More than a Master: Developing, Sharing and Using Knowledge in School-University Research Networks

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CONCEPT VERSION

Abstract Postgraduate master's programs for in-service teachers may be a promising new avenue in developing research partnership networks that link schools and university and enable collaborative development, sharing and use of knowledge of teacher research. This study explores the way these knowledge processes originating from master's students' research occurs in the school–university network of a master's program embedded in the K–12 school environment of a Central Management Organization in the US. Questionnaires, interviews, and logs were used to collect quantitative and qualitative data at four time-points over a10-month period. Data were analyzed at three network levels: school, dyad, and individual. Findings indicate that the school network context provided both master's students and research advisors with a supportive context for collaboratively engaging in knowledge processes during research as well as after they graduated. However, the network context was not enough to build sustainable and productive relationships in the partnership network.

Keywords: sharing knowledge; school–university research networks; master's program; partnership; teacher research

Introduction

In this study school-university partnerships were studied from a network perspective in a teacher education context, i.e.: school-university research networks embedded in master's programs. Recently, scholars have suggested that postgraduate master's programs for in-service teachers may be a promising new avenue in developing school-university research networks that link schools and university and enable development, sharing and use of valuable knowledge of teacher research (Baumfield & McLaughlin 2006; van Swet, Ponte & Smit, 2007). Given the recent proliferation of this kind of network, there is a dearth of empirical knowledge about its nature, processes and outcomes. This study examines the way knowledge is developed, shared and used in a school-university research network in the context of a master's program that is embedded in the school environment. The main aim is to increase our understanding of the way these

knowledge processes occur on different network levels and are influenced by aspects of this type of school-university research network.

Theoretical Framework

School-University Research Networks Embedded in Master's Programs

In school-university research networks embedded in master's programs, university supervisors support master's students (i.e., in-service teachers) in developing knowledge by conducting practice-oriented research in their own schools. This practice-oriented research refers to a broad array of research approaches that are geared toward the practice of practitioners, such as action research, self study and design research (Zeichner & Noffke, 2001). Knowledge processes that originate from such master's students' research are expected to continue within teachers' professional practice after their graduation, and may have immediate and future educational benefits. Figure 1 illustrates this school-university research network in the context of a master's program.

[Insert Figure 1 About Here]

Figure 1 shows that in the master's program the relationship between the research supervisors and their master's students in schools provides a potential bridge between university and school by connecting networks of both organizations. In such a school-university network knowledge that is developed in practice-oriented research of master's students can be shared and used with colleagues in school as well as university.

A master's program that is enacted as a school-university research network places new demands on schools and universities, as well as the teachers and supervisors involved. In the school-university research network, the master's program is no longer a single endeavour of postgraduate teacher education, but instead one that fosters the development of productive relationships between schools and universities (McLaughlin & Black-Hawkins, 2007; van Swet, et al., 2007). Universities not only focus on supporting master's students in developing valuable knowledge through conducting research and graduating from the program, but also aim to

increase collaboration and knowledge exchange in schools and universities. In this approach university faculty may, for example, collaborate with principals and teachers at their students' schools in finding ways to develop, share and use valuable knowledge from students' research in school or university (Martin, Snow, & Franklin Torrez, 2011).

The literature on school-university research partnerships suggests the importance of forming a partner network structure that may facilitate the building of collaborative relationships, which may foster knowledge processes (e.g. LePage, Boudreau, Maier, Robinson, & Cox, 2001; Baumfield & McLaughlin, 2006). In an earlier study we have argued that it is therefore critical to take structural and relational dimensions into account in forming research networks and understanding the knowledge processes that take place within these networks (Authors, 2013). These structural and relational dimensions suggest four possible types of school-university research networks in master's programs, which are shown in Figure 2.

[Insert Figure 2 About Here]

Figure 2 shows how school-university research networks in master's programs may differ (see for a more elaborate description Authors, 2013). The vertical axis in Figure 2 describes the structural dimension, which shows the physical proximity of the university staff towards the school environment of the practitioners with whom they collaborate. We distinguish two types of school-university research networks in master's programs that differ in such physical proximity:

(1) University-centered: in this type of school-university network, master's programs are characterized by the fact that universities offer postgraduate education for in-service teachers primarily within a university setting (van Swet, et al., 2007). As these programs are offered exclusively at the university they are considered 'distant' from the master's students' school settings.

(2) School-centered: in this type of school-university network, master's programs are characterized by the fact that teacher education institutes that offer the programs are completely embedded in the school setting of their master's students (Caillier & Riordan, 2009) and, in this

sense, are very close in proximity. In this context the university staff is able to offer the master's program to in-service teachers as well as work collaboratively within the same school environment with their masters' students.

The horizontal axis in Figure 2 describes the relational dimension, which shows the degree of reciprocity in research collaboration relationships between university and school staff. We distinguish two types of relationships that differ in reciprocity:

(1) One-way relationships: one partner, either the school or university, initiates the research process with the other party playing a more supportive role or both partners conduct research, but there is little mutual engagement in each other's research.

(2) Reciprocal relationships: relationships with high levels of mutual engagement between the school and university and with many collaborative opportunities to mutually exchange knowledge, experiences and resources. Research agendas, goals, methods, and outcomes are discussed and research activities are collaboratively undertaken.

Based on these dimensions, more insight can be gained into different types of school-university research networks in master's programs and the way knowledge based on master's students' research is developed, shared and used in school and university practice.

Developing, Sharing and Using Knowledge in Networks

In the literature, different views on the nature of knowledge and the processes in which it is developed, shared and used in a network are described. Paavola, Lipponen, and Hakkarainen (2004) build on the work of Sfard (1998), and describe three main ways of thinking about these knowledge processes. First, they describe knowledge processes from the 'acquisition metaphor', which focuses on knowledge in the head of the individual. In this commonly held view, the individual mind is a kind of 'container', into which knowledge can be constructed during processes of transfer and application. For many years this 'acquisition' view has been dominant in studying knowledge processes (e.g., Salomon & Perkins, 1989). Second, Paavola and colleagues describe a contrasting view of the 'participation metaphor', which focuses on interactive

knowledge development through participating in communities in situated contexts. Here, knowledge is distributed among individuals and situated in their relationships and participative activities. It is argued that knowledge and knowing are closely tied to the context of events in which people participate (e.g., Lave & Wenger, 1991). Third, Paavola and colleagues describe the 'knowledge creation metaphor', which focuses on the process of developing something new. Here, people collaboratively develop mediated artifacts, such as knowledge, ideas, practices, materials and concepts. It is emphasized that during this collaborative process different forms of knowledge and activities interact (e.g., Hargreaves, 1999).

In this study the developing, sharing and using of knowledge based on master's students' research was examined from the 'knowledge creation' view. The 'knowledge creation' view is considered a promising approach for building and studying knowledge networks in formal educational and informal workplace learning settings (Paavola, et al., 2004), as they both occur in the context of a master's program. It focuses on the interactive process of collaboratively developing new artifacts such as the knowledge, ideas, practices, materials and concepts that are being developed in practice-oriented research of master's students. Moreover, the 'knowledge creation' view values individual, relational, and contextual elements; it is considered that examining knowledge processes from this view can support a rich and broad understanding of knowledge processes in a school-university research network.

