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An Ego-Network Approach to Understanding Educator and School Ties to Research:

From Basic Statistics to Profiles of Capacity

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Introduction

Globally, expectations for research that can be used to inform education policy and practice have grown, resulting in increased efforts to build capacity across systems for greater use of research. The best way to build this capacity remains an open question. Prior research has reported that capacity for research-use is often determined by relationships, particularly those that feature trust, common goals and values, and regular engagement (e.g., Harrison, Davidson, & Farrell, 2017; Huberman, 1990). Further, research consistently shows that educators' social capital—that is, the resources generated from relationships—can support individual growth and organizational change. These literatures suggest a social network perspective is instructive for understanding and building research-use capacity. Although educators' professional networks have been found to contribute to capacity in other ways—including the implementation of reform, professional learning, and instructional improvement (e.g., Brown & Poortman, 2018; Coburn & Russell, 2008; Daly & Finnegan, 2011; Moolenaar, 2012; Penuel et al., 2009; Spillane et al., 2009; Yoon & Baker-Doyle, 2018)—evidence about their role in supporting schools' use of research remains thin.

We build on the emerging literature that has explored the role of networks, and brokerage in particular, in bridging the communication gap between researchers and practitioners (Daly et al., 2014; Debray et al., 2014; Neal et al., 2019). This chapter presents the application of network methods—specifically, ego-network methods—to understanding ties between research and practice that facilitate access to research, drawing on the work of the Center for Research Use in

Education, an Institute for Education Sciences-funded knowledge utilization center. We organize the chapter in the following way: First, we frame the issue within the larger context of network theories. Second, we offer a rationale for the use of an ego-network approach. From there, we share how ego-network data collection was integrated into a larger survey of schools' use of research. Next, we describe our approach to preparing and analyzing ego-network data, as well as the results of those analyses. Lastly, we describe how we extend those findings into additional quantitative analyses. We conclude with what the approach offered us in terms of deepening our understanding of research-use.

Using network theory to understand ties between research and practice

In keeping with the themes of this book, we draw on network theories of social capital and brokerage as a means for exploring educators' access to research. Specifically, we approach the study of research-use in this chapter through the lens of diffusion of innovation, as others in this field have done previously (e.g., Neal et al., 2015), which emphasizes the pathways by which information and ideas flow. In the context of increased expectations for educators to use research evidence to inform decision-making, remarkably little is known about the resources educators turn to, and what the use of those resources might mean for individual and school use of research. Of central importance, therefore, is tracing how research-based ideas, which are largely external to schools, find their way into decision-making and, ultimately, practice. Prior literature documents persistent challenges to the flow of information from research to practice, pointing to the need to improve educators' capacity to use research as well as researchers' ability to disseminate it. However, these suggestions demand large-scale systemic change—change that we support, but are realistic about.

Alternatively, these challenges to the flow of information may be thought of as the result of structural holes (Burt, 1992) between research and practice where, at a systemic level, the literature has long established weak ties between communities. Further, literature on schools' use of research suggests that most access to research is mediated through other sources, often described as brokers, intermediaries, boundary spanners, or linking agents (Malin et al., 2018; Neal et al., 2015; Neal et al., 2019; Spencer & Louis, 1980). These sources therefore serve an important brokerage or linking function in the ecosystem of research-use in schools—a means by which evidence-based practice could be transferred. Such brokerage may be a powerful lever for bridging gaps between communities.

In addition to understanding brokers as being positioned to bridge structural holes, ties that provide access to educational research can also be considered a form of social capital whereby individuals or organizations with such access enjoy a sort of competitive advantage in finding research based ideas (or "good ideas" as described by Burt (2004)). This conceptualization of social capital may then be a useful measure of individual and organizational capacity for research-use. At the individual level, educators' access to research-based ideas may make them a useful resource to their colleagues who lack similar access, and it may also shape their human capital, that is, their cumulative abilities, knowledge, and skills developed through formal and informal experiences (Pil & Leana, 2009) and which they bring to their practice. At the organizational level, schools' ability to recognize the value of external information and put it into practice—often referred to as absorptive capacity (Cohen & Levinthal, 1990)—depends on communications pathways, strategic knowledge leadership, and the qualities of external resources, among other factors (Farrell & Coburn, 2017). In this sense, school-level ties that

facilitate access to educational research are a requisite capacity on the path to influencing school practice.

Why use an ego-network approach?

At the foundation of social network theory are social ties between actors and resulting patterns of ties which comprise network structure. Thus, most applications of social network analysis (SNA) in education have focused on either network structure as a means of capturing social capital and/or on networks as a means for resources to flow among individuals in the network. Accordingly, network analysis aids in identifying, measuring, and testing hypotheses about structural form and contents of relations (Knoke & Yang, 2019). In the context of research-use, an examination of both the structure and content of relationships is relevant and useful, as described above.

However, the use of SNA in the context of education research has, to date, been heavily dominated by whole or complete network analyses. Such analyses are particularly instructive in understanding social capital within schools, including educators' positions within formal and informal networks, as well as the potential flow of ideas and practices within the organization. However, they are less well suited to capturing ties to *external* resources available to inform improvement efforts, often overlooking brokerage between communities and its associated social capital.

Egocentric network analysis (ENA) (Perry et al., 2018), sometimes referred to as "personal network analysis," may be particularly useful for understanding the flow of ideas and practices into schools. That is, educators' ties to others represent different kinds of relationships with different purposes, and rarely are people members of a single domain (e.g., school) but

rather members of multiple (e.g., school, community organization, professional association, etc.). Ego-network approaches facilitate an understanding of the range of domains that can influence educators' professional practice.

Secondly, ENA methods help document weak ties not often captured in traditional whole network methods. Within-group ties (e.g., school) are often stronger than external ties that support "bonding" capital, including trust, cooperation, and mutual support. However, weak ties, often to resources outside one's immediate social or professional group, support "bridging" capital, ties which facilitate access to novel resources or information (e.g., educational research) which can then flow into a community (Granoveter, 1977).

