A SOCIAL NETWORK OF STUDENT-ATHLETES AND EDUCATIONAL OUTCOMES IN HIGH SCHOOL

By

Seunghyun Hwang

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ABSTRACT

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Athletic participation is the most popular school-sponsored extracurricular activity. Regarding the relationship between athletic participation and educational consequences, this study is focused on social networks of student athletes in high school. The purpose of this study was to examine the effect of peer network on educational outcome variables (Study I), to identify how student athletes construct their peer networks among student athletes in school (Study II), and to apply a measurement model in polytomous multilevel item response theory for psychometrical evaluation. Data were longitudinally collected from approximately 300 student athletes in a local high school in the beginning and end of Winter season. In Study I, results indicated that the same team-exposure (interactions with athletes on the same team) had a positive effect on college expectation and athletic identity, while the different team-exposure (interactions with athletes on teams other than one's own) positively influenced academic efficacy. Also some fixed effects of team-level predictors were found. Results of Study II indicated that student athletes were more likely to choose friends to interact with if they were same gender and had a same team membership and similar orientation for going a college. They also formed peer networks that are different (not similar) in grade level, academic achievement, and perception toward their coach. Lastly, multilevel rating scale was an appropriate measurement model for the five items measuring peer interaction in this study in order to estimate the latent depth of interaction, which is suggested to be used when modeling the effect of interaction. Altogether, this study implies that athletic participation is not detrimental to educational outcomes. Instead athletic participation ameliorates peer relationships in school, which is a form of social capital for students to achieve their goals for academic, social, and physical wellbeing in school and future aspirations.

Key words: student-athletes, athletic participation, education, social capital, social network analysis,

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Chapter I. STATEMENT OF PROBLEM AND OVERVIEW OF THIS DISSERTATION

Athletic participation in the U.S. is the most popular school-sponsored extracurricular activity (Eccles & Barber, 1999; Edie & Ronan, 2001). According to the annual high school athletics participation survey conducted by the National Federation of State High School Association, 55.5% of students enrolled in high schools participate in athletic programs, and this participation rate increased for the 22nd consecutive school year in 2010-11 (Howard, 2011). Due to the popularity of athletic programs in high school, educators, researchers, and policy-makers have extensively investigated the role of athletic programs in students' educational pursuits.

However, the relationship between athletic involvement and educational consequences has been controversial and complex (Eitle & Eitle, 2002). The theoretical debates have yielded both positive and negative effects of athletic participation. The positive effects include increasing academic motivation, school engagement, educational attainment, and psychological well-being (i.e., self-esteem), while the negative effects, some argue, include reduced times and focus for studying as distracters and induced likelihood to exposure to delinquent behaviors, such as drug use, smoke, and skipping school (Sokol-Katz, Kelley, Basinger-Fleischman, & Braddock, 2006). Along with the theoretical debates, empirical investigations have also produced inconsistent results. In an economical analysis, high school sports participation resulted in a 2% increase in standardized math and science test scores, and students-athletes were 5% more likely to aspire to college attendance on a national survey sample, controlling for other background factors, such as socio-economic status

(SES; Lipscomb, 2006). These positive effects of athletic involvement were replicated in several large-scale longitudinal studies (e.g., Barber, Eccles, & Stone, 2001; Eccles & Barber, 1999; Marsh & Kleitman, 2003; McNeal, 1995; Rees & Sabia, 2010; Snyder & Spreitzer, 1990). Despite positively oriented myths and empirical results, there are skepticisms surrounding this claim that such findings are an artifact of preexisting differences (Eitle & Eitle, 2002; Marsh, 1993; Otto, 1982). Eitle and Eitle (2002) asserted that the relationship between athletic participation in school and academic achievement depends on different social groups, such as type of sport and participants' ethnicity. Eide and Ronan (2001) found evidence that sports participation has a negative effect on the educational attainment of white male student athletes. And, participation in football and basketball was negatively associated with academic achievement (Eitle & Eitle 2002; Goldsmith, 2003, 2004). Those differences are due to social group, cultural capital, household educational resources, and perceived importance of playing high profile sports, such as football and basketball (Eitle & Eitle, 2002).

