Principals' Systems Thinking:

The Meaning and Measure of a Leadership Construct

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Abstract

The present chapter explores the meaning of systems thinking (ST) in schools and reports on our development of a measure of elementary school principals' ST (PST). During the scale's development, data were collected in three waves, from three different samples totalling 414 mid-level school leaders in Israel, who rated the ST of the principals in their elementary schools. First, relevant items were developed and pilot-tested through principal components analysis. Then, exploratory and confirmatory factor analyses of items were conducted using two new independent samples to assess factorial validity. Findings indicated that a four-factor model of PST was the best fit between the empirical results and the conceptual formulation. Thus, according to mid-level leaders' perceptions, PST comprises the following factors: Evaluating significance; Openness to a variety of opinions; Leading wholes; and Adopting a multidimensional view. Further, supporting criterion-related validity, the PST Scale was found to correlate significantly with two relevant established constructs: instructional leadership and organizational commitment. The PST instrument developed in this study opens new avenues for research regarding school leaders' effects on organizational characteristics and student outcomes. Practically, measuring PST may be valuable at various stages throughout principals' professional and career development.

A school is an inherently complex organization, involving a vast number of interacting functions, people, and purposes (Crick, Barr, Green, & Pedder, 2017; Ng, 2015). As such, school leaders often encounter conflicts concerning potential choices of action, each with its pros and cons, as well as conflicts emanating from various stakeholders' diverse or even incompatible aspirations, views, expectations, and demands (Saiti, 2015). Practitioners

and researchers alike agree that recent years have brought even more challenging complexities to school leadership (Fullan, 2014; Hargreaves & Braun, 2013). Hence, the traditional “toolkit” that school principals have at their disposal is often insufficient to provide effective strategies for meeting today's almost incredible array of difficulties and expectations (Louis, Leithwood, Wahlstrom, & Anderson, 2010). Therefore, school principals sorely need comprehensive theoretical frameworks accompanied by complementary strategies to guide them toward success (Fullan, 2014). Particularly, current school principals facing today's educational leadership complexities may benefit from the holistic perspective of systems thinking.

Systems thinking (ST), which does not try to break systems down into parts in order to understand them but rather concentrates on how the parts function together in networks of interaction (Gharajedaghi, 2011; Senge, 2006), has been recognized as an effective management approach (Brown, 2012; Jolly, 2015; Wilson & Van Haperen, 2015) with a wide range of applications (e.g., Holmes, Finegood, Riley, & Best, 2012; Leischow et al., 2008; Tejeda & Ferreira, 2014). For example, strong statistical correlations have been found between ST and project performance (Elm & Goldenson, 2012).

However, in the context of school leadership, ST has not yet received sufficient empirical attention (Shaked & Schechter, 2017). Several educational guidebooks have suggested ways to implement ST into schools, offering practical advice on the use of such thinking to confront present-day educational demands and challenges, including structured models for successful educational reforms (e.g., Fullan, 2005; Senge et al., 2012). Yet, few researchers have empirically examined the dimensions of principals' ST (PST) and their application in school practices. Based on our recent conceptualization of ST in school leadership and qualitative exploration of PST characteristics (Shaked & Schechter, 2014, 2017), in this chapter we report on our development of a valid, reliable instrument to measure

PST as it is manifested in today's schools. Before describing the scale's development and testing, we first present theoretical background on ST in general, and ST in the context of school principals, and PST's expected associations with two other relevant, established constructs: instructional leadership and organizational commitment.

The Systems Thinking (ST) Framework and Definitions

ST is not a discipline in and of itself, but rather an interdisciplinary conceptual framework that is employed in a wide range of areas. It may be regarded as a type of orientation or approach toward the world at large, or a model for thinking and learning about any given system – scientific, organizational, personal, or public (Cabrera & Cabrera, 2015). Thus, the literature on ST encompasses a broad range of fields, yielding a variety of definitions for the concept. Mainly representing the interdisciplinary area of systems science, these definitions cover complex systems, cybernetics and dynamical systems theory, and applications in the natural and social sciences as well as in engineering (Hieronymi, 2013).

Here are some of the definitions and explanations for ST formulated by scholars in recent decades, presented in chronological order: Senge (1990, p. 68) defined ST as "a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static 'snapshots.' It is a set of general principles… It is also a set of specific tools and techniques." Richmond (1994, p. 141) asserted that ST is "the art and science of making reliable inferences about behavior by developing an increasingly deep understanding of underlying structure." Sterman (2000, p. 4) viewed ST as "the ability to see the world as a complex system, in which we understand that 'you can't just do one thing' and that 'everything is connected to everything else.'" Arnold and Wade (2015, p. 675) opined that ST is "a set of synergistic analytic skills used to improve the capability of identifying and understanding systems, predicting their behaviors, and devising modifications to them in order to produce desired effects. These skills work together as a system."