Research Question

McLaughlin and Black-Hawkins (2004, 2007) noticed that fundamental changes are needed in the organizational networks of schools and universities in order for sustainable knowledge processes to take place in the school-university research partnership (cf. Zeichner, 2010). Using master's programs for in-service teachers to create such new school-university research networks implies that these changes should converge with the way teacher education is provided. We suggest that two important dimensions of such change may be the: (1) structures: change from university-centered to school-centered, and (2) relationships: change from one-way to reciprocal.

Therefore, in this study we examined the second quadrant of Figure 2 as it reflects a reciprocal partnership structure embedded in the school environment of master's students. The overarching research question that guides this study is: In what way is knowledge from master's students' practice-oriented research developed, shared and used in a reciprocal school-university network that is embedded in a school-centered master's program?

Method

Context

In this study we explored a master's program offered by the Graduate School of Education (GSE) at the High Tech High schools in San Diego (U.S.). In the past decade this Charter Management Organization (CMO) has grown from a single charter school to 11 schools spanning the K-12 grades: five high schools, four middle schools, and two elementary schools. Teachers work in interdisciplinary teams of two (one from the Humanities Department and Mathematics and Sciences Department) to develop a program for their group of students (50-70 students); their teaching schedule accommodates team teaching, common planning time, and interaction with colleagues within and across grades, departments, and schools.

In 2007 the CMO opened the first GSE in the United States to offer a master's program in teacher leadership and school leadership embedded within a K-12 school environment that aims to link teacher education and school reform (see for an elaborate description Caillier & Riordan, 2009). The GSE focuses on building a community of learners and explicitly aims to build teachers' capacity for critically inquiring and designing their own practices. The backbone of the GSE's Master of Education (MEd) program is considered the action-research component in which master's students inquire into their own practice and contribute to change within their classrooms and the school. In the first year of this two-year, part-time program, students meet in three-hour classes once a week and design an action research project. In the program's second year, students conduct a yearlong action research and attend bimonthly research seminars to support their projects. Furthermore, students receive support and feedback on research activities

in regular meetings with a critical friend from the program and a GSE faculty member who acts as a research advisor.

Research Design

We used a longitudinal multi-method case study design to examine knowledge processes in the network of one of the CMO's schools where MEd students (i.e., in-service teachers) were conducting research in their CMO's MEd program. We examined the network at the level of the whole network (school of MEd students), dyad (pair of MEd student and research advisor), and individual (MEd students and research advisors). The network level analysis enabled us to understand the overall structure of the knowledge processes network within school by examining the patterns of interactions among school members. The dyad level analysis explored the quality of relationships between the school's MEd students and their research advisors in terms of supports and constraints in knowledge processes when conducting practice-oriented research at their school. The individual level analysis deepened understanding of how MEd students and their research advisors experienced knowledge processes over time.

Selection of Participants

We purposively selected participants who were actively engaged in knowledge processes based on practice-oriented research at their school based on three criteria: (1) an in-service school teacher conducting practice-oriented research in the second year of the MEd program, (2) an educator in the MEd program who as a research advisor was paired up to support the in-service teachers (i.e., MEd students) in conducting practice-oriented research at school, and (3) one of the CMO's schools where several in-service teachers were conducting research in the MEd program. The third criterion enabled us to take into account a variety of individual network participants and to distinguish differences and similarities among them. This resulted in the selection of one school with four participants: two MEd students (working at that school) and two research advisors from the graduate school (see Table 1).

[Insert Table 1 about Here]

Data Collection

Whole Network Questionnaire. In the academic year after the MEd students had finished their research we conducted an online questionnaire with questions about individual attributes and social relationships around knowledge processes in schools (see Figure 3). It provided us with data about the network, dyads, and individuals in the end of the 10-month data collection period and gave insight into the structure and network positions of the four selected participants after the MEd students finished their research.

This questionnaire was distributed to 21 respondents: the two selected MEd students, all of their 17 school colleagues, and the two selected graduate school research advisors. Data collection resulted in a 100% response rate. This high response rate strengthened validity and reliability of the subsequent network analysis. Prior to the data collection, we piloted the questions with a school teacher and university educator to improve formulations. Questions were designed to: (1) determine the grade and subjects that respondents were teaching and the years that they were working as an educator, both in general and at this school; and (2) determine the relationships when people develop new ideas for their own teaching practice in interaction with colleagues. We asked participants to respond to the following prompt: "Please select, from whom do you get new ideas for teaching?" We provided them with a roster of school staff, including the two graduate school research advisors, and asked them to assess the relationships with their colleagues on a binary scale (0 = No interaction; 1 = Interaction). The rational for this question was based on the knowledge creation view that we adopted for this study as described earlier. We focused on teaching ideas since the CMO's MEd program's knowledge processes originated from MEd students' practice-oriented research, which aimed to impact their own teaching practice. In this way we could gain insight into how the structure of the school network might support such knowledge processes of MEd students.

Personal Network Questionnaire. The personal network questionnaire collects data about social relationships in the personal networks of individual respondents (Wasserman &

Faust, 1994). We conducted the same personal network questionnaire at four different times, asking questions about individual attributes and social relationships between school staff during knowledge processes (see Figure 3). We focused this questionnaire on knowledge processes originating from MEd students' research, as this would enable us to better understand the role of relationships both during and after their research in this type of school-university research network. The questionnaire was conducted among the two selected MEd students and the two selected GSE's research advisors. We piloted the questions with a school teacher and a university educator to improve formulations. Questions were designed to: (1) nominate colleagues who gave respondents new teaching ideas while discussing MEd students' research. In order to generate these names, we asked respondents to respond to the prompt: "What colleagues in school provided you new ideas for your teaching when you discussed your research?" Research advisors were asked to only consider ideas connected to the research of the MEd student they were advising and only consider colleagues in their own GSE; and (2) state the position of nominated colleagues, and assess the quality of relationships with nominated colleagues with respect to trust, engagement, expertise, and value. In order to assess quality of relationships we asked four questions derived from Cross et al. (2001) and Borgatti and Cross (2003) that examined: (1) trust: "With whom do you discuss personal matters?"; (2) engagement: "When seeking advice who understands your issue and assists in solving the issue?"; (3) expertise: "Who do you consider to have knowledge and skills?"; and (4) value: "Who has expertise that is of value in your work?" Data collection resulted in 16 personal networks, with four from each respondent.