As such, studies on this controversial issue of athletic participation and educational outcomes have suggested that mediating or moderating variables, such as social factors (i.e., interpersonal relationships with peers, coaches, teachers, coaches and parents) may explain more about the relationship (Eitle & Eitle, 2002). There are many aspects of interpersonal relationship that positively influence educational outcomes. Perceived social and emotional support from peers has been related with motivational outcomes, such as the academic pursuit, pro-social goals, intrinsic value, and self-concept (Dubois, Felner, Brand, Adan, & Evans, 1992; Harter, 1996; Wentzel, 1994, 1998). Also, Cause, Connell, Spencer, & Aber (1994) and Wentzel (1998) found a positive association of parental support with perceived competence, academic effort, and interest in school. Perceived support from teachers has been related to pro-social behaviors, educational aspirations and values, intrinsic values, and self-concept (Goodenow, 1993; Hatter, 1996; Marjoribanks, 1985; Midgley, Feldlaufer, & Eccles, 1989; Wentzel, 1994, 1998). Hwang, Feltz, Kietzmann, and Diemer (in press) found that high school students' perceptions of the educational expectation of significant others such as parents, teachers, peers, and coaches predicted their educational expectations, which in turn, were predictive of later educational attainment.

Although the roles of parents and teachers in the social context of school have been widely emphasized in education (e.g., Berger & Riojas-Cortez 2011; Pellicer & Anderson, 1995; Pomerantz, Grolnick, & Price, 2005; Snook, Nohria, & Khurana, 2011), peer influence in education has received relatively less attention (Buckley, 2009; Ryan, 2000), the recognition of peer influence during adolescence has been increasing in the socialization process for their education. This may be due to the following reasons: (a) adolescents spend twice as much time with peers as with their family (Larson & Richards, 1991), (b) peers fulfill a developmental need that cannot be met by parents or other adults (Hartup, 1993), and (c) peers provide a source of companionship and help in school work (Wentzel, 2005).

To empirically support these claims, Hwang et al. (in press) found that peer support for academics led to higher academic identity, which, in turn, positively influenced educational expectation and attainment. Also, Buchmann and Dalton (2002) found the positive link between peers' influences and college aspiration. Likewise, longitudinal studies have shown the positive impact of peers on school adjustment, social competence, and academic achievement (Heaven, Ciarrochi, & Vialle, 2008; Wentzel & Caldwell, 1997). On the other hand, Scheider and Stevenson (1999) found that peers hold little influence on students' outcomes, such as educational aspiration. On the negative side, negative influences of peers have been reported for dropouts (Pittman, 1991) and anti-social behaviors, such as aggression, skipping class, being disruptive, and delinquency (Finn, 1989).

Previous research using the general high school student population has been explored based on data from nationally representative samples (i.e., National Education Longitudinal Study and National Center for Education Statistics). These have yielded more acceptable conclusions by longitudinal, multi-wave designs that relate effect of athletic participation and other social factors to a set of educational outcomes controlling for preexisting differences, such as background variables and previous status (e.g., Barber, Eccles, & Stone, 2001; Marsh & Kleitman, 2003; Snyder & Spreitzer, 1990), However, these studies were based on self-reported data and, specially for the effect of social relations with others, have used data based on students' perceptions of support from others (e.g., Wentzel, 1998).

The perceived reports may be subjective, and the studies may generate inflated correlations between respondents' and actual others' behavior (Ryan, 2001). To increase the validity of studies in a social context using actual report (i.e., indicating with whom I am interacting, and how often I am interacting with them) on their relations, a social network analysis can be used as a statistical model to quantify and evaluate the social relations. This sociometric data contains participants' reports on their interactions, such as specific names and amount of interaction, which is modeled to identify how to construct peer groups (i.e., peer selection), and examines the effect of their interaction (i.e., peer influence).