Third, ENA data is collected at the individual level, and while it does in fact collect relational data, the data do not have the same assumptions of interdependence as whole network data. In whole network approaches, all observations are conditional or dependent on others in the network, violating the underlying assumption of independence demanded by traditional statistical analyses. ENA, in contrast, is more readily incorporated into such analysis, which we illustrate later in this chapter.

Last, there are logistical advantages to using ENA (Crossley et al., 2017). Protocols for data collection can often be added within broader data collection instruments such as surveys, interviews, and observation protocols, enabling ENA to become a component of a larger study. In contrast, whole network approaches are more difficult to "tack on" to other designs because of the nature of data collection and complexity of instrument design. This, however, is not to say that ENA approaches are simpler to design, but rather that they are more readily compartmentalized within a larger study. For this reason, ENA is also more scalable and not bound by sampling at the organizational level (nor dependent on response rates in the same way

as whole network approaches). This enables more traditional sampling and survey distribution approaches to data collection.

Our approach to collecting ego-network data

We draw on a study of school-based educators' networks for accessing educational research in school improvement contexts. The *Survey of Evidence in Education* (*SEE*) survey was designed by the Center for Research Use in Schools to capture both researchers' and school-based practitioners' practices, beliefs, knowledge, and skills as they pertain to promoting research-use in schools (May et al., 2018). The practitioner version featured here (*SEE-S*) focuses on multiple dimensions of school-based decision-making and factors that shape the role of research in that process. There are five principal sections to the survey (see Figure 1). Noted earlier, one advantage of ego-network methods is that items can easily be embedded into larger instruments, which reduces data collection burden and enables linking of ego data to a wide range of other measures captured within the same instrument. We took this approach in the *SEE* surveys, gathering ego data in a section we describe as "networks through which research travels."

An Ego-Network Approach to Understanding Educator and School Ties to Research: From Basic Statistics to Profiles of Capacity

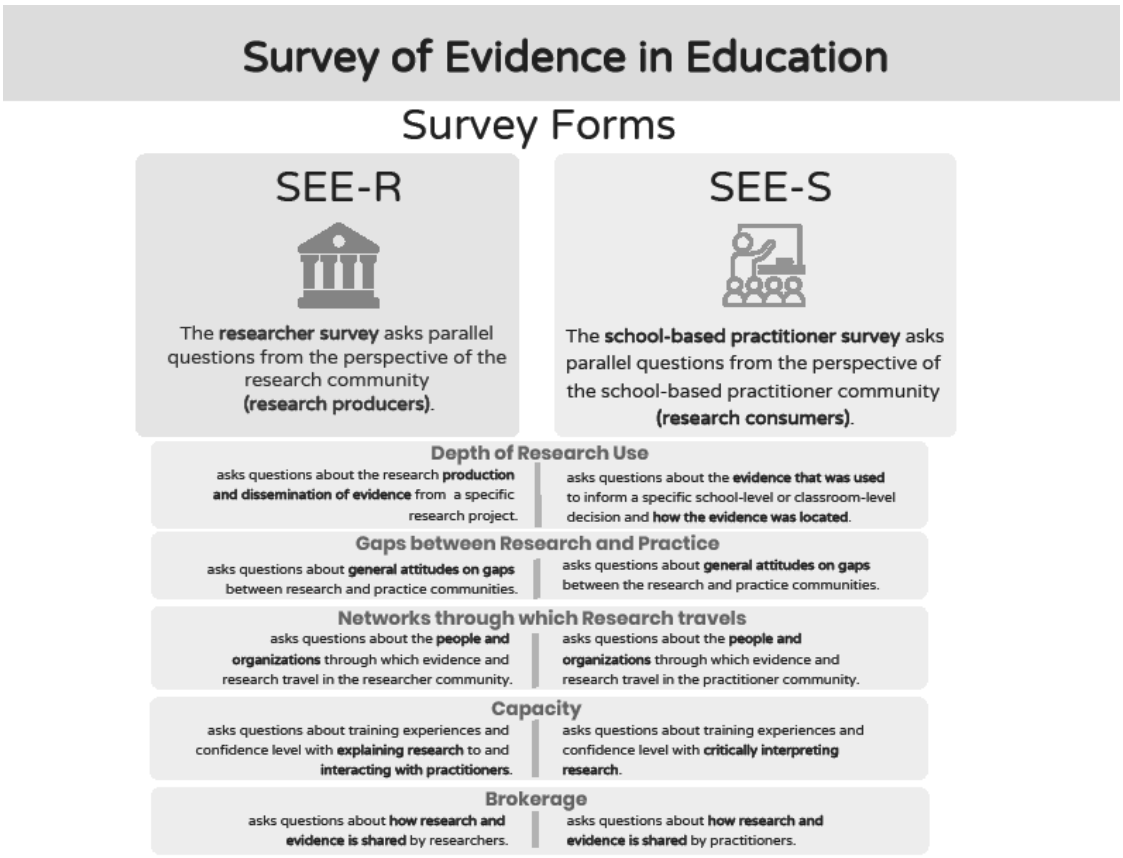
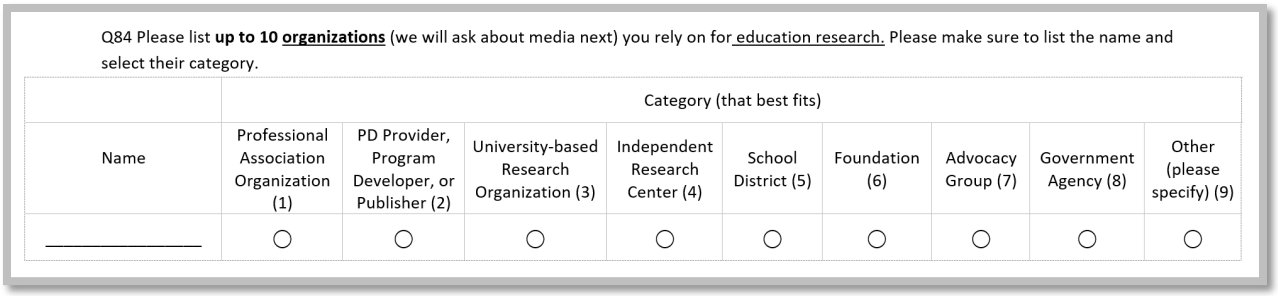


Figure 1. Overview of *Survey of Evidence in Education*

The networks section of the survey centered around three functionally specific (Perry et al., 2018) items framed to identify sources of educational research, which focused responses specifically on instrumental ties related to the use of research. We did not specify a definition of research at this point in the survey, which has had advantages and disadvantages. First, it enabled us to maximally capture what resources educators believe to be useful sources of education research, even if, as the research shows, they may have different conceptions of what constitutes research (Mills et al., 2020). On the other hand, this open framing made it difficult to distinguish which sources are relied upon for scientific-based research, which is prioritized and defined in U.S. education policy (ESSA, 2015; USDOE, 2002).