Logs and Interviews. Data was collected from the two selected MEd students and the two selected GSE's research advisors. Data collection took place over four time periods during and after MEd students' research. These periods co-occurred with the periods in which the personal network data was collected (see Figure 3). At the beginning of the data collection participants were given instructions to keep a log to report on critical incidents. Critical incidents

were defined as moments during their practice when they experienced that knowledge originating from MEd students' research was developed, shared, or used effectively or ineffectively. Focusing on these critical incidents helps track down concrete events from the participants' own practice and experiences (Butterfield, Borgen, Amundson, & Maglio, 2005). MEd students were asked to exclusively report on knowledge processes connected to their own research. Research advisors were asked to report only on knowledge processes connected to the research of their MEd students. They were asked to report on any significant critical incident during that particular period. As an aid to writing their logs, participants received a sheet with guiding questions. These questions not only focused on describing the critical incident itself, but also on their thoughts, feelings, and reasons for their behavior (Butterfield et al., 2005). Examples of these questions and critical incidents reported on in their logs are given in Table 2.

[Insert Table 2 about Here]

At the end of each period the researcher collected the participants' logs through e-mail. After reading the reports the researcher conducted a semi-structured online interview using Skype with each participant. Each interview lasted for 1 to 1.5 hours. An interview protocol was used to explore aspects of the critical incidents, which the participants had reported in their logs (see Table 2 for sample questions). In this way we could gain a broad and in-depth insight into how participants perceived the knowledge processes in the network. Interviews were conducted once every 8 to 10 weeks over a period of 10 months (see Figure 3). A total of 16 interviews were collected with four participants (four interviews with each participant) over the course of the year. In total, 55 critical incidents were collected with interview data about each incident. The number of critical incidents for each participant was: MEd Student 1 (MS1) (22), MEd Student 2 (MS2) (12), Research Advisor 1 (RA1) (12), and Research Advisor 2 (RA2) (9). On average participants reported three or four incidents in each period, with a maximum of six and a minimum of two.

[Insert Figure 3 about Here]

Data Analysis

We analyzed the quantitative and qualitative network data at each network level: school network, dyad, and individual. The quantitative analysis focused on examining network structures and patterns of relationships among colleagues during knowledge processes in school, the qualitative analysis on explaining and understanding these structures and patterns from the participants' perceptions within school.

Quantitative Analysis. Social network analysis was used to examine patterns of interactions between network members during knowledge processes. Social network data obtained from the surveys were entered into UCINET (Borgatti, Everett, & Freeman, 2005) for calculating network measures. We used NetDraw (Borgatti, 2002) to generate visual representations of the network. We applied social network measures to examine network properties at the level of the school network, dyad, and individual.

Network level analysis. We conducted social network measures of *density*, *reciprocity*, *centralization*, and *E-I index* to gain insight in the network structure (Wasserman & Faust, 1994). Density refers to the ratio of the number of existing relationships to the possible number of relationships between network members in the network. Density ranges from 0 (no relationships in the network) to 1 (all network members are connected). Reciprocity refers to the ratio of the number of reciprocated relationships to the total number of observed relationships in the network. Reciprocity ranges from 0 (no reciprocated relationships in the network) to 1 (all observed relationships are reciprocated). Centralization refers to the difference between one or a few highly central network members with many relationships and the other more peripheral network members. Centralization ranges from 0 (all network members have the same number of relationships) to 1 (all network members only have one relationship in the network with the same single network member). E-I index refers to the degree of group-embeddedness and cross-group connections and is used to explain the degree of closure within and between groups in a network.

The E-I index ranges from -1 (all relationships are internal to certain subgroups) to 1 (all ties are external to certain subgroups).

Dyad level analysis. As the student-advisor relationship is at the core of the research in the CMO's MEd program, we combined the personal network of the student and his/her advisor to create their dyad network. Sociograms were generated for each dyad network to understand the patterns of relationships between the student and his/her advisor. We examined the quality of these dyad networks, by measuring their density and reciprocity. In each dyad, we also examined similarities/differences between the size and quality of the personal network of the student and his/her advisor. Therefore we compared personal network measures of *size*, *density*, and *reciprocity* between the MEd student and research advisor in each dyad.

Individual level analysis. In our individual level analysis we explored the personal networks of the two MEd students and their two research advisors over time to get a better understanding of the way knowledge processes originating from MEd students' research occurred in the school-university research network of the CMO. In our analysis we focused on the strong relationships between each participant and his/her colleagues as they facilitate interactive knowledge processes. We defined these strong ties as relationships that network members perceive to be characterized by all four examined relationships (i.e., trust, expertise, engagement, and value). Such ties are considered to foster interaction, collaboration, and knowledge processes. We counted the number of strong relationships that each participant indicated within his/her own organization at four time points. We summarized outcomes in graphical time patterns for each individual in order to gain insight into the development of these personal networks.

Qualitative Data. The interviews were audio-taped and transcribed verbatim. In our analysis of the interview data we focused on understanding how participants perceived the knowledge processes. Three main elements of the network were explored, which corresponded with the three levels of the quantitative analysis: individual network members (individual level), relationships between the network members (dyad level), and context of events in which (joint)

activities by network members take place (network level). The analysis of the transcript data followed an approach described in more detail in the study of —Authors, 2011— in which 15 aspects were distinguished of these three network elements. From this study a category system was used to select fragments from the interviews. This category system was considered a reliable instrument for analyzing the data based on its scores for inter-rater reliability (*Cohen's Kappa* of 0.74), and intra-rater reliability (*Cohen's Kappa* of 0.83). The categories referred to 15 aspects of the individual network members, their relationships, and the context of events during knowledge processes originating from the research of MEd students (see for description of categories Authors, 2011). It resulted in the selection of 981 fragments. Examples of fragments pertaining to these different knowledge processes and network elements are presented in the results section. Table 3 presents fragments by members, their relationships, and context of events during processes related to developing, sharing, and using knowledge.

[Insert Table 3 about Here]

We describe our analysis for each element parallel to the levels in the quantitative analysis: context of events (network level), relationships between network members (dyad level), and individual network members (individual level).

Context of events. We started by assembling fragments pertaining to the context of events in which knowledge processes took place for each individual participant. A comparison of fragments examined the knowledge processes. After we clustered and summarized the fragments referring to a common theme, a descriptive label was assigned to each fragment cluster. We compared the themes of the individual participants, focusing on differences and similarities in the labels and summaries.

Relationships. We started by assembling fragments pertaining to each individual's relationships with colleagues when knowledge processes took place. After we clustered and summarized fragments referring to a common theme for each participant, a descriptive label was

assigned to each fragment cluster. We then compared the extracted themes for dyad 1 and dyad 2, focusing on differences and similarities in the labels and summaries.

Members. We started by assembling fragments pertaining to the individual members. We divided the fragments among each of the four instances when they were collected. We focused our individual analysis on distinguishing developments over time in the way knowledge processes originating from practice-oriented research of master's students were experienced by individual participants. This enabled us to compare for each individual participant their quantitative relational time-patterns derived from the personal network analysis with their qualitative perceptions of developments in their personal networks and knowledge processes over time. After we compared the fragments over time, we clustered and summarized fragments referring to common themes, which described developments in the participants' personal networks.