Few studies have been conducted using this frame of data analysis. For instance, Ryan (2001) used social network analysis to identify peer groups of adolescents in middle school and found changes of intrinsic motivation (i.e., enjoyment of school) in school. However, the nature and extent of peer relationships within an high school athletic teams may be different than described above because they form their own subcultures that are particularly defined by a team's norm and rule. Thus, it is probable to anticipate that peer interactions with team members can have different forms and effects on their academics, and that more adaptive interpersonal relationships with peers in an athletic team promotes better experience in academics as well as athletics in school.

In sum, this dissertation addresses the issues of social relation in the exploration of the role of peers for high school student athletes' academic outcomes through use of social network analysis. Applying a social network analysis helps enabling description and quantification of antecedents and consequences from peer networks. This peer group process has two phases, peer influence and peer selection (Frank, 1998; Kiuru, Aunola, Nurmi, Leskinen, & Salmela-Aro, 2008; Ryan, 2000, 2001). Students choose peers to interact with, which create a social context (i.e., athletic team) that exposes them to a set of their peers' thoughts, attitudes, and behavior. Within the group, they influence each other. Also, Moran and Weiss (2006) suggest these two dimensions of peer relationship should be examined together in sport.

Thus, Study I examined the effect of peers in athletic teams on outcome variables such as academic motivation, achievement, college aspiration, and identity. Study II identified how peers construct their patterns of relations based on variables such as academic/athletic ability and identities and demographics. Lastly, Study III tested if a network measure adapted in this dissertation is psychometrically sound, using Graded Responses Multi-Level Item Response Theory Model.

Considering various forms of peer interaction in school during adolescence, the following delimitations were applied to answer the above mentioned research questions:

1) This study focused only on peers in athletic teams (same and different teams), so other friendships formed with friends who were not enrolled in any athletic program was not included. Thus, the social context was the groups of student athletes in a high school.

2) An athletic team was defined as a sport team offered by a high school as an extracurricular activity, regardless level (i.e., varsity, Jr. varsity, and freshmen).

3) For peer network, only ego-centric data were utilized to model, in which egos were independent. Thus, dyadic relationships were not modeled.

4) Social interaction was delimited to the interaction regarding academics, athletics, social topics, and emotional supports within the group of student athletes.

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Chapter II: PEER INFLUENCE ON EDUCATIONAL OUTCOMES (STUDY I)

Introduction

Peer influence during adolescence is the more potent than the influence of parents and schools (Harris, 1995; Ryan, 2001; Schunk, 1987). Possible explanations offered are increased peer involvement (Brown, 1990; Brown & Theobald, 1999) and strong social identity to spend more time with their friends (Csikszentmihalyi, Larson, & Prescott, 1977). In this regard, peers are important as a socializing context. This dissertation proposes that an athletic team is a social context, in which team members are interacting with teammates not only for athletic development but also for educational development.

Peer influences, in general, can be negative during adolescence. Empirical research has demonstrated negative influences of peers on such anti-social behaviors as breaking rules (Aseltine, 1995; Haynie, 2001; Sieving, Perry, & Williams, 2000); delinquent behavior, such as drinking alcohol, smoking, and using illegal substances (Kobus, 2003; Urberg, Degirmencioglu, & Colleen, 1997; Urberg, Luo, Pilgrim, & Degirmencioglu, 2003); and development of psychopathology (Deater-Deckard, 2001). Of course, the positive role of peers has been emphasized in terms of positive development, particularly in school (Brown, 1990; Brown, Eicher, & Petrie, 1986; Wentzel, 1989, 1997). Likewise, the literature on adolescence has established that peer relations appear to play a significant role for educational experience among high school students, such as achievement, motivation, expectation, and aspiration (e.g., Cook, Deng, & Morgano, 2007; Gilman & Anderman, 2006; Liem & Martin, 2011; Ryan, 2001; Wentzel & Asher, 1995).