Despite the absence of one commonly accepted definition for ST, these diverse definitions clearly yield two basic complementary meanings of the construct: rising above the separate components to see the whole system, and thinking about each separate component as part of the whole system (Shaked & Schechter, 2014, 2017). Thus, ST advocates stepping back to focus not only on the trees but also on the forest – where the trees are particular situations or limited domains, while the forest is an overall view (Richmond, 2000). From the ST perspective, people should not get “snagged” by the details. Instead, one must discern an overall pattern from the mass of detail, aggregating and integrating this data into a holistic framework (Frank, 2012). The only way to fully understand a system is to understand its parts in relation to the whole, because the system's defining characteristics comprise the characteristics of that very whole, which cannot be found in the isolated parts. Once the system is analyzed – taken apart – these defining characteristics of the whole get lost (Jackson, 2010).

According to ST, the many interactions that transpire within each system cannot be reduced to a single cause-effect relationship. The first event is likely to contribute to the second event, but many additional events are also seen as contributing to that second event. Thus, all explanations for the second event should take into account the influence of multiple factors. The explanation for any phenomenon within a system cannot be too simplistic, and the impact of the environment cannot be ignored (Hitchins, 2007). That is, causation in systems is less straightforward and salient, necessitating a broader understanding of the system as a whole (Senge, 2006).

ST is considered to be a key management competency (Brown, 2012). Especially in the 21st century, as the world becomes ever more tightly interwoven globally and the pace of change continues to grow, managers need to become increasingly "system-wise," applying ST principles and practices in their organizations (Jolly, 2015; Wilson & Van Haperen,

2015). The benefits of ST in various management areas (e.g., Holmes et al., 2012; Leischow et al., 2008; Tejeda & Ferreira, 2014) suggest that ST may also be valuable for school principals.

Characteristics of School Principals' Systems Thinking (PST)

The existing literature on ST in school leadership, which we recently reviewed (Shaked & Schechter, 2017), is important, albeit limited. To advance knowledge in this domain, we conducted a qualitative study (Shaked & Schechter, 2014, 2017) to pinpoint the characteristics of PST. This study identified four major ways in which principals apply the ST approach and perform at the ST level in their schools:

(1) **Leading wholes.** This characteristic of "leading wholes" refers to principals' holistic perspective, oriented toward seeing the big picture and not only its individual parts. Such principals perceive and conceptualize all aspects of school life as one large system. Sub-characteristics include, for example, the capacity to tolerate ambiguity and uncertainty, which derives from an ability to understand that a current situation's seemingly separate or confusing details are actually parts of one big picture.

(2) **Influencing indirectly.** This characteristic refers to principals' ability to address school goals and challenges circuitously, based on their awareness that countless reciprocal influences are at play among various school elements, each of which is connected to others, affecting them and being affected by them. Sub-characteristics include, for example, the ability to motivate teachers through responsibility rather than through blame, which derives from principals' recognition of the indirect influences of their own actions on the staff's functioning.

(3) **Adopting a multidimensional view.** This characteristic refers to the principal's contemplation of several aspects of a given issue simultaneously. Any given issue's emergence and existence will be regarded by effective principals as stemming from a wide

range of potential sources. They will consider the issue's consequences, before proceeding to predict various optional courses of future action or development. Sub-characteristics include, for example, openness to a variety of opinions, which enables seeing the multiple aspects of any situation within school.

(4) **Evaluating significance.** This characteristic refers to the principal's ability to envision elements of school life according to their significance for the entire system. Principals prioritize issues to be resolved according to their degree of importance and urgency, while also identifying patterns as they go along. Sub-characteristics include, for example, the capacity to balance internal and external relationships and needs, thereby successfully negotiating between internal desires and capacities and outside demands and expectations.

These four characteristics clearly tie in with the two major meanings of ST. Leading wholes and adopting a multidimensional view reflect *seeing the whole beyond its parts*, while influencing indirectly and evaluating significance are related to *seeing the parts in the context of the whole*.

To date, ST in school leadership was rarely explored empirically, and then only through qualitative methodology, which did not yet yield a valid instrument to measure this construct and distinguish its characteristics. The present chapter presents our study that aimed to design such an instrument in line with the theoretical model and structural characteristics of PST, while testing its criterion-related validity by examining the newly developed scale's correlations with two established, related constructs: instructional leadership and organizational commitment.

Systems Thinking (ST), Instructional Leadership (IL), and Organizational Commitment (OC)

In recent decades, principals have faced superintendents' and policy makers' clear

expectation to become “instructional leaders” – who focus efforts squarely on the improvement of teaching and learning as the school’s primary goal (May & Supovitz, 2011; Rigby, 2014). The instructional leadership (IL) framework arose from the close connections identified between teachers' quality of instruction and students' academic results (Murphy, Neumerski, Goldring, Grissom, & Porter, 2016). Thus, as instructional leaders, principals are expected to give student learning top priority, with everything else revolving around the enhancement of that learning (Hallinger, 2011; Supovitz, Sirinides, & May, 2010). Practically, IL reflects those actions that a principal takes to promote growth in student learning and academic success (Armstrong, 2007; Stronge, Richard, & Catano, 2008; Walker & Slear, 2011). The links between principals' IL and students' achievements, predominantly through indirect means, have been clearly established through research (Glickman, Gordon, & Ross-Gordon, 2014).

