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The Temporal-Interactive Influence of Reading Achievement and Reading Attitude

Joseph C. Kush*[a], Marley W. Watkins[b], and Susan M. Brookhart[a]

[a]*Duquesne University, Pittsburgh, PA, USA and* [b]*Pennsylvania State University, University Park, PA, USA*

Although the relationship between attitudes toward reading and reading achievement has been well documented, the causal relationship between these constructs remains unclear.Using longitudinal covariance structure modeling, this study tested the hypothesis that 3 reading-related constructs in the primary grades (2nd-3rd grade) – reading attitude, behavior, and achievement – would predict reading achievement in the 7th grade. Results showed that primary attitude was not correlated with primary achievement yet both had causal paths to 7th-grade achievement, described as a ''temporal-interaction'' model. The resulting model suggests that while reading attitude and achievement may appear unrelated at the early stages of reading they become more closely linked over time, developing into important causal determinants of reading achievement by early adolescence.

Introduction

Variables that will demonstrate a positive impact on children's reading performance are important for both theory and practice. Historically, most empirical studies focused on the relationship between specific instructional practices and subsequent reading skills, but researchers are beginning to examine the contribution of affective factors to reading achievement (Barnett & Irwin, 1994; Lipson & Wixson, 1986; Paris, Wasik, & Turner, 1991; Walberg & Tsai, 1983, 1985).

The development of positive attitudes toward reading in children produces adults who continue to engage in sustained reading throughout their life (Cullinan, 1987). And while the relationship between attitudes toward reading and reading achieve-

*Corresponding author. Duquesne University, 102C Canevin Hall, Pittsburgh, PA 15282, USA. E-mail: kush@duq.edu

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ment has been well established (Alexander & Filler, 1976; McKenna & Kear, 1990; Walberg & Tsai, 1985), the causal relationship between these constructs remains unclear. Reading attitudes develop through repeated success or failure with reading activities. Students with well-developed reading skills are likely to have positive attitudes toward reading, while students with poor reading skills often have to overcome negative reading attitudes to improve their reading skills (Johnson, 1981). However, it may only be after repeated failure that attitude and achievement become more closely linked (Swanson, 1982, 1985).

Affective factors are commonly identified as an important component in a reading curriculum (Quinn & Jadav, 1987) and teachers rank attitude second, behind comprehension, for goals of reading instruction (Heathington & Alexander, 1984). Nevertheless, very little time is devoted to developing positive reading attitudes in the schools (Greaney, 1991).

However, the importance of affective reading development is beginning to receive more emphasis (Matthewson, 1985, 1994) and has been expanded into an integrated model that includes an attitudinal component (McKenna, 1994). This model proposes that reading attitudes develop as the result of three factors: (a) self-perceived judgments about reading outcomes, (b) self-perceived judgments about expectations of others, and (c) specific reading experiences (McKenna, Stratton, Grindler, & Jenkins, 1995). This model of reading attitude predicts a long-term cumulative process, which is formed by actual reading experiences as well as by influences from parents and teachers.

Although some theorists speculate that positive reading attitudes produce students with increased reading achievement (Bettelheim & Zelan, 1981), others contend that the causal relationship occurs in the opposite direction: from achievement to attitude (Schofield, 1980). Still others have argued (Quinn & Jadav, 1987) that despite the belief that attitude and achievement are related, no causal relationship between the variables exists. A similar debate, concerning attitude-achievement relationships, has been extended to mathematics (Reynolds & Walberg, 1992a) and science (Reynolds & Walberg, 1992b). In a structural model of high school math performance, Reynolds and Walberg (1992a) found that motivation and home environment had the greatest indirect effects on math attitudes (through paths involving prior attitude). Additionally, they found the relation between math attitude and math achievement flowed from achievement to attitude rather than the reverse.