Reliability and validity of this qualitative data analysis were ensured by using: (1) A reliable category system; (2) Peer debriefing by discussing and adjusting the assigned labels and formulation of the summaries with two other researchers who were familiar with the study's conceptual framework but unfamiliar with the specific case data; (3) Member checking with the participants, i.e., explaining to each participant a summary of their perceptions of the knowledge processes and inviting them to improve or add to the descriptions (Miles & Huberman, 1994). The peer debriefing led to some minor changes which focused on improving clarity of formulation of the summaries in the context of events. Each of the participants confirmed in the member checks that the summaries of their perceptions were complete and accurate.

Results

In this section the results will be described on each level of analysis: whole network (all educators at the MEd students' school and their two research advisors); dyad network (couple of MEd student and research advisor) and personal network (individual MEd student or research advisor).

School Network: Well Connected and Supportive of Knowledge Processes

Well-Connected Network. On average, network members engaged in knowledge processes with about 48% of their colleagues (*Density* = .48) and almost half of this number of relationships between network members were reciprocated (*Reciprocity* = .46). Furthermore, the relationships were relatively dispersed and there were no network members that were strongly dominating the school network (Overall *Centralization* = .37).

Figure 4 presents a visualization of the network. The network is densely connected and of reciprocal relationships (solid black lines). The members are sized by degree centrality (i.e., the proportion of relationships an individual member has with other members); the bigger the node, the more central position the member had in the network.

[Insert Figure 4 about Here]

An important observation from this network picture is that both research advisors (RA1 an RA2) were still part of their students' school network in which ideas and knowledge for teaching are exchanged in the year after their master's students (MS1 and MS2) had graduated from the program.

We continued examining the tendency of members to form internal (within group) or external (outside group) relationships for the two most prominent groups of teachers at school: the Humanities Department and the Math and Sciences Department. In Figure 4, the circular nodes represent members of the Humanities Department; the diamond-shaped nodes represent the Math and Sciences Department; and the triangle nodes represent members who did not belong to one of these departments (e.g., director and resource teacher).

Overall, the group level *E-I index* indicated that both departments had a tendency toward engaging in knowledge processes with network members of other groups (*E-I index* of Humanities Department and the Math and Sciences Department = .31 and .51 respectively). On average, network members of one department engaged in knowledge processes with about 43% of their colleagues in the other department (Inter-department *E-I Density* = .43) and network members of both departments had a large number of relationships with colleagues in their own

departments as well (Intra-department *E-I Densities* of Humanities Department and Math and Sciences Department = .93 and .43 respectively).

Findings of the social network measures suggest that the school network provides members with opportunities to access other network members in school and, as such, potentially fosters interactive knowledge processes across the school.

Supportive Context. Interview analysis of the context of events in which knowledge processes occurred indicated that in the school context many opportunities and support for knowledge processes were deliberately offered. The two MEd students were provided with a range of resources and professional development activities. MS1 noticed that the school context supported her to interactively engage in knowledge processes with her colleagues:

> I feel like everyone shares and listens to each other … I feel like that's been set up really well, I don't exactly know how, but everyone gets excited from each other.

Many of these knowledge processes appeared to be supported by the GSE. MEd students had opportunities to share knowledge they developed with colleagues inside and outside their department and school by: (1) collaborating with their teacher partner and school colleagues, (2) publishing in books and their school's journal, (3) contributing to meetings of the GSE's programs for the next cohort of MEd students and new teachers, and (4) presenting at conferences and meetings with colleagues from inside and outside their school.

Master's Student and Research Advisor: Similar Access, Different Patterns

Figure 5 presents the networks of dyad 1 (MS1and RA1) and dyad 2 (MS2 and RA2). On first examination these networks look similar, but we found distinct patterns in looking at the network position and connectivity between the MEd student (up-triangle) and their advisor (circle).

[Insert Figure 5 about Here]

Similar Access. Both dyad networks appeared to have potential for engaging in interactive knowledge processes with colleagues in school as they had similar properties in terms

of density and reciprocity. The dyad networks were both densely connected (Density of MS1/RA1 and MS2/RA2 = .51 and .53 respectively) and approximately 50% of all possible ties that existed in both dyad networks were reciprocated (Reciprocity of MS1/RA1 and MS2/RA2 = .48 and .49 respectively). Moreover, both dyad networks had a similar network size (Number of nodes of MS1/RA1 and MS2/RA2 = 20 and 19) and number of ties (Number of ties in MS1/RA1 and MS2/RA2 = 192 and 180). In other words, both dyads had a similar potential capacity for gaining access to other network members during knowledge processes.

Different Patterns. Differences were found when we examined the two dyad networks and compared the way the personal networks of the MEd student and research advisor were balanced in both dyad networks. Figure 6 presents four personal networks for both MEd students and their research advisors.

[Insert Figure 6 about Here]

Comparing MEd students' personal networks in the dyads, it is evident that in dyad 1 MS1 had a considerably larger number of colleagues she could reach (n = 19) than MS2 in dyad 2 (n = 13). In addition, the quality of relationships in terms of the number of reciprocal ties varied. MS1 had more reciprocal ties (*Ego Reciprocity* = .79) than MS2 (*Ego Reciprocity* = .39). MS1 would be considered to have more access to other network members during knowledge processes in comparison to MS2.

We noticed an inverse relationship when comparing the personal networks of the research advisors in the two dyads. RA1 had a considerably less number of colleagues she could reach (n = 9) than RA2 in the second dyad (n = 15). In addition, the quality of relationships in terms of the number of reciprocal ties varied; during knowledge processes RA2 had a larger proportion of reciprocal connections with his colleagues than RA1 (*Ego Reciprocity* of RA2 and RA1 = .67 and .44 respectively).

Advising or Supervising. Interview analysis indicated a main difference in the relationship between each MEd student and his/her research advisor. MS1 and RA1 described

their relationship as equal/collegial and they reported mutual trust and active engagement with the developing and sharing of knowledge. MS1 explained how she valued this kind of relationships with RA1:

> I would say that she [RA1] is a really good friend that I can be honest with and ask a lot of questions. If I have any questions, she always takes time and is really serious about it. She's a really good advisor and close friend, which makes it easy to ask her those kinds of questions and give me good, critical feedback … I feel like my work is very honoured.

RA2 described how he usual adopted a similar collegial approach of advising, but he noticed that this time it did not work with MS2:

> We've changed against that word [supervisor] a little bit because of our emphasis on collegial pedagogy. In many cases with our students that collegial pedagogy works, but it doesn't work for everyone and it doesn't work for him [MS2].

MS2 and RA2 described their relationship both as 'formal' in which RA2 was giving directions and setting deadlines for MS2 to complete his research. RA2 explained that he had to act as a formal supervisor, because he felt otherwise MS2 would not finish his research and obtain his MEd degree.

Individual Perceptions of Value Impact Continuation of Knowledge Processes

MEd Students. Figure 7 presents the pattern of the number of strong ties each MEd student had with school colleagues during knowledge processes originating from their research over the four time periods during which data was collected.

