	4.73	1	.03		
Full Range	22.35	18	.22	.44 [.38, .49]	19	Full Range	7.12	12	.85	.24 [.11, .35]	13
Academic Difficulties	5.55	7	.59	.45 [.36, .54]	8	SWD/At-Risk	.73	4	.95	.47 [.29, .61]	5

Note. K = number of studies; CI = confidence interval.

Table 5

Random-effects and moderator analysis results for oral language

Writing Quality					Writing Fluency				
Descriptive Statistics		Homogeneity			Descriptive Statistics		Homogeneity		
Mean ES [95% C.I.]	k	Q	p-value	I^2	Mean ES [95% C.I.]	k	Q	p-value	I^2
.31 [.20,.40]	16	66.84	< .001	77.6	.22 [.11,.33]	15	70.24	< .001	80.1

Moderator Analysis: *Grade Level*

	Q	df	p-value	Mean ES (95% CI)	k		Q	df	p-value	Mean ES (95% CI)	k
Between	.20	1	.66			Between	.00	1	.99		
K-3	5.41	7	.25	.30 [.19, .40]	5	K-3	3.24	4	.52	.15 [.04, .26]	5
4-6	1.64	8	.65	.26 [.13, .38]	4	4-6	3.68	3	.30	.15 [.02, .38]	4

Moderator Analysis: Student Ability

	Q	df	p-value	Mean ES (95% CI)	k		Q	df	p-value	Mean ES (95% CI)	k
Between	.04	1	.77			Between	.67	1	.41		
Full Range	7.89	11	.72	.30 [.18, .41]	13	Full Range	6.07	11	.87	.20 [.07, .33]	12
Academic Difficulties	.36	3	.95	.34 [.11, .53]	3	SWD/At-Risk	.07	2	.97	.33 [.04, .56]	3

Note. K = number of studies; CI = confidence interval.

Table 6

Random-effects and moderator analysis results for self-regulation

Writing Quality					Writing Fluency				
Descriptive Statistics		Homogeneity			Descriptive Statistics		Homogeneity		
Mean ES [95% C.I.]	k	Q	p-value	I²	Mean ES [95% C.I.]	k	Q	p-value	I²
.28 [.22, .34]	11	14.17	.17	29.4	.37 [.30, .43]	13	49.39	< .001	75.7

Moderator Analysis: *Grade Level*

	Q	df	p-value	Mean ES (95% CI)	k		Q	df	p-value	Mean ES (95% CI)	k
Between						Between	.00	1	.95		
K-3						K-3	7.38	7	.39	.37 [.27, .46]	8
4-6						4-6	4.29	3	.23	.37 [.22, .49]	4

Moderator Analysis: Student Ability

	Q	df	p-value	Mean ES (95% CI)	k		Q	df	p-value	Mean ES (95% CI)	k
Between						Between					
Full Range						Full Range					
Academic Difficulties						SWD/At-Risk					

Note. K = number of studies; CI = confidence interval.