Likewise, achievement and attitude in reading do not appear to reflect a simple association, but instead are influenced by a set of direct and indirect factors (Stanovich, 1986; Walberg & Tsai, 1983; Wigfield & Guthrie, 1997) such that achievement attitudes and reading experiences appear to mutually reinforce one another with a bi-directional influence. Similarly, using a longitudinal design, Aarnoutse and van Leeuwe (1998) found that reading comprehension, reading pleasure, and reading frequency, measured later in life, could be predicted by earlier measures of the same variables, however reading pleasure and reading frequency were found to run autonomously with reading comprehension.

Despite the controversy regarding the direction of causality, empirical findings do show that successful readers normally possess more positive reading attitudes than poor readers (Wigfield & Asher, 1984). However, not all poor readers simultaneously have poor attitudes toward reading; many maintain optimistic reading attitudes despite underdeveloped skills and increasing frustration (Russ, 1989). Empirical studies have also found a general decline in positive reading attitudes as children progress through school (Barnett & Irwin, 1994; Guthrie & Greaney, 1991; Kush & Watkins, 1996; Smith, 1990; Swanson, 1985). This pattern seems to parallel the shift in curriculum described by Chall (1983) from learning-to-read to reading-to-learn. McKenna, Kear, and Ellsworth (1995) found recreational reading attitudes to steadily decrease from a relatively positive attitude in first grade to a relative indifference toward reading in grade 6. These negative attitudes toward reading are related to reading ability and found to be the most pronounced for the least skilled readers; the attitudinal gap between ability levels widens with age.

The importance of recreational reading has been shown to impact reading achievement as well as attitudes toward reading (Manning & Manning, 1984). Anderson, Wilson, and Fielding (1988) found a positive correlation between reading books outside school and reading achievement. Their finding that American children typically engage in only approximately 18 min per day of leisure reading has been substantiated by Greaney and Hegarty (1987) as well as Campbell, Voelkl, and Donahue (1997), and is only slightly higher for Canadian (33 min per day; Romney, Romney, & Menzies, 1995) and Korean students (30 min; Yoon, Kim, Yi, & Yi, 2000). Similarly, Walberg and Tsai (1984) found that the average American child engages in leisure reading only 1 day out of 5.

The value of extracurricular reading behavior has been emphasized by Anderson et al. (1988), Greaney and Hegarty (1987), and Rothman (1990), who found that the more students read outside of school, the stronger their reading skills tend to be. Similarly, two experimental-intervention studies (Morrow, 1992; Stevens, Madden, Slavin, & Farnish, 1987) have shown that the combination of social interaction among students, an abundance of reading materials, and a teacher emphasis on free reading increased the time students spent devoted to reading.

Because longitudinal studies of reading attitudes are uncommon (Ley, Schaer, & Dismukes, 1994; Smith, 1990) the purpose of the present study was to explore the possible causal relationships among reading attitude, reading achievement, and reading behavior in a longitudinal design. This study will be particularly important to educational researchers and practitioners in view of the fact that, although the relationship between reading attitude and reading achievement has been well established, the causal association between these constructs remains uncertain. This study utilized covariance structure modeling to test the hypothesis that three reading-related constructs in the primary grades (reading attitude, behavior, and achievement) would predict reading achievement in the seventh grade. The relationships among reading attitude, behavior, and achievement in the primary grades and whether and to what degree they demonstrated a causal relationship with seventh-grade reading achievement were both of interest. Covariance structure analysis

allowed for testing both the validity of these constructs and the nature of their relationships.

Method

Participants

The sample included 151 students (80 male, 71 female) enrolled in the second grade in one school in a southwestern, suburban school district. Students were initially assigned randomly to teachers in one of seven second-grade classrooms. Ethnic status, as reported by parents, was: 94% White, 4% Hispanic, 1% Black, and 1% Asian. School socioeconomic level was determined to be middle-class based upon the percentage of students (4.9%) participating in free or reduced cost lunch programs (Peng, Wang, & Walberg, 1992) and because single-family homes comprised 76% of the housing and more than 50% of the parents had some college education.