In the light of positive influence, close friendship has been shown to be positively related to academic motivation and performance (e.g., Altermatt & Pomerantz, 2003; Berndt, Hawkins, & Jiao, 1999; Crosnoe, Cavanagh, & Elder, 2003; Wentzel & Caldwell, 1997). Also, early work has shown that high school friends influence one's aspiration to attend college (e.g., Campbell & Alexander, 1965; Cohen, 1983; Hauser, 1972). However, Cohen (1983) argued that the effect of peer influence on college aspiration is smaller than these findings suggest because estimates have been inflated by the omission of a control (i.e., initial aspiration before building friendship), and then found a weak effect with a path coefficient less than .15, controlling for their initial status. More recently, Nurmi (2001, 2004) found that peer groups form a social context wherein they discuss their thoughts and plans about the future. For example, adolescents often discuss their future-related decisions with their peers. Peers are also an important source of future-related information among adolescents (Malmberg, 1996). Moreover, young people may model their peers' decisions concerning future education, particularly when they are uncertain of their own plans (Kiuru, Aunola, Vuori, & Nurmi, 2007).

In criticism of such correlational studies, Cook et al. (2007) emphasized the methodological problems of research on peer influences (i.e., sampling issues, causal claims, biased standard errors, and construct validity of peer groups). Using the cluster algorithm, a longitudinally collected data set, and controlled confounding variables, Cook et al. found peers' attributes, such as grade point average (GPA), affected individual school performance outcomes.

This effect of peer relationship on the optimal educational outcomes in a social context is well explained by social capital theory. Social capital is defined as 'resources' that actors may access through social ties (Bourdieu, 1986; Coleman 1988, 1990; Frank & Yasumoto, 1998). In school settings, it includes resources obtained through interaction with friends, parents, and teachers. For example, with a basis of social capital theory, social capital of well-educated parents (i.e., parent-child discussion and parental involvement in school) has shown a positive association with educational outcomes, such as GPA, achievement test scores, educational attainment, high school completion, and college enrollment (e.g., Carbonaro, 1998; Hao & Bonstead-Bruns, 1998; Sun 1998). Also, positive help has been found from social capital of peers (i.e., number of close friends) attending a same school and ties with peers on achievement score (e.g., Morgan & Sørensen, 1999; Sun, 1999).

Social capital theory highlights the importance of social networks, and illuminates specific mechanisms through which the social ties (i.e., friendship) developed in school may benefit educational outcomes. Recently, research on peer effect as a form of social capital in educational settings has been conducted at different levels of social context, such as community (Levine & Painter, 2008), school (Angrist & Lang, 2004), cohort (Carrell, Fullerton, & West, 2009), and the classroom (Burke & Sass, 2008; Lavy, Silva, & Weinhardt, 2009). However, none of research has been conducted in a group of student athletes in schools. In this respect, this study focuses on athletic teams, where students are nested in high schools, which may serve to create more social capital for students' educational outcomes by providing more time and opportunities for increased social ties among team members within their teams or other friends in different teams with same interest in participating in an athletic program.

Early research on peer relationships within the culture of high school sport, however, focused primarily on peer acceptance. That is, students who were good at sports were more likely to be accepted as friends (Smith, 2003; Weiss & Stuntz, 2004). In observational studies, perceived sport competence is important to peer relationships (e.g., Adler, Kless, & Adler, 1992; Buchanan, Blankenbaker, & Cotton, 1976; Holland & Andre, 1994; Kane, 1988. For example, Buchanan et al. asked 4^{th} grade through 6^{th} grade students to nominate who were the best students, the best athletes, and the most popular. For boys, being good at sports was most important for popularity, while girls reported good grades were more important for popularity than just being good at sports, but only by a small margin. Similar to the result of Buchanan et al.'s study, Chase and Dummer (1992) found that being good at sport was the most important, followed by physical appearance for boys, while girls indicated being pretty was the most important, and good grades were the second, followed by being good at sport. To reflect changes of these factors for popularity more recently, Chase and Machida (2011) replicated and compared their findings to the previous studies (i.e., Buchanan et al., 1976; Chase & Dummer, 1992). Chase and Machida found gender differences for popularity. The importance of sport for girls' popularity has not changed in 30 years, but has decreased for boys. In addition, the positive association of peer acceptance to physical skill was found with observational studies (Evans & Roberts, 1987; Farmer, Estell, Bishop, O'Neal, & Cairns, 2003), whereas, Hymel, Bowker, and Woody (1993) found that students who had low athletic skills were perceived by peers as unpopular and socially isolated.