[Insert Figure 7 about Here]

Valuing developed knowledge. The pattern for MS1 shows a downward trajectory from time 1 to time 3, but then moves upward again after time 3. The pattern for MS2 shows a small increase after time 1 and again after time 3. The patterns indicate that both MS1 and MS2 increase the use of strong ties after time 3, using most of them at time 4. These patterns suggest that after finishing their research and writing (time 3) the MEd students started to increase the use of their strong ties in continuing to engage in knowledge processes with colleagues in their school.

We noticed from the interview analysis that MS1 reported mainly about sharing (76.4% of coded fragments), to a lesser extent to developing (16.7% of coded fragments), and almost none to using (6.9% of coded fragments) knowledge. She reported developing content knowledge about her research topic as well the procedural knowledge she developed about the method and procedure of her research. She referred to such knowledge development primarily during her research (time points 1-3) and stopped referring to it at time point 4 after her graduation. Toward the end of her research (time point 3) and after graduation (time point 4) she increasingly thought about ways to share her knowledge and started to plan activities to do so:

> Another thing I was thinking about, because of getting such positive feedback and people appreciating, just making things public online ... so that they can constantly be a resource for me for next year and for anyone that wants to use them and change stuff.

During this time, she reported on leading activities, through which she shared the knowledge developed about the content and procedure of her research. She was invited by her research advisor (RA1) to present for educators both inside and outside the school in a range of GSE's meetings. She was enthusiastic when she was able to collaborate and share her knowledge with colleagues. For example, she created a website containing her complete research project with all of her teaching materials and she hoped to inspire other teachers to use these materials in their classroom teaching:

> I think one of the coolest things about teaching is that we share, and it's free, and if something works in your classroom there's no sense that you're going to keep this because it works and it's yours. The coolest thing would be if somebody else did it.

Unlike MS1, MS2's reports on knowledge processes were somewhat more balanced between developing (41.4% of coded fragments) and sharing (55.1% of coded fragments). Like MS1, he referred little to using knowledge processes (3.5% of coded fragments). He reported mainly about the procedural knowledge he was developing about the method and procedure of his research and to a lesser extent about the content knowledge of his research topic. At time 3 and 4, when he finished his research and writing, he reported that he had not been able to

develop and share the kind of content knowledge about his topic he had hoped for due to personal circumstances during times 1 and 2. However, he appreciated support from his research advisor in reflecting and developing the procedural knowledge about his research:

> Even though everything went wrong, he gave me a chance to make me feel successful with part of it so those reflection pieces are the part, where if I had to say I'm proud of it, that would be the part I'm most satisfied with. The findings, ahhh...

In comparing the experiences of MS1 and MS2, we may conclude that MS1 perceived herself -more than MS2-as successful in developing valuable knowledge for school practice and in sharing that knowledge for the benefit of practice of herself and others.

Research Advisors. Figure 8 presents the pattern of the number of strong ties each research advisor had with graduate school colleagues during knowledge processes originating from their MEd student's research over the four time periods during which data was collected.

[Insert Figure 8 about Here]

Changing roles. In comparing the patterns we notice that unlike RA2, RA1 continues to increase the use of her strong ties within the graduate school after time 2.

In interviews, RA1 reported that knowledge processes focused mostly on sharing (72.8% of coded fragments), less on developing (25.7% of coded fragments), and almost not at all on using (1.5% of coded fragments) knowledge processes. At time points 1 and 2 she mainly referred to the procedural knowledge she was developing; that is, that her student innovatively conducted her research and thesis. She was enthusiastic about her student's research and recognized it as an example of 'good practice' for the work they were doing in the MEd program:

> I use her as an example so much! ... She really modeled this process of making research be collaborative and honoring students' voices in the process. There's kind of her goals with her research, her process with the research, but also just the format ... she made this beautiful website and it's a great resource for teachers.

RA1's enthusiasm grew toward the end of her student's research and after her graduation (times 3 and 4), RA1 reported on sharing knowledge related to the procedure as well as the content of

her student's research. At that time RA1 changed her approach from being a research advisor supporting her student in conducting her research to more of a 'connector' setting up connections and providing opportunities for her student to share her knowledge:

> I feel like I'm always trying to put people in contact with MS1… It's funny, even though they graduated and I don't see them all the time, I still see my role as supporting them in continuing to step up as leaders and share their work.

Unlike RA1, RA2's reports about the knowledge processes focused almost exclusively on developing (95.4% of coded fragments). In particular, at times 2 and 3 he referred to the development of procedural knowledge about supporting his struggling student in his research. At time 1 he was still confident that MS2 would do well:

> There are so many supports that it's hard to imagine someone emerging from this process with an inferior product or a product that doesn't mask muster.

However, at times 2 and 3 RA2 was puzzled that his student (MS2) did not respond well to his support and he gradually learned how he could change his approach in order for MS2 to complete his research:

> Somebody was saying, 'He was being a Dutch Uncle to me' and that meant being very stern and demanding. I wondered if I should've been like a Dutch uncle or more patient and understanding … I had to change the relationship a little bit.

RA2 concluded that in this particular case he had to change his role to that of a 'formal supervisor' who supported such a struggling student with firm deadlines and by demanding certain outcomes. RA2 felt that this procedural insight was the only knowledge he had developed based on MS2's research and, therefore, his reports on sharing knowledge remained scarce.

In comparing the experiences of both advisors we noticed that RA1 recognized more than RA2 the value of her student's knowledge for practice both in school and in GSE. This incited RA1 to change her role to that of a connector who supported the further sharing of MS1's knowledge, while RA2 felt he needed to change his role to that of formal supervisor for the sake of supporting his student in getting his research done so he could graduate.

Conclusion and Discussion

In this study we examined knowledge processes originating from MEd students' practice-oriented research in a school-university research network of a school-centered MEd program, which had an orientation toward collaboration and reciprocated relationships in research. Our analyses suggest four key findings:

1. *Network level.* After graduation, research advisors remained a part of the network in which knowledge processes took place in their MEd students' school, indicating that in a school-centered network where the teacher education institute is embedded in the school-environment research supervisors have a good opportunity to remain active members of the school network and support continuous knowledge processes before as well as after their master students' graduation.

2. *Dyad level.* Both student-supervisor relationships showed similar potential for supporting knowledge processes by providing access for students and supervisors to each other's personal networks in school and graduate school. The student-supervisor relationship that was predominantly collegial/equal and characterized by mutual trust and engagement tapped into this potential and fostered knowledge processes before as well as after the student's graduation. The student-supervisor relationship that focused on completing research in order to graduate appeared more formal/directive with lower levels of mutual trust and engagement. This relationship did not tap into the aforementioned potential and knowledge processes seemed to quickly stop in the network after the student's graduation.

3. *Individual level.* After graduation, MEd students appeared to increase their use of strong ties within their school for developing and sharing knowledge originating from their research with their school colleagues. However, if MEd students and research advisors did not perceive the developed knowledge as valuable to practice then further processes of knowledge sharing or using quickly stop;

4. *Individual level.* Over time both advisors changed their approach in supporting their MEd student; one advisor switched to the role of 'connector' in enhancing knowledge processes with respect to her student's research and the other advisor switched to the role of a 'formal supervisor' to support his struggling student in completing his research. In contrast to the first, the latter switch did not seem to contribute to continuing knowledge processes in the network.