Instruments

Reading achievement. Reading achievement in second, third, and seventh grade was assessed by the state-mandated Iowa Tests of Basic Skills (ITBS; Hieronymous, Hoover, & Lindquist, 1990). The ITBS is a norm-referenced test used from kindergarten through ninth grade. Second-grade and third-grade reading achievement was measured in the spring of 1990 and 1991 with the Total Reading battery that consisted of decoding and comprehension. Seventh-grade (Spring 1995) scores on the Total Reading battery and Vocabulary battery, assessing how well students understood the meaning of words shown in sentence context, were also available. ITBS scores were reported in normal curve equivalent (NCE) format.

Reading behavior. Extracurricular reading was recorded through a structured school-based program designed to increase students' reading engagement. Students were asked to keep a reading log that recorded the number of minutes read each day outside of school. Extracurricular reading was defined as the number of minutes the student spent engaged in reading non-school assigned material. The amount of time that a parent spent reading to their child was not included. Teachers assisted children in logging and maintaining records. Parents were requested to review daily entries with their children and re-review and sign the logs each month. Total extracurricular reading was recorded for each student following the return of the logs to school. Total minutes read in second grade (1989 – 90) and third grade (1990 – 91) were recorded for each student. Distributions of both second- and third-grade minutes read were highly skewed, consistent with previous research (Anderson et al., 1988; Watkins & Edwards, 1992). Square root transformations normalized the minutes-read variables. Two students reported reading approximately 20,000 min during second grade. These values were outliers even after square-root transformation and were eliminated from further analyses.

Reading attitude. The Elementary Reading Attitude Survey (ERAS; McKenna & Kear, 1990) is a 20-item self-report instrument developed for use in grades 1 through 6. Pictorial representations are presented on a 4-point scale that asked children to rate how much they like to read. Percentile ranks are obtained for total reading attitude and two component subscales: recreational reading attitude and academic reading attitude. Internal consistency coefficients for third grade students are .80 for the recreational subscale, .81 for the Academic subscale, and .88 for the Total scale. Comparable internal consistency estimates have been reported for the ERAS when it was applied to an independent sample of children (Allen, Cipielewski, & Stanovich, 1992); concurrent validity with other measures of reading attitude has been demonstrated as well (Estes, Estes, Richards, & Roettger, 1981; Marjoribanks, 1992).

Procedure

Students completed the ERAS in the fall semester of their third-grade school year, while the ITBS was given during the spring semesters of students' second-, third-, and seventh-grade years. Administration of both measures was via intact classrooms. Total extracurricular reading was recorded for each student following the return of reading logs to school. Failure to return a log counted as zero minutes read for that month. Although several students submitted logs with missing monthly totals, cumulative logs were submitted by all students included in the present study.

Analyses

Covariance structure modeling tested the hypothesis that three reading-related constructs in the primary grades – reading attitude, behavior, and achievement – would predict reading achievement in the seventh grade (See Fig. 1). Sample size for the path analysis was 151; the AMOS 4.0 computer program used full information maximum likelihood estimation where subjects were missing values for one or more variables (Arbuckle & Wothke, 1999).

Primary reading attitude was indicated by Academic and Recreational ERAS scores in the fall of third grade. Primary reading behavior was indicated by the square root of number of minutes read in second and third grades. Primary reading achievement was indicated by ITBS total reading scores the spring of second and third grade. Seventh-grade reading achievement was indicated by ITBS Reading and Vocabulary scores in the spring of seventh grade.

Results

Table 1 presents means, standard deviations, and zero-order correlations for reading achievement, behavior, and attitude measures. Each statistic was based on maximum available data.