IL may be related to PST because, as an approach that allows a view of the whole picture, ST enables managers to concentrate on the organization's main goals (Frank, 2012). It allows managers to keep focused on the organization's key objectives, and not to be distracted by other events or pressures (Brown, 2012; Jolly, 2015). Therefore, PST may be linked to IL, which calls upon principals to maintain their focus on achieving the school’s central goal – to improve teaching and learning in order to affect student achievements (Neumerski, 2012).

In addition, the current study explored the relations between the characteristics of PST and teachers' organizational commitment (OC). OC as defined by Mowday, Steers, and Porter (1979) is “the relative strength of an individual's identification with and involvement in a particular organization” (p. 226). ST was found to be advantageous for various managerial aspects (Holmes et al., 2012; Tejeda & Ferreira, 2014), including increased OC among employees. Specifically, in schools, the OC of teachers is important for school effectiveness

and indirectly affects students' outcomes (Park, 2005). The OC concept is based on three factors: *identification* – acceptance of the organization's goals and values; *involvement* – willingness to invest effort on behalf of the organization; and *loyalty* – the importance attached to keeping up membership in the organization (Bogler & Somech, 2004). Several studies indicated that teachers' commitment to the school can be an important predictor of teachers' job performance because it is positively related to their dedication to attaining organizational goals (Dee, Henkin, & Singleton, 2006; Sammons et al., 2007). When a manager is running at systems level, employees' psychological attachment to the organization is expected to increase (Brown, 2012; Jolly, 2015). Thus, PST may be related to teachers' OC.

Development of the PST Scale

To empirically assess the characteristics of PST, we sought to identify the practical ways in which principals might lead schools through the ST framework, as perceived by the mid-level school leaders working in everyday situations under the principal. Mid-level leaders constitute the “intermediate layer” in the school's organizational structure, located between the senior leadership – which usually includes the principal and assistant principal – and the classroom teachers (Crane, 2014; Gurr & Drysdale, 2013). Inasmuch as they hold management responsibility either for staff or for a certain aspect of the school's work, such as grade-level coordinators or subject coordinators, their role involves close work with principals (Fleming & Amesbury, 2012; Thorpe & Bennett-Powell, 2014). Thus, they were chosen as reliable informants to reporting on the everyday ST of their principals.

As described below, we developed the Principal System Thinking (PST) Scale in two phases, examining three independent samples. In Phase 1, we first generated relevant items for the PST Scale based on our prior qualitative research (Shaked & Schechter, 2014, 2017). These potential items were then pooled, subjected to content validation, and pilot-tested on

185 mid-level elementary school leaders using Principal Components Analysis to explore the scale's factor structure, reliability, and validity. In Phase 2, a revised scale was created, the items were submitted to exploratory factor analysis (N = 129), and then the proposed scale was validated by confirmatory factor analysis (N = 100). Then, we examined correlations of PST with the two other established constructs, IL and OC, to check criterion-related validity.

Phase 1: Item Generation, Content Validation, and Pilot Testing (N = 185)

Item generation. To design a measure based on Shaked and Schechter's (2014, 2017) aforementioned four characteristics of ST in school leadership, we have developed empirical indicators specifically formulated for mid-level school leaders to assess practical indicators of their principals' competencies. Thus, we initially designed 45 items with the following characteristic-level distribution: Leading wholes (14 items); Influencing indirectly (7 items); Adopting a multidimensional view (18 items); and Evaluating significance (6 items).

Content validation. Proposed items' applicability was evaluated by five experts from the educational administration field and two additional experts from the ST field. Experts were asked to evaluate the 45 proposed PST Scale items, and to either retain or generate a modification/replacement for each item. Thereafter, each member of our research team independently reviewed the full list of potential items and the experts' comments. Based on this procedure, a draft version of the PST Scale was devised.

Next, 60 teachers from various elementary schools in Israel evaluated the draft version of the proposed Hebrew scale. Their remarks regarding items' clarity and response scale, as well as their recommendations for modifying, adding, and deleting items, were considered. This procedure yielded a 38-item pilot scale to be rated along a 5-point Likert-type response scale ranging from *Never* (1) to *Always* (5). The pilot PST Scale had the following subscale distribution according to the four characteristics: Leading wholes (13 items); Influencing indirectly (5 items); Adopting a multidimensional view (15 items); and

Evaluating significance (5 items).