Overall, we conclude that the school-centered network in the CMO's context provided both MEd students and research advisors with a supportive context for collaboratively engaging in knowledge processes. This network structure can foster knowledge processes in school and GSE during MEd students' research as well as after they are graduated. Although important, the study showed that such a supportive network context was in itself not enough to build sustainable and productive relationships in the partnership network. The way the knowledge

processes occurred also depended to a significant extent on the quality of the relationships between master's students and their research advisors, and their individual perceptions of the value of the developed knowledge for practice in school and/or university.

Sustainable School-University Research Networks

In response to McLaughlin and Black-Hawkins' (2004, 2007) observation that fundamental changes are necessary in partnership structures between schools and universities to support sustainable knowledge processes we suggested that two important dimensions of such change may be the: (1) structures: change from university-centered to school-centered, and (2) relationships: change from one-way to reciprocal (Figure 2). The unique CMO case provided us with a rich example and showed that such a type of school-university research network is promising, but will require a structural change in the way teacher education is offered by embedding the institute of teacher education in the school environment; moreover, it will require a change in relationships between schools and universities to become more equal, reciprocal and collaborative.

School-Centered Structure. In traditional university-centered programs the networks and knowledge processes between school and university often appear limited to the duration of the MEd program (LePage et al., 2001). After MEd students graduate the school-university connection between MEd students and their research supervisors is likely to dissolve and the distance between both organizations may become a gap again. Evidence from our network level analysis suggests that in the school-centered network of the CMO both research advisors remained part of the MEd student's school network in which knowledge processes took place after graduation. Moreover, outcomes indicated that graduate school staff deliberately provided ongoing opportunities for school staff to engage in knowledge processes. Although this finding might suggest that the school-centered network of this MEd program supports the sustainability of the network and its knowledge processes, our findings of the dyad and individual analysis

indicate that such sustainability also depends on the reciprocal relationships in research collaboration.

Reciprocal Relationships. In traditional master's programs, relationships in research collaboration between MEd students and research supervisors are mainly service-oriented with a low level of reciprocity; university staff mainly provides a 'service' to MEd students by providing them research support and training for obtaining a MEd degree (McLaughlin & Black-Hawkins, 2007). Results of the dyad and individual analysis in this study suggest that the relationship between MS1 and RA1 was reciprocal. Both considered the knowledge that MS1 had developed to be valuable for their practice, and their relationship seemed to be an ongoing two-way traffic of knowledge and support. In contrast, analysis suggests that over time the relationship between MS2 and RA2 became less reciprocal and knowledge processes quickly stopped. We consider this difference as an important observation, because it shows that creating a school-centered structure by embedding a GSE is not the single 'silver bullet' for enabling knowledge processes in the school-university research network. This difference that we found in the student-supervisor relationships indicates that in the teacher education context of such partnership network there can be an important tension between the hierarchical, more directive role of research supervisors who have to assess the research of their master's students and the collegial, more equal role of research supervisors who are engaging in reciprocal, partnership relationships of research collaboration with master's students and school staff (cf. Le Page et al., 2001). Although this tension seems inevitable during the MEd program, it might be relieved by creating transparency on roles, boundaries and assessments and be further diminished after master's students graduation when research supervisors can step out of their hierarchical role into a more equal role of collaboratively sharing and using valuable knowledge from students' research.

Limitation and Implications

This study had some limitations. For exploring the school network we used a bounded network approach that confined the network to the educators in the school of the Master's

students. We acknowledge that the knowledge processes network might have stretched beyond the boundaries of this particular school. We used a qualitative approach in which we focused on participants' perceptions of critical incidents to gain deeper insight in the complex knowledge processes on each network level. Although this approach provided us with rich data sources, we acknowledge that this focus also limited our data collection. Furthermore, the exploratory nature of this case study implies that generalization of the results will require follow-up studies. We would recommend researchers to use the distinction we made in possible school-university research networks in master's programs (Figure 2) for categorizing and studying other cases of school-university research networks.

This study has implications for the practice and design of teacher education programs. It draws attention to the important role of university staff in supporting ongoing knowledge processes in the school-university research network. In this approach university staff not only support MEd students in practice-oriented research—to develop knowledge for their own practice during the MEd program and graduate—but also in further sharing and using this knowledge after graduation. This will require another role and competences of the research supervisors, which are more directed to fostering knowledge processes and maintaining productive partnership relationships in MEd students' schools. Subsequently, it will also imply changes in the design of MEd programs that will allow research supervisors to fulfill such partnership roles and become more embedded in school communities.

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Tables

Tables

Table 1. Selected Participants

Participant	Age	Task in school or university	FTE[a]
Master's Student 1 (MS1)	29	Classroom teacher	1.0
Master's Student 2 (MS2)	27	Classroom teacher	1.0
Research Advisor 1 (RA1)[b]	34	Graduate School educator	1.0
Research Advisor 2 (RA2)[c]	68	Graduate School educator	1.0

Note. [a]FTE = Fulltime-equivalent. [b]RA1 is the advisor of MS1. [c]RA2 is the advisor of MS2.

Table 2. Examples of Critical Incidents, Log and Interview Questions

Knowledge process	Critical incidents	Log questions	Interview questions
Developing	Master's student discusses and revises the content of thesis with a critical friend.	- What happened? - When did it happen? - What was the occasion? - What did you develop, share or use? - What did you think? - What did you feel? - What did you do? - Who were involved? - What did others do? - What was the result?	- What happened exactly? - What was the purpose of the activities? - What did relationships look like during the activity? - In what way did people collaborate? - In what way were outcomes used to support processes in school? - In what way were people supported in developing, sharing, using knowledge?
Sharing	While visiting another teacher's classroom a research advisor talks about her master's students' research.		
Using	Master's student uses research outcomes to collaborate on developing a new project for classroom teaching.		