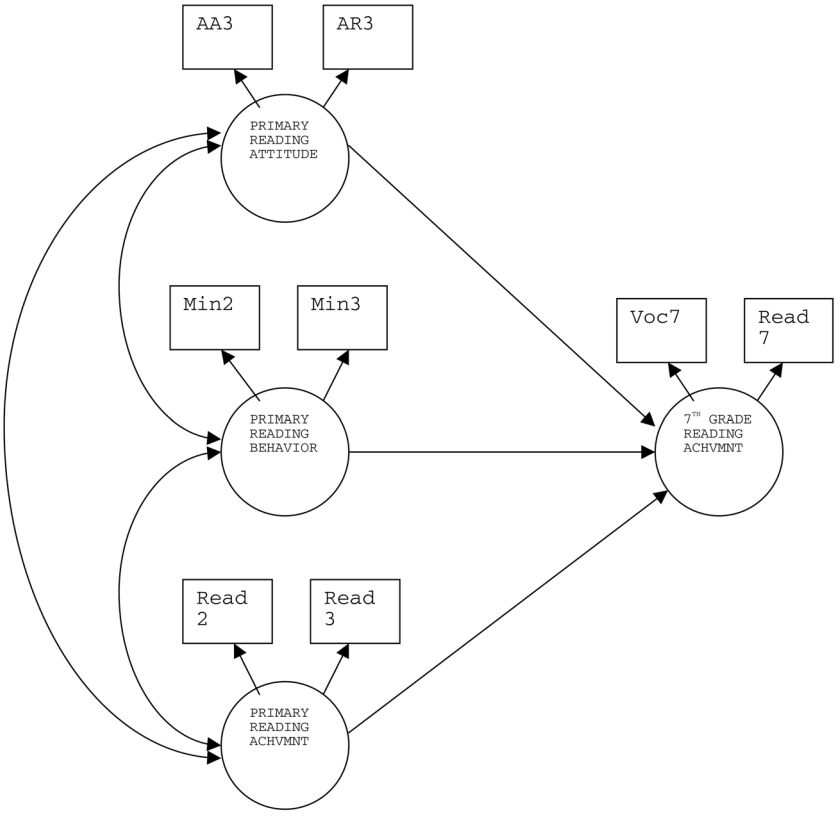

Fig. 1 Theoretical Model tested

Measurement Model

The measurement model was tested with confirmatory factor analysis. Indicator reliabilities (squared factor loadings) and composite reliabilities were inspected. Variance extracted estimates gave evidence for construct validity[1]. Covariances between latent variables gave evidence of convergent and discriminant validity. Table 2 presents reliability and validity evidence from the measurement model.

The measurement model fit was adequate (see Table 3). The chi-square/df ratio was 2.14, and the fit indices were good. Composite reliabilities for the latent variables ranged from .80 to .86 (see Table 2). The indicators had substantial loadings on their respective latent variables, which was evidence of construct validity. Variance extracted estimates for the latent variables ranged from .67 to .75, also suggesting construct validity.

The correlations among latent variables gave convergent and discriminant evidence for validity. Discriminant evidence was demonstrated in that all correlations among different constructs were moderately weak (.21 to .27) or zero (correlation between Primary Reading Achievement and Primary Reading Attitude = − .02). Convergent

Table 1. Means, Standard Deviations, and Intercorrelations Among Reading Achievement, Behavior, and Attitude.

	Voc7	Read7	AA3	AR3	Min2	Min3	Read2	Read3	Mean	SD
Voc7	1.00								52.7	16.0
Read7	.70	1.00							56.5	17.5
AA3	-.09	.20	1.00						101.4	14.1
AR3	.05	.34	.67	1.00					102.7	14.5
Min2	.21	.26	.07	.10	1.00				32.3	22.7
Min3	.07	.19	.18	.15	.71	1.00			28.3	23.9
Read2	.62	.62	-.08	.01	.29	.10	1.00		52.1	17.7
Read3	.69	.75	-.09	.03	.15	.14	.66	1.00	54.2	16.6

Note.
Voc7 - 7th grade ITBS Vocabulary NCE score.
Read7 - 7th grade ITBS Reading Total Battery NCE score.
AA3 - 3rd grade Attitude toward Academic Reading.
AR3 - 3rd grade Attitude toward Recreational Reading.
Min2 - Square root of Minutes Read in 2nd Grade.
Min3 - Square root of Minutes Read in 3rd Grade.
Read2 - 2nd grade ITBS Reading Total Battery NCE score.
Read3 - 3rd grade ITBS Reading Total Battery NCE score.
Max $N = 151$.

evidence was demonstrated in that the correlation between the two achievement constructs, Primary Reading Achievement and 7th-Grade Reading Achievement, was .96.