In contrast, friendship in sport settings has been examined to see the impact within its social context. Weiss & Smith (1999) developed a self-report assessment of sport friendship quality in an attempt to account for the context-specific nature of friendship perceptions in sport settings. The six sub-scales of the Sport Friendship Quality Scale (SFOQ), validated by Weiss and Smith (2002), are self-esteem enhancement and supportiveness, loyalty and intimacy, things in common, companionship and pleasant play, conflict resolution, and conflict elements of sport friendships. These sub-scales distinguished youth perceptions of a best friend versus a third-best friend, suggesting that the measure is relatively sensitive to the quality of particular relationships. Using this scale, research on friendship has been examined in conjunction with motivation–related variables in youth sports. Higher friendship quality has been demonstrated to associate with more adaptive achievement goal orientations (Ommundsen, Roberts, Lemyre, & Miller, 2005; Smith, Balaguer, & Duda, 2006), greater perceived physical competence, lower sport stress, greater sport enjoyment, more self-determined motivation (Ullrich-French & Smith, 2006), and greater self-worth and stronger sport commitment (McDonough & Crocker, 2005).

However, due to the limitation of self-report that can only be interpreted as individual perception for friendship quality with a single best friend, a social network analysis has been suggested to study peer relationships in sport (Smith, 2003) by which we can quantitatively model the effect of multiple peer relationships (see exposure in Method). For instance, Smith et al. (2006) showed a positive correlation with task-goal orientation, and a negative correlation with ego-goal orientation based upon youth athletes' perceptions of friendship with a single best friend, which does not cover modeling the actual effect of friends in changing the goal orientation. Very few studies have adopted a social network analysis in sport settings. For example, Hwang, Machida, Feltz, and Frank (in press) studied the influence of peer interaction on sport-confidence and goal orientation in a youth soccer club. Hwang, Machida et al. concluded that peer interaction influenced changes in sport-confidence and achievement goal orientation. More specifically, the interaction among peers in the same age groups positively influenced the change in sport-confidence about cognitive efficiency and resiliency, and in task goal orientation, while ego goal orientation was positively affected by the interaction among peers in the different age groups.

For educational outcomes, however, no studies have been systematically conducted regarding the effect of social interaction among student athletes. However, the study of social ties within athletic teams has great potential to help understand the link between sport participation and educational pursuits because an athletic team is a type of social context, just like a school and classroom, in which student athletes build their social relationships. Although not directly relevant to the reciprocal relationship in a team, research has found that high school student athletes have identifications as a student and an athlete, but they develop their educational expectations through their student identity (Hwang, Feltz et al., in press). Also, there is a general argument that athletic identity leads to a stronger identity with one’s school and academic achievement objectives (Barber, Eccles, & Stone, 2001; Guest & Schneider, 2003).

In addition, peers in athletic teams have been found to develop tight bonds and sub-culture (Philips & Schafer, 1971; Schneider & Stevenson, 1999), which may lead to more social interaction for both athletic and educational aspirations. Also, peer influences among athletic team members may be greater than other friends in school because peers in a same athletic team have similar interests and goals (i.e., skill improvement), and participation in school athletic teams requires time commitment beyond a regular school curriculum, which may facilitate more frequent interaction with team members (Broh, 2002; McNeal, 1995). Due to the nature of athletic teams in high school, there is reason to investigate how effective the social interaction with team members is on their educational goals. The effect is hypothesized to be positive because of the followings set of possibilities: increased interest in school, the need to maintain good grades to stay eligible, increased attention from teachers and coaches, and interaction with educationally oriented peers (Snyder & Spreitzer, 1990).