Pilot study: Item reduction (Principal Components Analysis). The 38-item pilot scale was distributed to a sample of 185 mid-level leaders (response rate = 70%) from 43 randomly selected elementary schools in Israel. These mid-level leaders had a mean age of 38.30 years (*SD* = 8.01), 50.3% were women, and their mean job tenure in the profession was 12.32 years (*SD* = 7.88). Participation was voluntary, the purpose of the study was explained, anonymity was guaranteed, and the importance of candid answers was emphasized.

Data collected from these 185 mid-level leaders were subjected to principal components factor analysis with varimax rotation of the items, identifying common factors with eigenvalues greater than 1. In general, factor loadings were strong, above .50. Seven items, which loaded on more than one factor at .40 or above, and six items which loaded lower than .35 on any one factor, were eliminated. Moreover, four items that substantially reduced subscales' internal consistency (Cronbach coefficient alpha) were also deleted (Items 3, 10, 11, 12). The weightings of Items 14, 16, 19, 29, 35, 36, and 37 could not be classified under any of the categories; thus, these items were omitted from the final scale. Items 5, 15, 24, 26, 33, and 38 were removed in order to resolve some of the multicollinearity between factors and to improve alphas. Finally, one factor was judged problematic (Items 1, 2) and thus was classified as non-interpretable because no single grouping of items representing the intended factor emerged as the dominant source for the factor.

Thus, altogether, a total of 19 items were eliminated during this procedure. Deleted items included: "The principal tends to react to anything that happens in the school, big or small; The principal takes into account that action in one realm indirectly affects others; When the principal tries to understand why a certain event occurred in school, he/she usually come up with only one explanation for it." This process resulted in a set of 19 items to measure PST, entering Phase 2.

Phase 2: Exploratory Factor Analyses (*N* = 129), Confirmatory Factor Analyses and Criterion Validity (*N* = 100)

Exploratory factor analysis. We conducted this analysis to explore the number of factors that account for covariation between variables due to insufficient a priori evidence to form a hypothesis about the number of factors underlying the data (Stevens, 1996). We distributed the 19-item scale to a new sample of 129 mid-level leaders (response rate = 90%) from 42 new randomly selected elementary schools. This sample was 63% female, with mean age of 37.79 years (*SD* = 6.23) and mean job tenure in the profession of 11.33 years (*SD* = 7.03). As before, participation was voluntary, and we explained the study's purpose, guaranteed anonymity, and emphasized the importance of candid answers.

Exploratory factor analysis of the item matrix was performed to study which items clustered together and which did not. For this purpose, a principal-axis factor analysis, rotated using Kaiser's (1958) varimax criterion, was used to examine the 19-item measure and to identify common factors with eigenvalues greater than 1. Items 8 and 17 were removed in order to resolve some of the multicollinearity between factors and to improve alphas. This analysis enabled us to discern a 4-factor structure among the remaining 17 items, which explained 56.91 percent of the variance. As seen in Table 1 (which presents rotated factor loadings for each of the 17 items), all four factors had eigenvalues greater than 1 (ranging from 5.10 to 1.33). After examining the items that loaded on each factor, the four characteristics of PST were identified: Evaluating significance (4 items; α = .75); Openness to a variety of opinions (4 items; α = .78); Leading wholes (3 items; α = .66); and Adopting a multidimensional view (6 items; α = .70). The PST Scale demonstrated a high level of internal consistency (α = .85).

Confirmatory factor analysis. This procedure used AMOS 21.0 structural equation modeling software to validate the 17-item PST Scale, as administered to a new independent

sample of 100 elementary school mid-level leaders. This sample size is considered appropriate for confirmatory factor analysis model testing because the ratio of sample size to items surpassed the minimum of 5:1 (Hair, Anderson, Tatham, & Black, 1998). This third sample was 62% female, with mean age of 40.06 years (*SD* = 8.30) and mean job tenure in the profession of 13.49 years (*SD* = 7.97). As before, participation was voluntary, and we explained the study's purpose, guaranteed anonymity, and emphasized the importance of candid answers.

This analysis was based on the covariance matrix, and we used maximum likelihood estimation, yielding the results shown on Table 2. Fit indices provide feedback about the appropriateness of hypothesized research models based on the covariance structure of the observed data. As recommended by researchers (Jöreskog & Sörbom, 1993; Kline, 1998), we used several goodness-of-fit indices: the chi-square statistic divided by the degrees of freedom (χ^2/df) is recommended to be less than 3; the values of comparative fit index (CFI), incremental fit index (IFI) and Tucker-Lewis index (TLI) are recommended to be greater than .90; root mean square error of approximation (RMSEA) is recommended to be up to .05, and acceptable up to .08 (Steiger, 2007).