An Ego-Network Approach to Understanding Educator and School Ties to Research: From Basic Statistics to Profiles of Capacity

The three core items asked respondents to identify up to ten individuals, ten organizations, and ten media sources through which they access research-based information (name generation). For each, respondents were to provide a text name (open ended) and to classify the resource in one of several pre-determined options (name interpretation), which had been developed, tested, and revised in pilot administrations of the survey. An "other" option with subsequent open- ended text box were also provided. Figure 2 provides an illustration of how an item was presented to a respondent.



Q84 Please list **up to 10 organizations** (we will ask about media next) you rely on for education research. Please make sure to list the name and select their category.

	Category (that best fits)								
Name	Professional Association Organization (1)	PD Provider, Program Developer, or Publisher (2)	University-based Research Organization (3)	Independent Research Center (4)	School District (5)	Foundation (6)	Advocacy Group (7)	Government Agency (8)	Other (please specify) (9)
_____	○	○	○	○	○	○	○	○	○

Figure 2. Example item from network portion of *SEE-S*.

This approach approximates an exhaustive census of resources, though due to its design for online administration, it necessitated a limit on the number of nominated resources. Absent prior literature estimating the size of educators' research networks, we estimated that 30 resources (distributed across individuals, organizations, and media sources) would not be restrictive, though there is the possibility that our approach excluded some weaker ties through which educators access research. We also note that the framing of each item permits the identification of resources outside of their school organization (a benefit of ego-network analysis) but also inside their organization, capturing the multiple domains of an educator's network as well as stronger "bonding" capital and weaker "bridging" capital.

After completing these three items, respondents received additional name interpretation items. Specifically, they were asked to identify, from the set of names generated, the three most important sources, about which a follow up series of items were then administered. Subsequent items focus on the conditions under which they interact with these sources and the frequency and nature of that interaction. We do not attend to those variables in this paper, but note that our measurement approach included opportunities to capture strength (e.g., importance, frequency) and directionality of those ties. A complete listing of the item set is found in Appendix A.

The *SEE-S* survey was designed using the Qualtrics survey platform and was administered to more than 90 schools in 16 districts and charter organizations between January and June 2019. Schools were located in a range of areas with 45% suburban, 22% rural, 33% urban, and half characterized as elementary schools. More than 2,500 educators responded to the survey, and the mean number of respondents per school was 26. However, not all completed the multiple components. As the network component is the third section of a lengthy survey administered to professionals, survey fatigue may have contributed to non-response. However, we have no expectation that there is any systematic bias induced by this issue. The final sample for analyses presented here includes responses from 1,238 educators.

Preparing and analyzing ego-network data

Our data collection strategy enabled us to capture egocentric network data at scale relatively easily. A disadvantage, however, was that online administration precluded clarification questions about the name generator items and classification items. This elevated the importance of preparing and cleaning the data for analysis.

Data were cleaned through an iterative process. First, we identified cases in which no text was entered for the source, yet the source was classified, demonstrating some intent to complete the item but an unwillingness or inability to specifically name the source. We excluded these from analyses. Second, we identified the complete set of alters (individuals, organizations, and media sources) and recoded text-entry items to ensure consistency of spelling, abbreviation, and acronyms across sources. For example, the National Education Association may have been entered as NEA, Nat Ed Assoc, or in its full form.

Third, we examined categories in which respondents reported sources, which included 26 options grouped by individuals, organizations, and media sources to evaluate reliability. We took a random sample of 10% of responses and calculated the percent of responses within each category that we believed were substantively misclassified. For example, we believe Google was misclassified as a research database, whereas JSTOR was not. Where appropriate, we deferred to respondents classification. This included the categorization of individuals as well as multiple ways in which an educator might experience or engage with a resource. For example, NEA is a professional association, but respondents also noted the NEA as a media source, with categorizations such as blogs and magazines. Because these are reasonable categorizations of the resources our respondents used, we left those as categorized. Our reliability check identified 110 of 1,765 responses as misclassified (6%). However, an analysis by category revealed a need to improve the quality of our data. We found 11 categories with misclassification rates of less than 10%, five categories with misclassification rates of between 10% and 20%, inclusive, five with misclassification rates between 20% and 30%, and five with misclassification rates of greater than 30%. Upon closer examination, we noted that the more rarely the category was utilized, the greater the misclassification rates. For example, foundations, advocacy groups, research

databases, and peer reviewed journals had the highest rates, along with "other" for which recoding was planned. The research team conducted checks with the full set of responses for all categories with greater than 10% misclassification and reclassified them based on a) others' classifications of the same source where possible, and b) an Internet search for information which was used to determine the most appropriate category.

Finally, we reviewed all sources categorized as "other," which were either a) recoded into existing categories where possible or b) coded into new categories to qualitatively distinguish among the other resources educators referenced. These included: sites providing web-based resources for educators; multimedia resources (including YouTube, TeacherTube, and TED Talk presentations); assessments or assessment organizations; apps, tools, or learning platforms; standards, regulations, or policy documents; and general searches (including Google and Yahoo). Remaining sources that did not fit these categories were labeled as other individuals, other organizations, other publications, or other unknown.