Prediction Model

The measurement model's preliminary analyses for reliability, validity, and confirmation of the theoretical constructs as latent variables provided a satisfactory foundation for testing the prediction model in Figure 1. One modification was made to eliminate a nonsignificant path from Reading Behavior to Reading Achievement in 7th Grade. Table 3 presents fit statistics for both models. Figure 2 presents the reduced model.

Removing the nonsignificant path (Model 2) did not alter the fit (see Table 3). The chi-square/df ratio was approximately 2 for both models; fit indices were good, and almost identical, for both models. For Model 2, the best model identified for these data, chi-square (15) = 30.38, $p = .011$. The significance level changes with sample size, and models with significant chi-squares may have acceptable fit if chi-square/df ratio is 2 or less (Arbuckle & Wothke, 1999). Chi-square/df was 2.03. The comparative fit index was 1.00, the non-normed fit index was .99, and the normed fit index was .99. *T* tests for all parameters were significant; normalized residuals were normally distributed. These results suggest an acceptable model fit.

Table 2. Properties of the Measurement Model.

Latent Variable Indicators	Standardized Loading	Reliability*	Variance Extracted Estimate
7th Grade Achievement		.83	.72
Voc7	.78	.60	
Read7	.91	.83	
Primary Attitude		.80	.67
AA3	.82	.67	
AR3	.82	.66	
Primary Behavior		.86	.75
Min2	.83	.68	
Min3	.90	.82	
Primary Achievement		.82	.70
Read2	.76	.57	
Read3	.90	.82	
	7th Grade Achievement	Primary Attitude	Primary Behavior
Correlations Among Latent Variables			
Primary Attitude	.25		
Primary Behavior	.27	.21	
Primary Achievement	.96	−.02	.27

Note.
Voc7 - 7th grade ITBS Vocabulary NCE score.
Read7 - 7th grade ITBS Reading Total Battery NCE score.
AA3 - 3rd grade Attitude toward Academic Reading.
AR3 - 3rd grade Attitude toward Recreational Reading.
Min2 - Square root of Minutes Read in 2nd Grade.
Min3 - Square root of Minutes Read in 3rd Grade.
Read2 - 2nd grade ITBS Reading Total Battery NCE score.
Read3 - 3rd grade ITBS Reading Total Battery NCE score.
* Squared loadings for indicators, composite reliabilities for latent variables.

The model tested hypotheses about predicting seventh-grade reading achievement from primary (second and third grade) reading attitude, behavior, and achievement. The model in Figure 2 predicted 98.6% of the variance in 7th Grade Reading Achievement. Most of that predictive power was from Primary Reading Achievement (path coefficient = .96). A moderate amount of predictive power came from Primary Reading Attitude (path coefficient = .27), an interesting result given that Primary Reading Attitude was not related to Primary Reading Achievement (correlation = − .02). Model 2 did not contain a path from Primary Reading Behavior to 7th Grade Reading Achievement, suggesting that amount of out-of-class reading behavior in the primary grades did not predict future reading achievement after taking into account preexisting reading skills and attitudes.

Table 3. Fit Statistics for Measurement and Prediction Models.

Model	χ^2	*df*	*p*	CFI	NNFI	NFI
Measurement Model	29.90	14	.008	.99	.99	.99
Prediction Models						
Model 1	29.90	14	.008	.99	.99	.99
Model 2	30.38	15	.011	1.00	.99	.99

Note.
CFI = Comparative Fit Index.
NNFI = Non-normed Fit Index.
NFI = Normed Fit Index.