We compared four models: the proposed second-order model (Model 1) and three first-order models (Models 2 to 4). Model 1 denotes that the 17 observable items load on the four first-order factors (Adopting a multidimensional view; Openness to a variety of opinions; Leading wholes; and Evaluating significance), which in turn load on the second-order factor (PST). The specific PST competencies were the indicators of one second-order latent factors. Model 2 denotes that the 17 observable items load on the four first-order factors (Adopting a multidimensional view; Openness to a variety of opinions; Leading wholes; and Evaluating significance). Model 3 denotes that the 17 items are accounted for by a single first-order factor, PST. Model 4 denotes that the 17 observable items are accounted

for by three first-order factors (Evaluating significance; Openness to a variety of opinions; and two factors merged together as one – Leading wholes and Adopting a multidimensional view).

Fit indices (Table 2) and the chi-squared differences revealed that the three alternative models were significantly weaker than the second-order model (χ 2/df =1.272, CFI = .956, TLI = .946, IFI = .958, RMSEA = .052). This confirmed that PST is a second-order structure (Bollen, 1989). All items had significant loadings on the intended PST characteristics, and all characteristics had significant loadings on the intended second-order latent factor. Figure 1 shows the factor loading values of all items in the confirmatory factor analysis, which ranged from .38 to .93.

Together, the results of both the exploratory and confirmatory factor analysis support a multidimensional conceptualization of the PST construct, identifying four characteristics. Table 3 indicates the range of factor loadings, descriptive statistics, alpha coefficients, and correlation analysis for PST. The results reveal several insights. Overall, in all subscales, the means were close to 4 (“often shown”), indicating high means for all competencies. Second, the results regarding the internal consistency coefficients for the latent factors indicated good results (ranging from .73 to .83). The 17 items of the PST Scale demonstrated a reliability of .90. Finally, the results of the intercorrelations for the PST subscales (see Variables 2-5 on Table 4) indicated relatively moderate to high degrees of association between the latent factors (r = .49-.63, p < .001). These values are appropriate for models that have proposed a priori that the latent factors (characteristics) are interrelated (Brew, Beatty, & Watt, 2004).

Validation Variables. To test criterion-related validity, the PST Scale was examined for its correlations with two other well-established constructs: IL and OC. Both the four-factor model and the whole scale were examined for validity criteria. The 100 elementary school mid-level leaders who provided the data for the confirmatory factor analysis

responded to both validity criteria surveys: IL and OC.

Instructional leadership survey. Validity for the PST Scale was measured using an IL survey completed by the third sample of 100 mid-level leaders. We expected that perceptions of principals' higher ST levels would relate positively to principals' higher IL. For this purpose, we used an abbreviated version of the Principal Instructional Management Rating Scale (PIMRS), originally developed by Hallinger and Murphy (1985) and adapted slightly to accommodate the Israeli context and the elementary school level. The 31-item brief version has shown adequate reliability and validity estimates (Schechter & Qadach, 2016). It measures the following three IL subscales: (a) *Defining the school's mission* (12 items such as "Defines the responsibilities of the team in achieving the school's educational goals"; α = .83); (b) *Managing the instructional program* (10 items such as "Clarifies who is responsible for coordinating the curricula"; α = .86); and (c) *Promoting a positive school-learning climate* (9 items such as "Praises students for high achievements through reinforcements such as prestigious roles or mentioning them in the school paper or site"; α =.81). Mid-level leaders responded on a 5-point Likert scale, ranging from *Never* (1) to *Always* (5). The whole scale's internal reliability was .93.

Organizational commitment survey. Validity for the PST Scale was also measured using a survey of the OC experienced by the third sample of 100 mid-level leaders. We expected that principals' higher ST levels would associate positively with their school mid-level leaders' higher OC. For this purpose, we used Mowday et al.'s (1979) 15-item OC scale, which taps the strength of respondents' identification with and involvement in a particular organization, adapted by Somech and Bogler (2002) to suit the current educational setting. This measure includes three subscales: (a) *a strong belief in and acceptance of the organization's goals and values* (4 items such as "I find that my values and school values are very similar"; α = .61); (b) *a willingness to exert considerable effort on behalf of the*

organization (3 items such as “I'm willing to invest a lot of effort, even beyond expectations, to help my school succeed”; α = .63); and (c) *a strong desire to maintain membership in the organization* (8 items such as “I'm proud telling others that I work in my school"; α = .74). Mid-level leaders responded on a 5-point Likert scale, ranging from *Strongly disagree* (1) to *Strongly agree* (5). The whole scale’s internal reliability was α = .80.

Analysis of findings for the two validation constructs. Descriptive statistics and intercorrelations of the PST and validity variables collected from this sample (N = 100) are presented in Table 4. Findings indicated a positive relationship between overall PST and IL (r = .63, p < .001). Also, significant positive correlations relatively moderate to high emerged between IL and each of the four PST subscales: *Evaluating significance* (r = .52, p < .001), *Openness to a variety of opinions* (r = .48, p < .001), *Leading wholes* (r = .47, p < .001), and *Adopting a multidimensional view* (r = .58, p < .001). More specifically, as seen in Table 4, each of the four PST subscales revealed significant positive correlations at the p < .001 level with all three of the IL subscales – *School mission*, *Instructional program*, and *Climate*.