To further consolidate these categories, the research team created codes for broader types of resources. These are guided by prior literature and theory and provide additional means for examining the composition of ego-networks. The first type is based on whether the identified resource is an individual. Prior literature on research-use suggests that engagement with research often happens as a result of relationships (e.g., Harrison, Davidson, & Farrell, 2017; Huberman, 1990), and therefore we sought to understand the extent to which educators' networks are comprised primarily of individuals. The second type created reflects whether the source was internal or external to the local education system. The literature on search, which is drawn primarily from organizational research, finds that the search for a solution is frequently compromised by several factors including desire to leave the work of the organization intact and

preference for internal sources of evidence (Williams & Cole, 2007; Finnigan, Daly, & Che, 2012; Massell et al 2012). Internal, or *local*, sources include members of one's own school or district staff as well as district level organizations (e.g., board of education, central office). The final type pertains to whether connections to the research community or to research are direct or mediated by other individuals, organizations, or media sources. Categories for external researcher, professor, independent research organizations, university-based research organizations, professors, peer reviewed journals, and research databases were coded as *direct*, resources external to the local education system but not considered within the research community were coded as *externally mediated*, and resources within the local education system were considered *locally mediated*.

Cleaned sources were linked back to respondents, creating a usable dataset for ego-network analyses. The resulting dataset networks from 1,238 respondents from 95 schools, inclusive of more than 9,000 sources (mean=7.42, sd=5.88, median=6, min=0, max=30) distributed among categories as per Table 1.

Table 1. Multi-level categorization of resources for accessing research-based information.

Locally mediated	*Externally mediated*	*Direct*
Coach or Interventionist	Advocacy Group	External Researcher
District Administrator or Staff	App Tool or Platform	Independent Research Center
Other School Staff	Assessment or Assessment Organization	Peer-Reviewed Journal
Principal/Assistant Principal	Book	Professor
School District	Digital Communication	Research Database
Teacher	External PD Provider, Program Developer, or Publisher	University-based Research Organization
	Foundation	
	General Search	
	Government Agency	
	Magazine Newsletter Brief	
	News Source	
	Other Individual	
	Other Organization	
	Other Unknown	
	PD Provider, Program Developer, or Publisher	
	Professional Association	
	Standards Regulations and Policies	
	Web-based Resources	

Data were entered into UCINet (Borgatti & Borgatti, 2006) to generate network statistics. UCINet offers a range of analytical tools for ego-networks that can address a wide range of questions related to individuals' networks. For our purposes, we utilize simple descriptors of ego-networks that provide insight into the ties that link educators to educational research: size, composition, heterogeneity.

Size. Network size is often conceptualized as a measure of social capital. In other words, the larger the network, the more resources available. In the context of educators' networks, more ties may indicate greater access to educational research. However, larger networks often come at a cost, of either time or effort, to maintain those ties, limiting educators' ability make use of the resources available through them. Network size is ascertained from the total number of resources reported by educators in the sample. Because of item design, the maximum network size is 30 and the minimum is 1, as those who chose not to respond to these items are excluded in these analyses[1].

Composition. Networks are comprised of many types of alters or, here, resources. Alters were categorized in a number of ways (see Table 1), including meta-categories to capture whether the resource represented a local, external, or direct connection to research. From a diffusion perspective, composition is useful in differentiating the nature and quality of ties for accessing research. Composition statistics were generated for each category and type of resource based on the proportion of the network constituted by each. Proportions eliminate the bias of network size and permit comparisons among educators' networks.

Heterogeneity. Related to composition, heterogeneity of a network provides insight into the extent to which an actor's network features different kinds of resources on which to draw. Given networks often serve multiple purposes (e.g., instrumental and affective), diverse networks may be advantageous for meeting many needs. In the case of access to research, heterogeneity may help evaluate whether networks are providing novel or redundant information. Heterogeneity of educators' networks is captured through index of qualitative variation (IQV),

[1] It is not possible to determine whether non-response indicates failure to complete the item or the absence of any ties to educational research resources.

calculated as [1—sum(p^2)] * [K / (K—1)], where p is the proportion in each category, and K is the number of categories. The variable ranges from 0 to 1, where 0 represents a completely homogeneous group, and 1 represents a group with equal parts in each category. IQVs were calculated for types of resources to consider the diversity of resources.

The resulting dataset networks from 1,238 respondents from 95 schools, inclusive of more than 9,000 sources (mean=7.42, sd=5.88, median=6, min=0, max=30) diffusely distributed among the final set of categories of resources. We present the distribution of overall resources (Figure 3) and the mean percent within each educator's network as well as a set of network statistics encompassing size, composition, and heterogeneity (Table 2).

Table 2. ENA size, composition, and heterogeneity statistics

	Mean	***SD***	***Median***	***Min.***	***Max.***
Network Size	7.42	5.88	6	1	30
Proportion individual	0.60	0.31	0.57	0.00	1.00
Proportion local	0.55	0.32	0.50	0.00	1.00
Research Relationship					
Proportion locally mediated	0.55	0.32	0.50	0.00	1.00
Proportion externally mediated	0.59	.43	.84	0.00	1.00
Proportion direct	0.07	0.15	0.00	0.00	1.00
Individual index of qualitative variation (IQV)	0.58	0.42	0.75	0.00	1.00
Local IQV	0.49	0.34	0.67	0.00	1.00
Research relation IQV	0.60	0.31	0.57	0.00	1.00