Table 3. Division of Coded Fragments

Fragments related to	Members	Relationships	Context of events	Total
Knowledge developing	21.4%	3.7%	10.5%	35.6%
Knowledge sharing	32.6%	7.2%	20.8%	60.6%
Knowledge using	2.7%	0.3%	0.8%	3.8%
Total	56.7%	11.2%	32.1%	100%

Figures

Figure 1. School-University Research Networks in the Context of a Master's Program

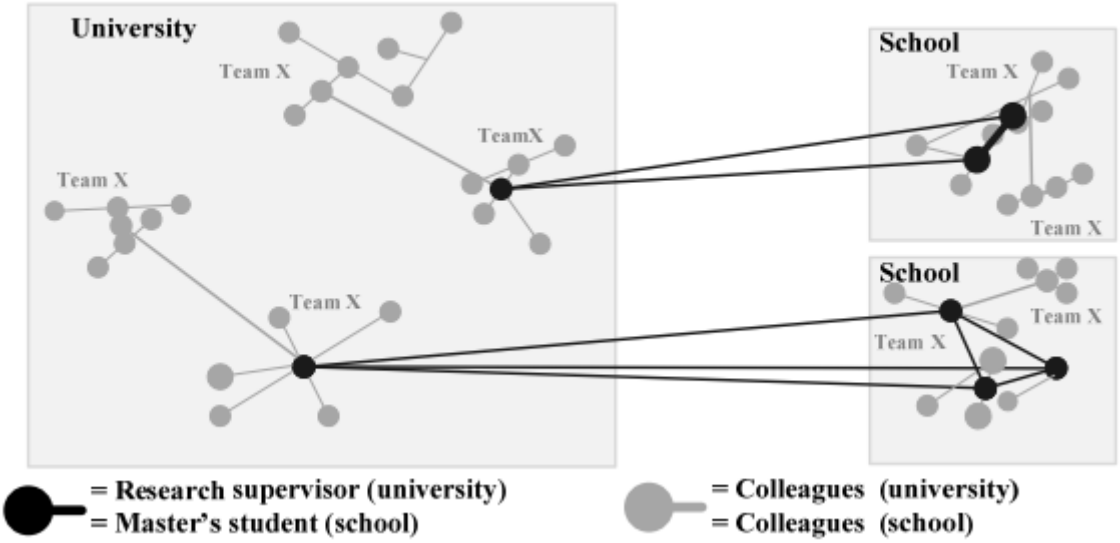


Figure 2. Representation of Possible School-University Research Networks in Master's Programs based on Dimensions of Proximity and Reciprocity

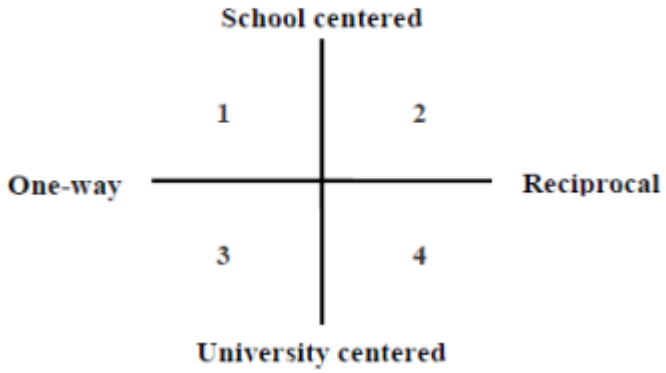


Figure 3. Data Collection Process

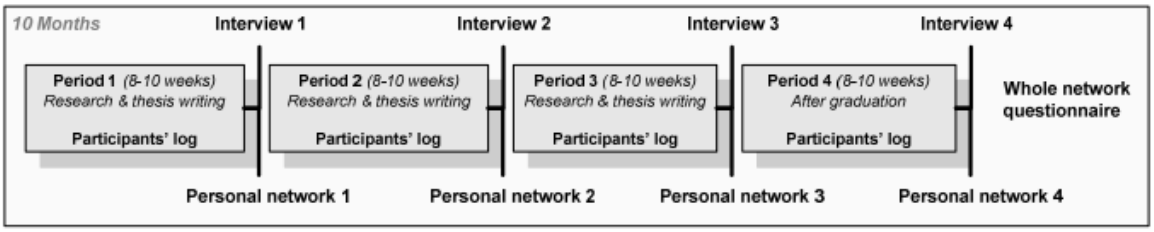
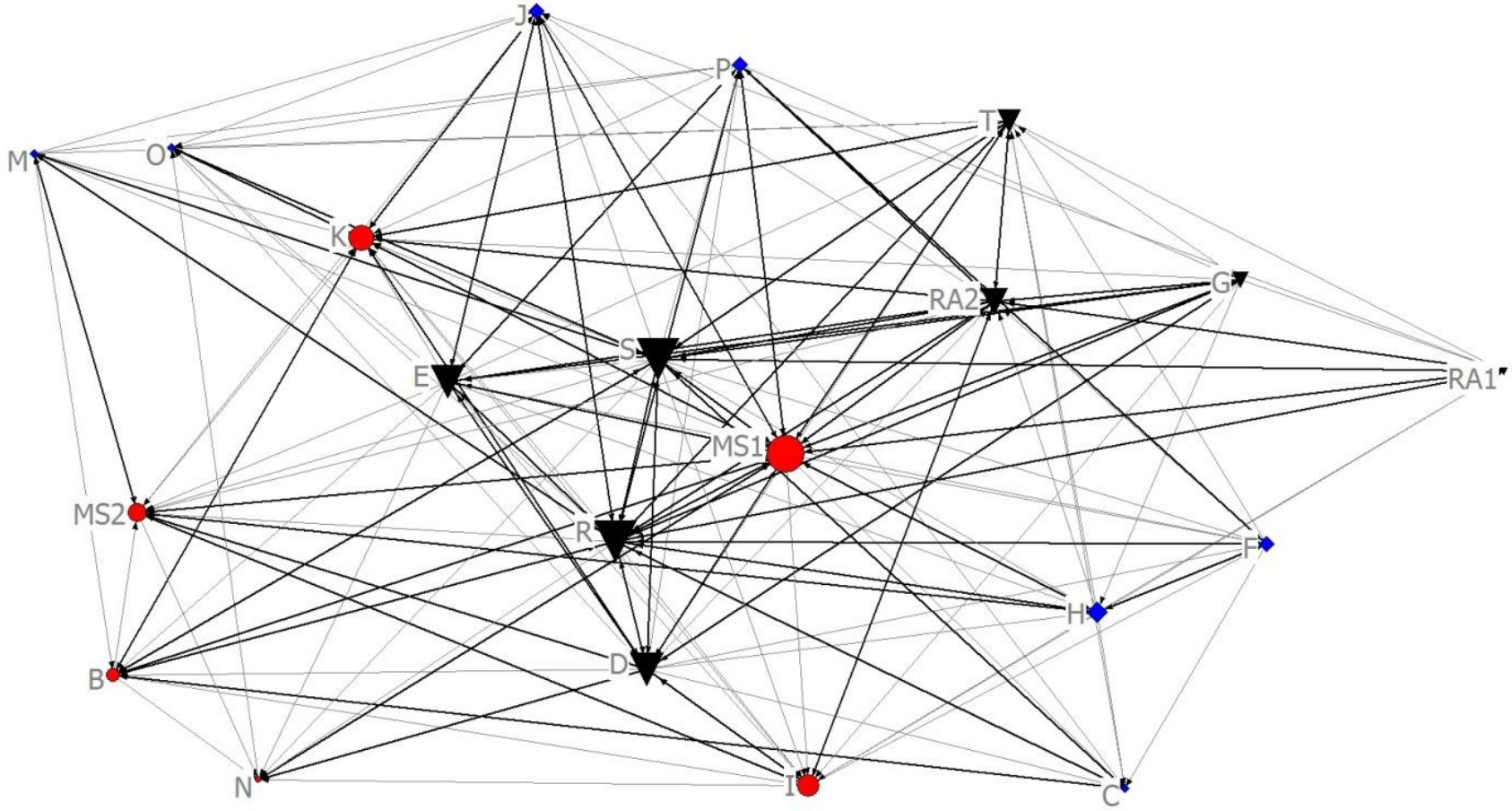
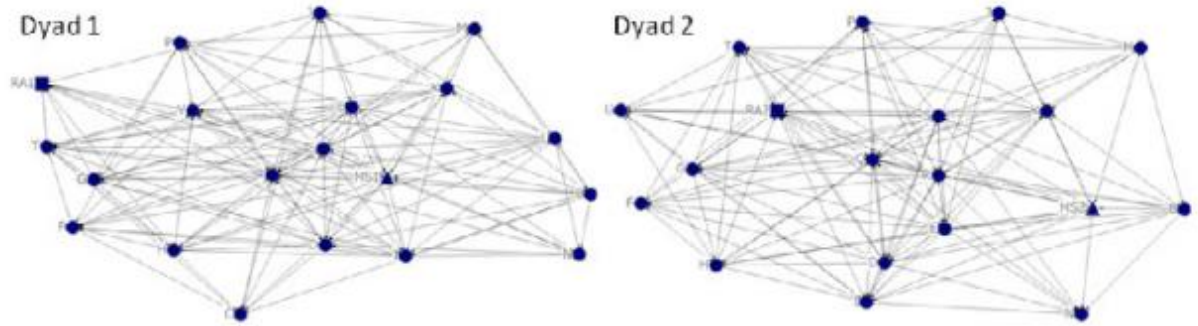