Furthermore, as predicted, the whole PST Scale was significantly and positively related to the OC survey (r = .37, p < .001). Also, significant positive correlations emerged between OC and each of the four PST subscales: *Evaluating significance* (r = .38, p < .001), *Openness to a variety of opinions* (r = .28, p < .01), *Leading wholes* (r = .28, p < .01), and *Adopting a multidimensional view* (r = .27, p < .01). More specifically, as seen in Table 4, each of the four PST subscales revealed significant positive correlations with two out of the three OC subscales, *Accepting goals* (at the p < .05 level) and *Maintaining membership* (at the p < .01 or .001 level), although not with the third OC subscale of *Willingness to exert effort*.

Discussion of the PST Scale and its Implications

Given that the literature has recommended ST’s utilization as an effective approach

for managers in general (Brown, 2012; Jolly, 2015; Wilson & Van Haperen, 2015), and for school principals in particular (e.g., Fullan, 2005; Senge et al., 2012), and in light of the lack of available instruments to measure PST, we undertook the development and testing of the multidimensional PST Scale. As seen in this chapter, our exploratory and confirmatory factor analyses provided support for 17 items comprising four PST characteristics, thus providing evidence of construct validity for these characteristics of ST as manifested in elementary school principals: *Adopting a multidimensional view*, *Openness to a variety of opinions*, *Leading wholes*, and *Evaluating significance*.

The four characteristics emerging from the current factor analyses of this quantitative scale differ somewhat from the four characteristics that we found in our previous qualitative research (Shaked & Schechter, 2014, 2017), where we conducted content analysis of interview and focus-group data that elicited school principals' articulations about PST. First, *openness to a variety of opinions* was found to be a characteristic rather than a sub-characteristic of PST, as originally proposed in the qualitative studies. A principal who understands that each situation has several aspects and several possible implications seeks to understand the full picture by listening to other points of view. In order to see the whole beyond the parts and to see the parts in the context of the whole, principals must be willing to listen to others and learn from others. Through such openness, principals involve teachers in decision-making and engage in dialogue with those holding educational perceptions that differ from their own. Second, *influencing indirectly*, which did not emerge here as a distinguishable characteristic of PST but rather was found to be a sub-characteristic branching out from *adopting a multidimensional view*. Apparently, the use of an indirect approach when dealing with tasks and challenges is not considered a central principal characteristic in the eyes of those mid-level leaders who experience PST in elementary schools. The differences between the findings of this study and the findings of the previous

study may be a result of differences in the research method (qualitative vs. quantitative) or in study participants and data collection (self-report by school principals vs. reports of mid-level school leaders on their principals). These differences also may stem from the fact that the present study focused only on primary schools, while participants of the previous study were principals of primary schools, middle schools, and high schools.

Finally, the relationships that we found for PST with principals' IL and with mid-level leaders' OC not only provided further support for the PST Scale's validity but also have important implications. Links between principals' IL and students' achievements have been clearly established through research (Glickman et al., 2014; Robinson, Lloyd, & Rowe, 2008). In addition, teachers' OC was found to be a key component of school success, which positively affects teacher performance and student outcomes (Dee et al., 2006; Park, 2005; Sammons et al., 2007).

Although these findings are encouraging for the school leadership literature, this study's design and context imply some limitations requiring further inquiry before generalizing our outcomes. First, due to our study's cross-sectional design, the data cannot provide direct evidence of causal links between PST and other outcomes like principals' instructional leadership behaviors or mid-level leaders' commitment to their schools. Conceivably, the causal order could be reversed, or causality could be reciprocal. Furthermore, this scale measures principals' behavior that reveals a ST approach to school leadership, but only future research will confirm if such PST tendencies contribute significantly to student achievements or other desired school outcomes. Second, the research was conducted in a specific educational context – elementary schools in Israel – limiting generalizability to other educational and sociocultural contexts and calling for replication in other populations and settings, to possibly substantiate the scale's international validity. Research is already underway to validate this scale for secondary school principals and to

examine cross-validation by comparing principals' self-reports with mid-level leaders' ratings in the same schools.

Overall, an instrument measuring PST also holds practical implications, opening up new avenues for research, principal candidate screening, and professional training. The PST Scale can allow for comparisons of possible ST patterns exhibited by principals who differ in experience, gender, education, or type of school (e.g., primary vs. secondary, regular vs. special education). It permits researchers to examine PST's potentially important relations with other variables related to the principal (e.g., distributed leadership, transformational leadership, cognitive complexity), with the school as an organization (e.g., organizational learning, organizational resilience), with the teaching staff (e.g., motivation, self-efficacy), and of course with student outcomes.