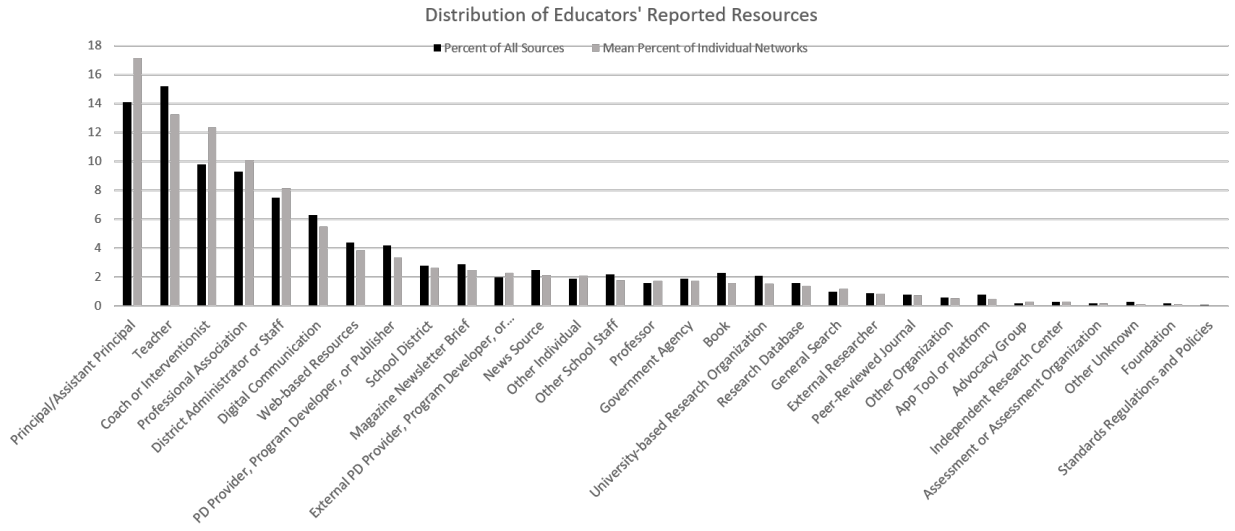


Figure 3. Distribution of reported resources

As our purpose in this chapter is to focus on the use of ENA methods for the study of policy and practice, we focus less on the substantive meaning of the results for improving research-use in schools and more on the ways in which ENA results are instructive for understanding research-use. First, the ENA approach generates a comprehensive set of resources to which educators turn—in other words, a set of potential brokers that may enable the flow of research information between research and practice communities. This set of resources is highly diffuse, with more than 9,000 identified, of which the most frequently cited is mentioned by 2% of respondents. This diffuseness certainly points to the potential for novel information to flow into schools, but poses a challenge to developing a coherent evidence-informed approach to instructional practice, school improvement, or other change initiative. Furthermore, we can point to specific types of resources that are particularly influential—potentially high leverage brokers

that bridge the research-practice gap. Table 3 lists the top organizations and media sources[2] nominated by educators in our sample. We found that many of these organizations may not have specific research mobilization missions and may be general resources to inform practice, whereas others are more explicitly focused on sharing research-based information. These distinctions help to surface important differences in the composition of educators' networks and types of resources that facilitate the flow of information into schools.

[2] Individuals are excluded for privacy purposes and organization names that reveal sample participants are given pseudonyms

Table 3. Most frequently nominated resources

Source	*Frequency*	*Percent*	*Source*	*Frequency*	*Percent*
Teachers pay Teachers	184	2	[District]	24	0.3
YouTube	126	1.4	Learning Science International	24	0.3
National Education Association	112	1.2	Scholastic	24	0.3
Pinterest	103	1.1	NJEA	23	0.2
Facebook	77	0.8	Edutopia	22	0.2
Google	74	0.8	National Science Teachers Association	20	0.2
ASCD	56	0.6	New York Times	18	0.2
Twitter	49	0.5	CCIU	17	0.2
[District]	40	0.4	Robert Marzano	17	0.2
[District]	38	0.4	SolutionTree	17	0.2
ERIC	37	0.4	AMSTI	16	0.2
Google Scholar	36	0.4	AP/College Board	16	0.2
Instagram	31	0.3	CNN	16	0.2
AEA	30	0.3	Khan Academy	16	0.2
EBSCO	30	0.3	PA Dept. Of Education	16	0.2
National Council of Teachers of Mathematics	30	0.3	District	16	0.2
Santillana	30	0.3	Region 4 Education Service Center	16	0.2
Ed Week	26	0.3	ASHA	15	0.2
Texas Education Agency	25	0.3	Idaho Education Association	15	0.2

Second, ENA statistics begin to paint a picture about individuals' capacity for research-use. For example, we can describe the average educator's network—it has more than seven resources, has about half of its ties to others within their education system (internal) and half to ties outside of their system (external), with almost no direct ties to research. Relatedly, we can

see the variability in educators' networks—finding that size, composition, and heterogeneity vary widely. If we extend networks to be an indicator of social capital, we can see that educators have varying levels of capacity for research-use—at least from an access point of view. Further, compared against an analysis of a school network, ENA results here present a more comprehensive portrait of the resources on which educators draw. They allow us to understand that educators are not merely learning from or within single, bounded contexts, but from across many contexts.

Extending ego-network analyses to broader questions about capacity for research-use

Described earlier in this chapter, an advantage of ego-networks is the ease with which statistics can be incorporated into other advanced quantitative methods that can help answer broader questions about research-use. Specifically, we sought ways to utilize these data to capture differences in educator and school capacity to use research. We focused in particular on the use of ENA statistics in latent profile analysis, a mixture model used to identify configurations of interdependent variables and that helps researchers identify homogeneous subgroups within a heterogeneous dataset. Identifying educators or schools with particular network configurations was helpful in multiple ways, including describing the distribution of access to different resources, comparing and contrasting the relationship between profiles and other dimensions of research-use and ultimately identifying, or designing levers to strengthen ties between research and practice based on the needs of particular profiles.

We opted to use our ego-network statistics in a person-centered approach, latent profile analysis, to classify the subgroups of the educators who show different patterns of networks for accessing research-based information based on the following measures:

Direct: proportion of sources which provide direct access to research based information rather than mediated access

Local: proportion of local sources which mediate access to research based information and are not directly tied to research or researchers

External: proportion of sources which mediate access to research based information to many people (i.e., not locally mediated) and are not directly tied to research or researchers

Specifically, a multiple latent profile analysis (MLPA) was conducted to address the violations of independency assumption that usually take place in a multilevel setting, such as where teachers are nested in schools, as is the case in our data. Since traditional latent profile analysis assumes that observations are independent of one another, it is not suitable for this kind of hierarchical data set (Henry & Muthén, 2010). To perform MLPA, we used Mplus 7.4 (Muthén & Muthén, 1998-2015).

The analysis consists of two steps: individual-level and school-level analyses. At the individual level (or level 1), the number of profiles (or groups) was determined by: 1) selecting a model with the lower values of statistical criteria such as Bayesian information criterion (BIC) and sample size-adjusted Bayesian information criterion (SABIC), 2) testing models by using Lo-Mendell-Rubin likelihood ratio test (LMR LRT) and the bootstrap likelihood ratio test (BLRT), 3) considering the quality of the classification by looking into the models' entropy values whose range is 0 to 1 (indicating the clarity of group classification with the value closer to 1), and 4) taking profile interpretability into account.