Figure 4. School Network in Knowledge Processes



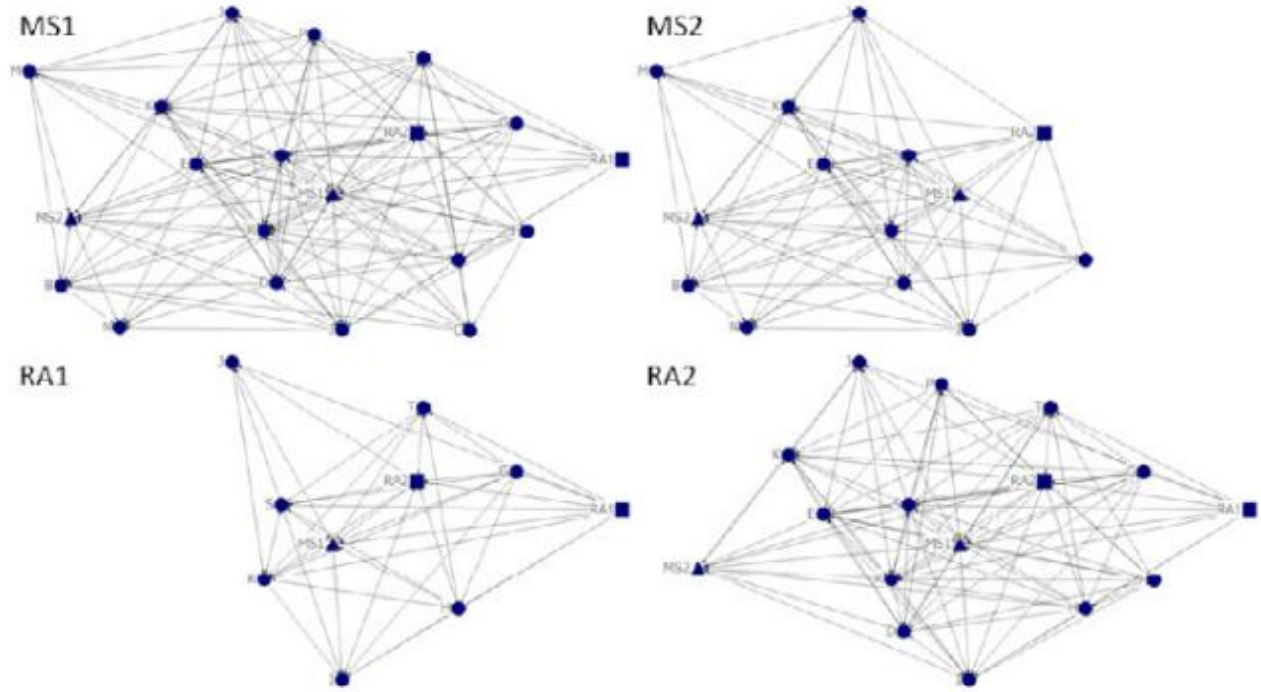
Note. Nodes are sized by degree centrality and shaped/colored by department (circle: Humanities; diamond: Math/Sciences; down triangle: other). Lines are sized by reciprocity (Reciprocal ties: thick/black lines; Non-reciprocal ties: thin/grey lines). MS1/MS2=Selected MEd students; RA1/RA2=Selected research advisors; Letters=Master's students' school colleagues.

Figure 5. Dyad Network in Knowledge Processes



Note. Dyad 1 refers to the combined ego network of MS1 and RA1; dyad 2 refers to the combined ego network of MS2 and RA2. Nodes are shaped by role: Up-triangle: Master's student; Square: Research advisor; Circle: Other.

Figure 6. Personal Networks in Knowledge Processes



Note. Nodes are shaped by role: Up-triangle: Master's student; Square: Research advisor; Circle: Other.

Figure 7. Strong Ties in Knowledge Process within School by Student

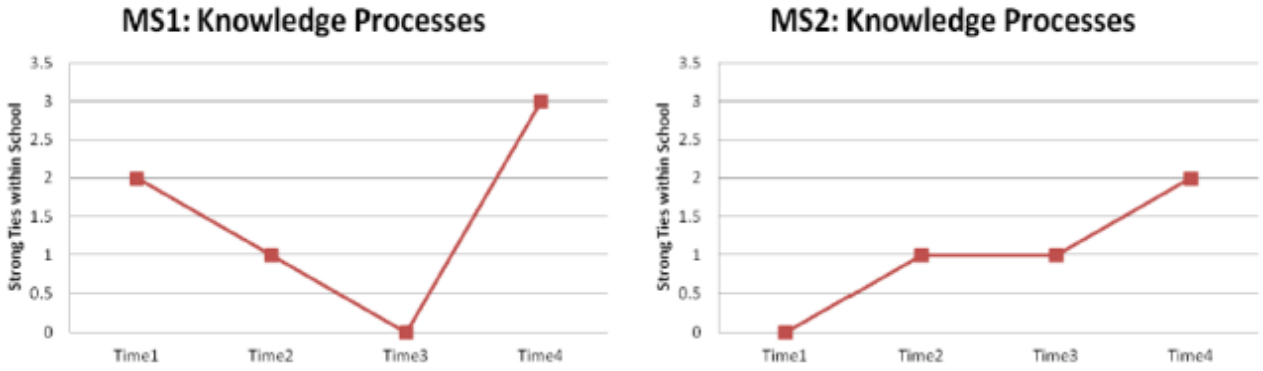


Figure 8. Strong Ties in Knowledge Process within Graduate School by Advisor