In the studies of peer relationships in school, several methodological issues are involved. Social network analysis has been recently suggested in order to resolve the following issues (see Frank, 1998; Ryan, 2000, 2001 for a review). Firstly, many studies have relied on respondents' perceptions of their peers' characteristics rather than asking for peers' names and collecting the characteristics from the referred peers. Data based on students' perceptions may not be accurate and involves students' own projection onto peers although the use of the data is often justified by reasoning that what students think of peers is more influential than who peers actually are (Ryan, 2000). A social network analysis requires a network metrics that contains the referred peers' names and responses in order to quantify the relational information among peers, such as referred friends and their characteristics).

For socialization of peers (i.e., peers tend to become similar), early studies employed correlational techniques to assess similarity of peer groups for academic characteristics, such as GPA (Epstein, 1983), college aspirations (Cohen, 1983;

Epstein, 1983; Hallinan & Williams, 1990), time spent on homework (Cohen, 1977), and general engagement in schoolwork (Kindermann, 1993). However this correlational evidence does not warrant the conclusion that peers influence academic outcomes. Instead, it could be that the students select peers who are similar to them to begin with.

A social network analysis examines data longitudinally. Longitudinal data have a benefit over a single data collection. Longitudinal data can specify and estimate changes in individuals' beliefs as a function of the beliefs of others with whom they are interacting with in previous time periods (Frank, 1998; Friedkin & Marsden, 1994). Also, the individual's previous belief can be used as a covariate to control for the effect of his or her own previous belief (Time 1) on current belief (Time 2).

Regarding the issue of nested structure of data, Frank (1998) suggests a potential to integrate multilevel models and models of social network processes. Multilevel models enable partitioning of the variance of an outcome variable into individual level (i.e., athletes) and group level (i.e., team) components. By the multilevel models of network analysis, the researcher can characterize the extent of variation of an outcome variable within- and between- athletic teams, and specify and estimate effects of individual- and team-level characteristics, as well as the interaction of individual and team characteristics. In the light of methodological advancement, Ryan (2001) used a social network analysis in a multilevel model and found peer groups socialized some academic characteristics. That is, changes in achievement and intrinsic motivation (i.e., enjoyment of school) were predicted by peer group socialization over the school year.

The review of the methodological issues and characteristics of student athletes' groups suggest a statistical model, which includes the network metrics, longitudinal type of data, and two-level multilevel modeling (i.e., student and team levels). At the team level, coaches' attitude on academics as a predictor is added, along with the unique effect of the team, because team members share the team norm and culture, which affect team members differently across teams. A coach's regard on academics influences team culture and student athletes' identity as students (Feltz et al., 2013). At the student level, other external influences are specified and controlled beside the effect of peer interaction in teams. They include the perceived educational expectation of significant others, such as father, mother, and teacher as well as their previous status by a longitudinal data. Therefore, the purpose of Study I was to examine the effect of peers in athletic teams on educational and identity outcome variables, controlling for individual effects, group effects and coaches' direct effect on groups, using an integrated model of social network (influence model) in multilevel model.

Method

Participants and Procedures

Data were collected from a local high school in which approximately 500 students are enrolled, and 350 students play at least one sport for the school. The school has a total of 22 athletic teams regardless season. After getting approvals from the athletic director of the school and the University Committee on Research Involving Human Subjects (UCRIHS), a meeting with all student athletes was made in an auditorium for data collection. The data were collected longitudinally to examine the social interaction during a certain period and control the initial status on the outcome variables. The first data set was collected in the beginning of 12-13 Winter season (i.e., the first week of November), and the second data set was collected in the end of 12-13 Winter season (i.e., the fourth week of February). Participants were told that they would receive $5 by completing the two surveys. Two-hundred and ninety-one and 242 student athletes completed the first and second survey respectively. Table 2.1 shows participants' distribution on each team. This distribution is based only on the primary sports team reported by them regardless season (i.e., one belongs to one sport team). There were students who reported multiple sports in the two surveys (137 and 91 respectively).

Two-hundred and thirteen student athletes completed the both surveys, 79 and 29 completed only the first survey and second survey respectively. Three-hundred and twenty-one student athletes participated in at least one survey, among which 82.5% are White. The distributions of gender and school years are in Table 2.2.