Measuring PST may be valuable at various stages throughout principals' career. The selection process for new principals may be optimized if candidates' capacity for ST is taken into account. In addition to screening prospective principal candidates for their ST skills before appointment, new principals' ST capabilities may be reevaluated after several years on the job. This later reevaluation is required because the development of ST takes time (Shaked & Schechter, 2017), and it unfolds gradually as an outcome of manifold long-term experiences. The reevaluation, accompanied by detailed feedback, may help the growing principal to pinpoint which areas are well-developed and which need further improvement. Moreover, this screening tool may also help superintendents determine which principals have not adequately acquired ST capacities and can even suggest which necessary professional development processes should be tailored to the specific principal to narrow the existing gaps in his or her holistic leadership development. Measuring PST capacities may be timely even after the first few years on the job, because principals need to continuously enhance their skills and consolidate their leadership knowledge. This new scale may thus facilitate the

exploration and evaluation of professional training processes aimed at developing PST, from early preservice stages to the mentoring of veteran or experienced principals.

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Table 1
*Item Loading Values from Exploratory Factor Analysis of the Principals' Systems Thinking Scale (*N*=129)*

	Factors			
	Evaluating significance	Openness to a variety of opinions	Leading wholes	Adopting a multi-dimensional view
The principal spots small events that are nevertheless meaningful	.82			
The principal tends to take unexpected occurrences into account	.62			
The principal explains decision-making processes in accordance with the school's goals	.76			
The principal tends to take different points of view into consideration when deciding on various matters	.55			
The principal tends to involve teachers in decision-making processes		.83		
The decisions made by the principal are based on the school's policy		.79		
The principal usually tries to figure out how various events have led to each other		.71		
The principal engages in dialogue with those holding educational outlooks that differ from his/her own		.57		
The principal tends to suggest solutions that affect the entire work environment, rather than just specific details			.79	
The principal attempts to identify repetitive patterns in the information at hand			.67	
At meetings and discussions, the principal tries to present most points of view			.66	
The principal functions well also in ambiguous situations				.75
During decision-making, the principal tends to view the entire picture before examining its details				.46
The principal takes into account that the effects of a certain action may vary in different situations				.48
The principal acts with the understanding that small changes can bring about significant results				.59
The principal tries to understand how certain components of the school affect the way other components in it function				.42
When making decisions the principal is aware that his/her assumptions may be incorrect				.40
Eigenvalues	5.10	1.79	1.44	1.33
% R^2	30.01	10.53	8.49	7.86
Cronbach α (subscales)	.75	.78	.66	.70

Note. Principal-axis factoring extraction method. Only values ≥ .40 are shown. *% Cumulative R^2* = 56.91. Cronbach α for whole scale = .85.

Table 2

*Comparison of Competing Models' Fit Indices for Principals' Systems Thinking Scale (*N=*100)*

Model description	χ^2	*df*	Compared with Model 1 $\Delta\chi^2$	χ^2/df	CFI	IFI	TLI	RMSEA
Model 1: Second-order	139.921	110		1.272	.956	.958	.946	.052
Model 2: Four-factor model	139.141	108	.78	1.288	.954	.956	.943	.054
Model 3: Three-factor model	186.145	111	46.22**	1.677	.890	.894	.865	.083
Model 4: One-factor model	248.175	117	108.25**	2.121	.808	.813	.777	.106

Note. χ^2 improvement is reflected by a lower value. CFI = comparative fit index; IFI = incremental fit index; TLI = Tucker–Lewis index; RMSEA = root mean square error of approximation.

** $p < .01$.

Table 3

*Range of Factor Loadings, Descriptive Statistics, Alpha Coefficients, and Correlation Analysis for the Principals' Systems Thinking Scale (*N=*100)*

Composite factors	No. of items	Range of factor loadings	*M*	*SD*	Cronbach alpha	Correlations		
						2	3	4
1 Evaluating significance	4	.45 to .71	3.42	.72	.73	.53***	.53***	.56***
2 Openness to a variety of opinions	4	.42 to .93	3.51	.71	.83	1	.63***	.56***
3 Leading wholes	3	.62 to .81	3.48	.80	.79		1	.49***
4 Adopting a multidimensional view	6	.38 to .70	3.58	.62	.78			1

Note. Response scale from *Never* (1) to *Always* (5).