At the individual level, a four-latent-profile-solution provides the best fit for the data. The Akaike information criteria (AIC), BIC, and SABIC decrease continuously as complexity increases, but the decreasing gaps continue getting smaller. Considering the model fit statistics and the desirability of a parsimonious model, the four-profile model is interpretable and theoretically meaningful. See Appendix B for model comparison and fit statistics.

The four individual-level profiles shed light on the types of networks in which educators are engaged to inform their practice (Figure 4). Profile 1 (n=573, 46.3%), or *balanced*, consists of educators that rely on a balance of internal and external resources, but have little to no direct relationship to research or the research community. Profile 2 (n=409, 33.0%), described here as *internally-focused,* includes educators whose networks are heavily localized, with virtually no direct interaction with research and much less reliance on external resources than other educators. Profile 3 educators (n=78, 6.3%), which we characterize as *research-dominant,* rely on local and external (non-research) sources much less than other educators, and turn directly to research or the research community much more often. Educators in Profile 4 (n=178, 14.4%) have a nearly homogenous network of external resources, rarely turning to local or research expertise. We label this profile *externally-focused*.

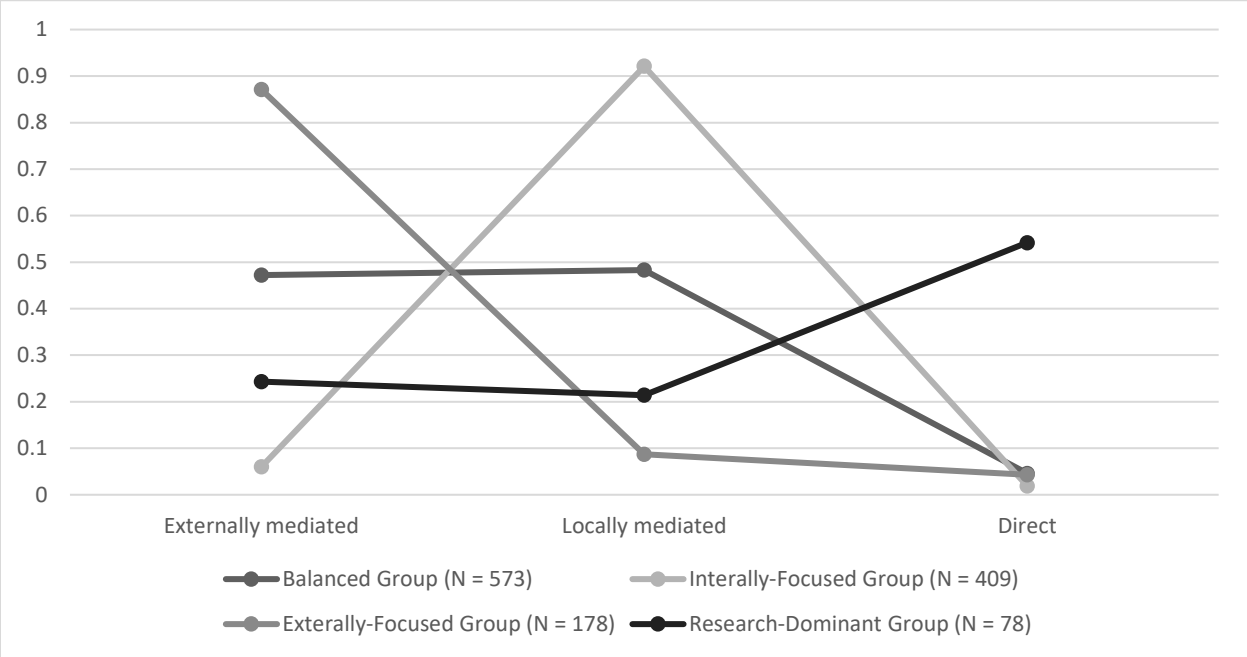


Figure 4. Four profile MLPA solution for level 1 (educators)

Individual profile analyses showcase significant differences in educators' approaches to accessing research based information, which help us achieve our goal of capturing differences in at least one dimension of educators' capacity to use research, as well as dimensions of social capital as it pertains to the potential flow of research based information into schools. Further, these profiles may relate to other research-use factors and outcomes, such as prior experience with research, beliefs about research, and engagement with research in decision making. These profiles are useful in subsequent predictive inquiry in these areas.

Further, these profiles allow us to understand the distribution of access to research both across individuals, with direct access relatively rare, and across schools (Table 4). For example, in these data, less than half of schools have an educator with a research-focused profile, and only a handful have more than one. Such findings help us to understand (and address) the tenuousness of ties to research and to target resources to individuals and organizations with less capacity.

Table 4. Distribution of profiles across schools

School membership	Balanced	Internal	Research	External
Has at least one educator with profile	92.6%	92.6%	49.5%	63.0%
Has more than one educator with profile	82%	78%	17%	40%
Has *only* this profile	5%	5%	0%	3%
Mean proportion of profile	.45 (SD .21)	.35 (SD .22)	.06 (SD .08)	.13 (SD .17)

At the school level (or level 2) of the profile analysis, the model of level 2 classes are determined based on 1) the relative frequency of the level 1 profiles as a non-parametric approach which relaxes the assumption of normality and reduces computational demanding (Muthén & Asparouhov, 2008) and 2) the value of BIC, which is the most efficient criterion for the upper-level model specification (Finch & French, 2014; Makikangas et al., 2018). The AIC, BIC, and SABIC (Table 6) are slightly lower in the three school-level profiles, but the sample sizes of 4 out of 12 multilevel profile combinations (four individual level profiles * three school level profiles= 4*3 model) are quite small ($n < 10$). The insufficient sample sizes within multilevel profile combinations may have limitations for its utility (e.g., parametric statistical analysis). These findings suggest the four individual-level and two school-level profiles (4*2 model) are most appropriate.