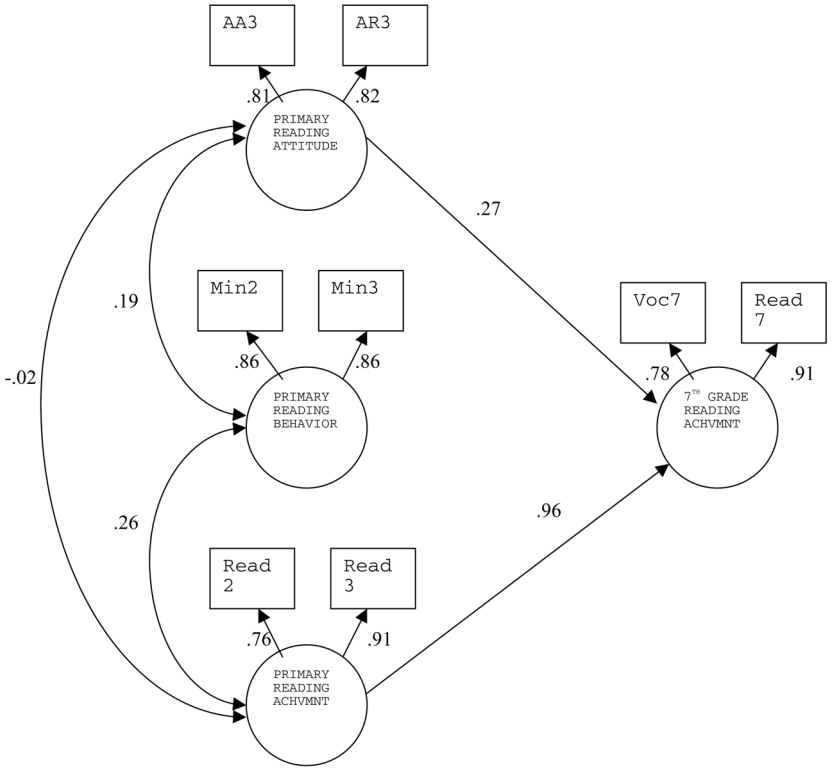

Fig. 2 Results for Model 2 (Best model, nonsignificant path eliminated)

Discussion and Conclusion

Current results reaffirm the importance of preexisting reading proficiency in predicting future reading success. In the present study, most of the variance in seveth-grade reading achievement was derived from primary reading achievement. Similar findings have been reported by Anderson et al.(1988), Cunningham and Stanovich (1997), and Smith (1990) and are consistent with Stanovich's (1986)

theory of reading development. In this regard, early reading achievement offers a ''cumulative advantage'' which leads to faster rates of subsequent achievement. The result is the so-called *Matthew effect* (Stanovich, 1986) where the rich get richer and poor get poorer, producing accompanying educational, psychological, and emotional consequences.

Primary reading attitude was also found to have significant, but secondary, power in the forecasting of seventh-grade reading achievement. Specifically, there was an effect size of .27 in the attitudes students held toward reading approximately 5 years earlier on seventh-grade achievement. This finding suggests that preexisting attitudes toward reading cannot be perfunctorily dismissed as an unimportant determinant of future reading achievement. However, given the finding that primary reading attitude was unrelated to primary reading achievement, it appears that the casual relationship between reading attitude and reading achievement may be developmental in nature and may be much more of a long-term phenomenon than had been previously thought.