Outcome Measures

The outcome measures included academic-related variables, such as academic achievement, academic efficacy, college aspiration, academic and athletic identities, and self-regard. These measures were chosen based on the literature review of the relationship among peers, sport participation and educational outcomes.

Academic Achievement: Grade point average (GPA) was derived from self-reports of the most recently earned overall grade. Cassady (2001) supported the use of self-reported GPA by showing a high correlation with official records, r = .88.

Academic Efficacy: Academic efficacy refers to students' judgments of their capability to complete their work successfully, and was measured using the Pattern of Adaptive Learning Scale (PALS: Midgley et al., 2000). Midgley et al. reported the internal consistency (α) was .78. Also, Bong (2001) tested the construct validity across subjects (i.e., English, math, science, and social studies) of this measure and yielded CFI=.96 and NNFI=.94 for high school students. The PALS consists of the five items with a five-point Likert scale (1 = *Not at all true*, 3 = *Somewhat true*, and 5 = *Very true*). Items are in Appendix.

College Aspiration/ Expectation: Two items from the National Longitudinal Study of Adolescent Health (Add Health) were used to measure college aspiration (‘*how much do you want to go to college?’*) and expectation (*‘how likely is it that you will go to college?’*) on a five-point Likert scale (1=*low* through 5=*high*). Aspiration reflects the degree to which students want to attend college while expectation reflects the degree to which students believe they will attend college. Aspiration is considered to be somewhat abstract, representing idealistic preferences for the future, whereas expectation is a more realistic self-assessment (Bohon, Johnson, & Gorman, 2006).

Academic and Athletic Identities. Athletic identity was measured by Athlete Identity Measurement Scale (AIM) (Brewer, Van Raalte, & Linder, 1993), which assesses the importance of the athlete role to the individual with two dimensions, strength and exclusiveness. AIM consists of 10 items with a 7-point Likert scale, raning from 1 (*strongly disagree*) to 7 (*strongly agree*). Brewer et al. (1993) reported an internal reliability for the AIMS of $\alpha = .83$. And, for academic identity, AIM was revised by changing athlete for student and academics for sport for one's academic identity. Items are in Appendix.

Self-regard. The sub-set of Self-Rating Scale (Fleming & Courtney, 1984) was adapted to measure their perception on physical appearance and ability because they were found to be factors in forming a higher level of social identity with a group (Tarrant, MacKenzie, & Hewitt, 2006). The Self-Rating scale originally consists of five dimensions: general self-regard, school abilities, social confidence, physical appearance, and physical abilities with 30 items. For this study, only 10 items for physical appearance and abilities were used with a 7-point Likert scale, ranging from 1(*almost never*) to 7 (*very often*). Fleming and Courney (1984) reported internal consistency (α=.92) and test-retest reliability (r=.84). Also, using principal component analysis, they confirmed the five factor solutions and selected 30 items, which factor loadings were above .40 to each dimensions. Bushman and Baumeister (1998) also reported .93 of internal consistency. Items are in Appendix.

Control Measures

Team Characteristic. Team characteristics were considered as predictors at Level 2 (Team-level) because it was hypothesized that peer interaction is formed based on team characteristics, which includes size, popularity, season, revenue generating, and traditions (state championship banner). For instance, interaction on a popular team is hypothesized to be more effective. These data were obtained from the athletic director of the school. Table 2.3 shows the team characteristics.

Group cohesion. Individual perception of group cohesion was measured to use and control group norms on team (i.e., highly cohesive vs less cohesive teams), using the Youth Sport Environment Questionnaire (YSEQ; Eys, Loughead, Bray, & Carron, 2009). The YSEQ is an 18-item questionnaire on a 9-point Likert scale ranging from 1 (strongly disagree) to 9 (strongly agree) that assesses task and social cohesion. However, two spurious negative items were not included in the survey. According to Eys et al. (2009), Task cohesion (8 items) is defined as an individual's perception about the closeness, bonding, and similarity around team's goal and task, while social cohesion (8 items) is around team as a social unit. In addition, task cohesion includes personal involvement with team's goal and task, while personal acceptance and social interaction with team are part of social cohesion. Eys et al. (2009) demonstrated content validity by focus group, open-ended questionnaires, and a literature review, and construct validity by principal component analysis and confirmatory factor analysis. Also, Bosselut, McLaren, Eys, and Heuze (2012) showed high internal consistency for both task (.94) and social (.95) cohesion. The task- and social-norm (i.e., average of each team both at Time 1 and Time 2) on each team are in Table 2.3.