The two-profile solution at the school level distinguishes among two general classes (Figure 5). Because research-focused profiles were relatively rare, neither school-level profile features significant differences in direct ties to research, but do point to significant differences in internally versus externally focused profiles. These findings suggest schools differ in the extent to which external resources are valued, a quality associated with an organization's absorptive capacity, and, subsequently, may be linked to capacity to use research in improvement efforts.

As with individual level profiles, these profiles may be useful in subsequent exploratory and predictive analyses alongside additional research-use factors and outcomes.

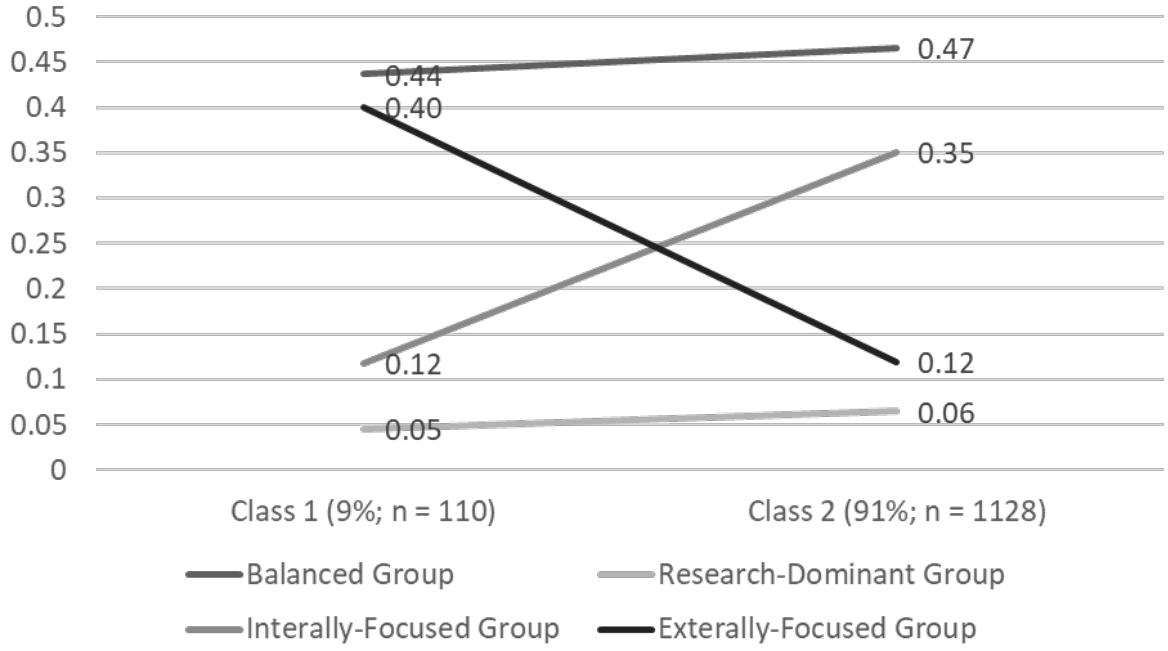


Figure 5. Two-profile MLPA solution for level 2 (schools)

Conclusion: Learning about educator and school ties to research from ego-networks

Our findings provide a landscape perspective on educators' networks for accessing research-based information and offers a unique view of what influences practice in schools. As our primary purpose in this chapter is to focus on the application of ego-network analyses to the study of research-use, we briefly attend to the substantive implications of our findings and focus primarily on the utility of the ego-network approach.

With respect to understanding educators' capacity to use research, our results are useful in two ways. First, the ENA approach generates a comprehensive set of resources that comprise educator networks. This set of resources is highly diffuse, heavily dominated by individuals, and

rarely provides direct pathways to research. Findings clearly establish that the path between research and practice is mediated, and suggest that the ways in which research information is brokered by these wide-ranging resources may vary significantly. Our data are only able to point to lower levels of brokerage as described by Burt (2004)—specifically paths by which practice is transferred, but additional research is needed to understand more about mediation itself. These findings are instructive for understanding more specifically where ideas and practices come from and, subsequently, potential partners or pathways for supporting professional learning.

We also learn a good deal about educator networks from ENA statistics, both in terms of the average educator, the variability in educator networks and, ultimately, profiles of educator networks. We were able to identify four profiles, which capture distinct sets of resources through which educators connect with education research, and which can be interpreted as one measure of capacity at the individual level. We were also able to extend network results to characterize schools, revealing profiles dominated by the internal and external sources to which educators turn. This measure of capacity offered less nuanced information than individual level profiles, but results are instructive nonetheless.

While findings are instructive about the potential for research to find its way into schools, they are also helpful in promoting a network perspective on research-use. Importantly, these data and findings would not be possible without an ego-network approach.

First, the use of an ego-network approach enabled us to engage in network-focused inquiry at scale. Our project benefitted tremendously from the advantages that ENA affords: the ease of embedding items within a larger survey, the appropriateness of traditional sampling and distribution methods, and its integration into other quantitative analyses. We were able to generate a set of name generator and interpreter items that fit within the scope of our larger

survey to which nearly half of all surveyed educators responded. Resulting data were of high quality and were useful in achieving our network analysis goals.

Second, ENA has been useful in operationalizing key concepts from network theory in the context of research-use in schools. Specifically, our collection of network data from more than one thousand educators nationwide helps to establish a broad set of brokers that facilitate the flow of research information into schools, and through the frequency of nominations, establish those that might be best positioned at the system level to improve access to research information. Further, by classifying those brokers, we are able to clarify specific types of resources, such as professional associations, that might be leveraged in evidence use policies.

ENA data also help to operationalize the social capital associated with brokerage, both through individuals' ego-network statistics and through the results of the latent profile analyses at the educator and school level. These findings proved useful in differentiating among different capacities to access research-use, which help to establish the distribution of capacity and can be used in future exploratory and predictive analyses of research-use in schools.

Additionally, ENA has offered insight into the multiple domains of educators' networks. Compared against an analysis of a school or other organizational network, ENA results here present a more comprehensive portrait of influences on educators' practice. The results allow us to understand that educators are not merely learning from or within specific, bounded contexts, such as their schools, but from a wide range of internal and external resources. Our data show that *a full half* of educators' networks might have been overlooked when considering a whole-network approach.