Results of the present study provide some support for McKenna's (1994) developmental model of reading attitude. Adapted from models of Matthewson (1985, 1994), the McKenna model suggests that attitudes toward reading develop over time as the result of three factors: social beliefs, personal beliefs, and reading experiences. These factors are thought to influence one another as well as influence reading attitude. Similarly, because attitudes develop, in part, on the basis of reading outcomes, the bi-directional influence of reading attitude and ability is predicted from the earliest stages of instruction (McKenna, Kear, & Ellsworth, 1995). While results of the present study provide support for McKenna's developmental association between reading attitude and achievement, the bi-directional nature of his theory could not be directly tested (future achievement cannot cause previous achievement). Because primary attitude was not correlated with primary achievement in the present study, yet both had causal paths to seventh-grade achievement, a ''temporal-interaction'' model may better characterize the developmental nature of the relationship among these variables. The present model suggests that while reading attitude and achievement may appear unrelated at the early stages of reading, they become more closely linked as the child matures, developing into important causal determinants of reading achievement by early adolescence.

Interestingly, this developmental relationship does not appear to extend to the amount of reading a student engages in outside of the classroom. While the amount of reading has been found to correlate with reading achievement (Allen et al., 1992; Anderson et al., 1988; Block & Mangieri, 2002; Cunningham & Stanovich, 1991), this relationship may be temporary, or indirect, as the student progresses through school. Consistent with Wigfield and Guthrie's (1997) call for more longitudinal studies in this area, the present study found that extracurricular reading behavior was related to both reading attitude and achievement at the early stages of reading but was unrelated to subsequent reading achievement, 5 years later. This finding presents a challenge for the view of Guthrie, Wigfield, Metsala, and Cox (1999) that reading ''motivation increases reading amount, which then increases text comprehension'' (p.

250). That is, while the importance of extracurricular reading cannot be questioned, a student's prior level of reading ability, combined with his/her attitude toward reading, forecasts future reading achievement much more strongly than does the amount of reading engaged in by the student.

The interactive relationship between reading attitude and reading achievement also relates to Bandura's (1978, 1986) theory of reciprocal determinism, which posits that an individual's interpretation of his or her performance serves to influence and alter the environment and beliefs about self, which in turn serve to influence subsequent performance. This view is also similar to the position posited by Ng, Guthrie, Van Meter, McCann, and Alao, (1998) that the student's perception of the context, rather than the context itself, influences the nature and strength of their intrinsic motivation for literacy.

Research examining the role of an individual's expectancy beliefs or self-efficacy has been undertaken across a variety of educational and psychological fields including a recent focus given to academic motivation (Pintrich & Schunk, 1995). For example, using path analyses, Schunk (1984) and Zimmerman, Bandura, and Martinez-Pons (1992) found that academic self-efficacy influenced achievement both directly and indirectly. Similarly, Pajares and Kranzler (1995a, 1995b) found that the direct effect of math self-efficacy on performance was as strong as the influence of general mental ability. Students with positive motivational beliefs have also been shown to be more likely to use cognitive and self-regulated learning strategies (Pintrich, Roeser, & De Groot, 1994), and these variables have been shown to be important predictors of long-term educational attainment (Kuyper, van der Werf, & Lubbers, 2000).

The reciprocal influence between reading attitude and reading achievement is also consistent with Wigfield and Guthrie's (1997) multifaceted theory of reading motivation. Their research has shown that children's reading motivation is a strong predictor of the amount and breadth of future reading even when previous amount and breadth of reading were controlled statistically. And, while both intrinsic and extrinsic motivation were found to be important predictors of amount and breadth of reading, intrinsic motivation contributed to this prediction more strongly. Additionally, it did not appear that children became frequent readers and then became motivated to read; rather children who were motivated to read increased their reading in both the present and the future.

Guthrie and Wigfield's (1999) model of text comprehension recognizes the direct importance of both cognitive and motivational processes. This view is further supported by Ng et al. (1998), whose self-determination theory emphasizes the importance of intrinsic motivation characteristics such as curiosity, challenge, and social interaction, and posits that these characteristics will lead to enhanced literacy competencies. Intrinsically motivated students have also been shown to demonstrate high achievement measured by standardized tests (Gottfried, 1990) and grades (Sweet, Guthrie, & Ng, 1998).