*** $p < .001$.

Table 4

*Descriptive Statistics and Correlations Among the Principals' Systems Thinking (PST) Scale and Validity Variables (*N*=100)*

Variables		*M*	*SD*	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1)	PST: Total	3.51	.57	1	.80***	.82***	.78***	.84***	.64***	.49***	.66***	.57***	.37***	.28**	.01	.39***
(2)	PST: *Evaluating significance*	3.42	.71		1	.53***	.53***	.56***	.52***	.37***	.58***	.47***	.38***	.24*	.08	.43***
(3)	PST: *Openness to variety of opinions*	3.51	.71			1	.63**	.56***	.48***	.37***	.49***	.45***	.28**	.23*	-.02	.28**
(4)	PST: *Leading wholes*	3.48	.80				1	.49***	.47***	.37***	.51***	.40***	.28**	.22*	-.02	.32**
(5)	PST: *Adopting multidimensional view*	3.58	.62					1	.58***	.48***	.57***	.51***	.27**	.22*	.01	.26**
(6)	IL: Total	3.76	.62						1	.91***	.87***	.91***	.40***	.30***	-.11	.45***
(7)	IL: *School mission*	3.64	.66							1	.65***	.78***	.36***	.30**	-.09	.39***
(8)	IL: *Instructional program*	3.94	.73								1	.70***	.42***	.35***	.01	.45***
(9)	IL : *Climate*	3.73	.70									1	.27**	.14	-.23*	.38***
(10)	OC: Total	3.54	.49										1	.86***	.59***	.91***
(11)	OC: *Accepts school goals, value*s	3.30	.52											1	.55***	.63***
(12)	OC: *Willing to exert effort*	3.21	.66												1	.34***
(13)	OC: *Maintains membership*	3.75	.52													1

Note. IL = principals' instructional leadership. OC = mid-level leaders' organizational commitment.

*$p < .05$; **$p < .01$; ***$p < .001$.

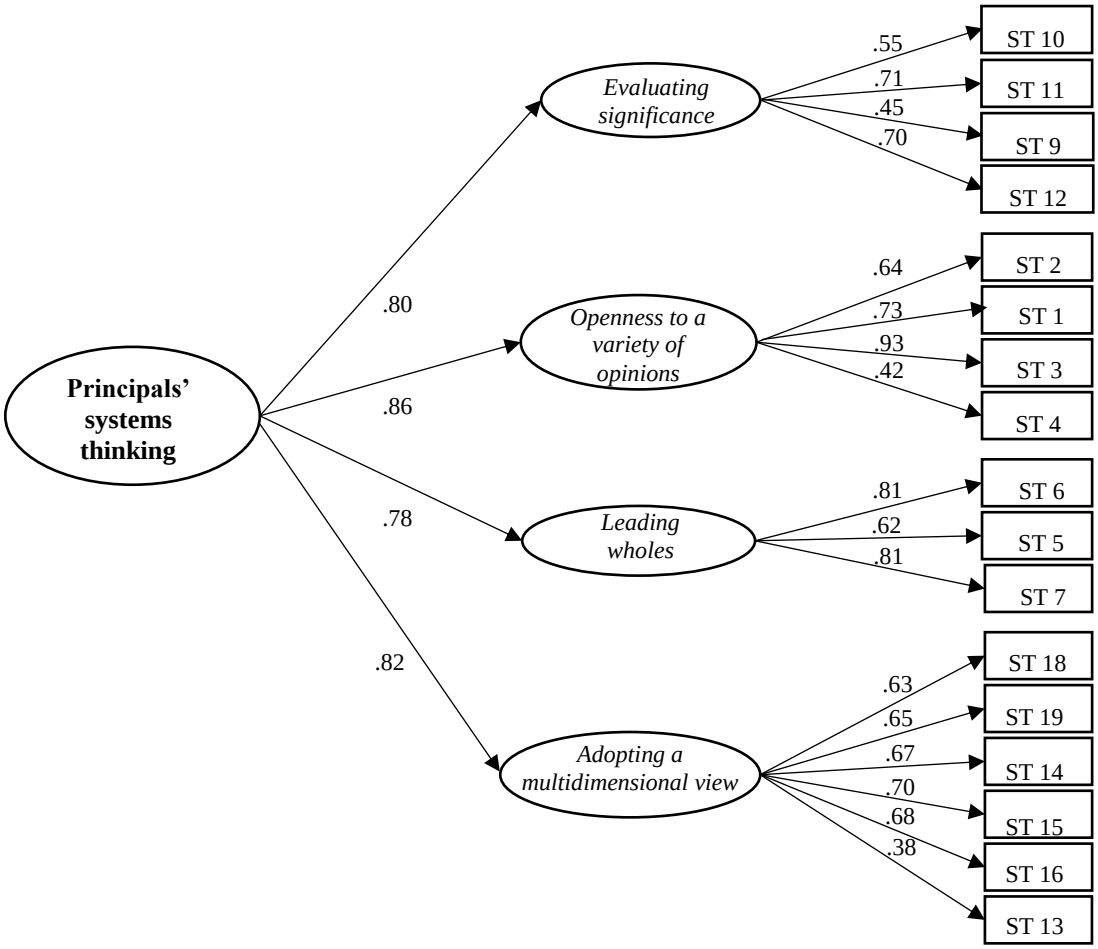

Figure 1. Results of the confirmatory factor analysis for 17 principals' systems thinking (PST) items. $\chi 2$ = 139.912; df = 110; CFI = .956; IFI = .958; TLI = .946; RMSEA = .052.