Of course, our approach is not without limitations. Described earlier, we made decisions about ego-network data collection that had implications for our findings. For example, the

wording of our name generator item left "research" open for interpretation, which we believe significantly contributed to the diffuseness of the resources identified. While very useful in understanding the flow of information, this diffuseness created questions about how research was conceptualized in each resource or path as well as questions of quality in mediation. In other words, we established breadth but not depth in this work. An alternative approach might allow deeper inquiry into network alters (resources), and be an important next step for inquiry. We also noted earlier that choices about name interpreter items created challenges for data cleaning, which may have introduced error into our findings.

Beyond our items, a focus on ego-networks in general limited our ability to examine internal networks—those within schools. While we tap into social capital associated with brokerage between research and practice, the corresponding social capital one might have within schools—that is, their betweenness or centrality in school-based networks—is unaccounted for. Therefore, a person may have a high capacity for accessing research (e.g., a research profile), but be relatively isolated in their building such that those "good ideas" meet a dead end, whereas a person with lower capacity to access research may be highly influential, such that their non-research based ideas are widely shared. Future research should integrate these internal and external perspectives where possible.

In summary, an ego-network approach proved useful in unpacking educators' networks for connecting with research. It allowed us to better understand the larger ecology of research mediation in the context of education, to operationalize network concepts, and to develop indicators of educator and school level capacity. Its flexibility as a method—from design and administration to its utility in subsequent quantitative analyses—was advantageous in our work,

and may make it a valuable tool to researchers pursuing evidence use research agendas in the future.

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An Ego-Network Approach to Understanding Educator and School Ties to Research: From Basic Statistics to Profiles of Capacity

Appendix A.

Q80 The following three questions will ask you to list separately the **people**, **organizations**, and **media sources** you rely on for education research.

Q83 Please list **up to 10 people** (we will ask about organizations and media next) whom you rely on for education research. Please make sure to list their name and select their title or role.

For each person, please provide the following:

A. Name
B. Primary Role or Title
    a. Teacher
    b. Principal/Assistant Principal
    c. Instructional Coach
    d. Other School Staff
    e. District Administrator or Staff
    f. External Researcher: defined as an Individual that is not a member of the school district who has responsibility for conducting educational research.
    g. External PD Provider, Program Developer, or Publisher: defined as an Individual that is not a member of the school district who delivers PD, develops programs, or publishes
    h. Professor
    i. Interventionists (e.g., math or reading specialist, etc)
    j. Other (please specify)
C. If "Other", please specify
D. Organization

Q84 Please list **up to 10 organizations** (we will ask about media next) you rely on for education research. Please make sure to list the name and select their category.

For each organization, please provide the following:

A. Name
B. Category that best fits
    a. Professional Association Organization constituted by members representing an educational profession, such as Principal/Assistant Principal
    b. PD Provider, Program Developer, or Publisher
    c. University-based Research Organization District Administrator or Staff
    d. Independent Research Center
    e. School District
    f. Foundation defined as a philanthropic organization that provides funding to support programs, research, etc on educational issues
    g. Advocacy Group defined as a special interest organization or group with a primary mission to advance a particular set of policies/practices
    h. Other (please specify)
C. If "Other", please specify

An Ego-Network Approach to Understanding Educator and School Ties to Research: From Basic Statistics to Profiles of Capacity

Q85 Please list **up to 10 media sources** you rely on for education research. Please make sure to list the name and select the category.

A. Name
B. Category that best fits
    a. Blog
    b. Social media
    c. Magazine (Online, Print)
    d. News Source (Online, Print, TV)
    e. Book
    f. Peer-Reviewed Journal
    g. Research Database (e.g., Google Scholar)
    h. Other Resources (e.g., YouTube, Teachers-Pay-Teachers)
    i. Other Website (please specify)
    j. Other (please specify)
C. If "Other", please specify

Q86 From the answers you provided, please choose the sources (**up to 3**) that you rely upon most for education research. [this question filters responses; see p.iii]

1. _____

2. _____

3. _____

Q87 We would now like to ask you about the three sources that you indicated you rely upon most. (Questions 86, 87, and 88 are asked about each of the three sources)

For **1** please answer the following questions.

Q88 How frequently do you interact with [Source] around education research?

- o Daily (1)
- o Weekly (2)
- o Monthly (3)
- o Quarterly (4)
- o Yearly or less often (5)

Q89 My interactions with [Source] around education research...

- o are regularly scheduled. (1)
- o occur as needed or spontaneously (2)

Q90 Please select the option that best represents your relationship with [Source].

- I'm required to interact with [Source] concerning research. (1)
- It is optional for me to interact with [Source] concerning research. (2)

Q91 Please select the option that best represents your relationship with ${lm://Field/2} around education research.

I usually initiate the interaction OR I usually search for the information that I read from this source (1)

the person usually reaches out to me OR the organization usually reaches out to me OR the source usually sends me the information that I need (2)

The interaction is equal. (3)

Q92 What activities do you engage in with [Source]? Please check all that apply.

I get research from [Source]. (1)

I share research from [Source] (2)

I share research through [Source] (3)

I discuss specific research from [Source] with my colleagues (4)

I share my needs/concerns about my practice with [Source] (5)

An Ego-Network Approach to Understanding Educator and School Ties to Research: From Basic Statistics to Profiles of Capacity

Appendix B. Model comparison fit statistics for MLPA

No. of profiles	AIC	BIC	SABIC	LMR LRT (p)	BLRT (p)	Entropy
Level-1						
2	-532.78	-488.49	- -520.24	< 0.001	< 0.001	.84
3	-1107.52	-1045.52	-1089.97	0.0938	< 0.001	.91
4	-1556.68	-1476.97	-1534.12	0.0030	< 0.001	.93
5	-1888.10	-1790.68	-1860.52	< 0.001	< 0.001	.94
Level-2 with 4 level-1 profiles						
2	-3061.73	-2949.07	-3018.95			.91
3	-3067.13	-2934.0	-3016.56			.92

Note. AIC = Akaike information criteria; BIC = Bayesian information criterion; SABIC= sample size-adjusted Bayesian information criterion; LMR LRT = Lo-Mendel-Rubin likelihood ratio test; BLRT = bootstrapped log likelihood ratio test