It is well established that teachers can impact student attitudes toward reading through the use of specific classroom interventions (Barnett & Irwin, 1994; Lehr, 1982; Wigfield & Asher, 1984). Direct reading instruction in metacognitive training

(Payne & Manning, 1992) and in sustained silent reading (Holt & O'Tuel, 1989) has been shown to produce improved reading skills as well as more positive attitudes toward reading. However, not all instructional practices improve reading attitudes. Traditional drill and practice activities have been found to correlate negatively with reading attitudes (Barnett & Irwin, 1994); student attitudes increased in classrooms where teachers encouraged reading from paperbacks and minimized the use of worksheets. Similarly, McKenna, Stratton, et al. (1995) found no differences between a whole language approach and traditional reading instruction in influencing students' reading attitudes.

Similarly, in an extensive survey of the reading preferences of sixth-grade students, Ivey et al. (2001) found that these students identified independent reading and the teacher reading out loud as valued instructional activities. Additionally, students further indicated that the quality and diversity of reading materials or personal reasons for reading had a greater impact on their attitudes toward reading than did social influences. Student responses indicated that they were interested in a wide range of informational topics even if these topics did not match the curriculum content set forth by the school. While a student-driven curriculum may be popular among students, it may also produce students who avoid conceptually challenging material. It is critical, therefore, that reading curricula link in-class reading activities with recreational reading rather than engage in an either/or debate. These factors most relevant to student reading attitudes have been termed ''engaging instruction'' and ''variety in reading materials'' (Worthy, 2002). Clearly, students who can read proficiently across a variety of formats will be better prepared to become life-long reading advocates.

It is also important to note that research of this type typically examines multiple, alternative models given that any number of models can fit a given set of data. Although this approach was certainly considered a priori, it was determined inappropriate for several reasons. First, given the longitudinal nature of the study, it would have been impossible to test alternative models where future reading achievement was used to predict previously occurring reading attitudes and achievement. Second, the selection of the model selected was based on the principle of parsimony; three independent variables (reading attitude, reading behavior, and reading achievement) were examined simultaneously as they related to future achievement. While future researchers may wish to consider more complex alternative models, they will also have the burden of proof to demonstrate that more complicated models are significantly more robust than the simple, parsimonious explanation offered in the present study.

The covariance structure model in this study confirmed constructs and demonstrated that primary reading attitude *and* achievement, but not behavior, affected seventh-grade achievement. These results suggest that the relationship between attitude and achievement is both developmental and coordinated. That is, attitude and achievement interact together over time - more complex than simply simultaneous or bi-directionaly. This ''temporal interactive effect'' of prior attitude and achievement on subsequent achievement may be the most important finding

from the present study. If confirmed in further research, this interactive effect suggests instructional strategies designed to enhance reading motivation and those designed to improve skills will both be effective in fostering future reading achievement. The double-barreled effectiveness supports teachers' use of a wide range of instructional and motivational tools.

Note

[1]Reliabilities and variance extracted estimates for the measurement model were calculated according to a method described by Hatcher (1994). Reliabilities for measured variables were calculated as squared factor loadings in order to describe the percent of variance in the latent variable (reading attitude, achievement, or behavior) shared by the particular measured variable. Composite reliabilities for the latent variables were calculated as follows:

$$\text{Composite reliability} = \frac{(\Sigma L_i)^2}{(\Sigma L_i)^2 + \Sigma \text{var}(E_i)}$$

where L_i=standardized loading for each measured variable on the latent variable and $\text{var}(E_i)=(1-L_i^2)$ – indicating error variance for each measured variable.

Variance extracted estimates for each latent variable were calculated as follows:

$$\text{Variance extracted estimate} = \frac{\Sigma L_i^2}{\Sigma L_i^2 + \Sigma \text{var}(E_i)}$$

Variance extracted estimates describe the proportion of variance on the latent variable shared by the set of measured variables that comprise its indicators and are thus an estimate of construct-relevant variance accounted for.

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