Courses and Other Extracurricular Activities. Beside friends on an athletic team, friendship can be formed in various school activities, such as taking the same course, participating in the same club (e.g., art club), and belonging to the same academic organizations (e.g., Model UN) (Frank, Muller, & Muller, 2013), which need to be taken into account. Participants were asked to list courses that they were taking, and choose extracurricular activities in the list of extracurricular activities obtained from the National Longitudinal Study of Adolescent Health (Add Health): French Club, German Club, Latin Club, Spanish Club, Book Club, Computer Club, Debate team, Newspaper, Honor Society, Student Council, Yearbook, Drama club, band, Chorus or Choir, Orchestra. Beside sport participation, the numbers of shared activities, including extracurricular activities and courses between nominators and nominees at Time 1 ranged from 0 to 8 with a mean of 1.36 and a standard deviation of 1.72. The shared activities at Time 2 ranged from 0 to 6 with a mean of 1.19 and a standard deviation of 1.54.

Perceived Educational Expectations of Significant Others. In order to control the effect of significant others (i.e., parents, teachers and coaches) on educational outcomes, perceived educational expectations of significant others were measured by items from NELS-88: How far in school do your father, mother, teacher, and coach want you to go after high school? Response anchor follows as 1 = *get a job after high school*, 2= *enter a trade school*, 3 = *go to community college*, 4 = *go to four years college*, 5 = *go to graduate school*. The range of the means was from 4.12 to 4.37 with the range of standard deviation from .53 to .75 both at Time 1 and Time 2.

Coach's Regard on Academics. I measured the subjects' perception on their coaches' opinions of academic ability because coaches' attitude toward academics is pertinent to the norm and circumstance about academics in athletic teams of high school. In the team, the coach has a role to guide student-athletes for both academics and athletics (Gould, Chung, Smith, & White, 2006; Jackson & Beauchamp, 2010). Feltz et al. (2013) found that coach's attitude toward academics predicted perceived stereotype threat, and academic/ athletic identities of student athletes. An item from Feltz et al. (2013) was revised and used with a seven-point scale (1=*strongly disagree* through 7=*strongly agree*) as follows: My coach has a high opinion of my academic ability. For this study, the means were 5.58 (SD=1.35) and 5.11 (SD=1.64) at Time 1 and Time 2 respectively.

Social Network Measure

The network data were collected through a socio-metric instrument at the 1st (i.e., around the beginning of the 2012-2013 Winter season) and 2nd data collection (i.e., around the end of 2012-2013 Winter season), and measured as complete networks with each participant referring to friends on same and other teams when responding to a network item. Complete network analysis includes all interactions among actors within the student group who were participating in at least one sport in the school, which produces an actor-by-actor matrix of relational values. The interaction network item asks participants to rate how frequently they talk with each of the referred friends about general, academic, athletic, social, and emotional topics. Participants were asked to circle the appropriate number next to the five types of interaction on a 5-point rating scale, ranging from 1 (*Daily*) to 5 (*Monthly*). These values were reversely recoded in order to interpret higher values as more frequent interactions. Depending on the research questions, each frequency and the mean were used for the extent of relation between two actors. Table 2.4 and Table 2.5 include the descriptive statistics of friendship at Time 1 and Time 2, such as total number of ties, and average degree (i.e., total ties are divided by the total number of student athletes on each team). The total number of ties at Time 1 was 1,179, and 855 was the total number of ties at Time 2.

Data Analysis and Statistical Model

The influence model of a social network analysis was employed to examine the effect of social ties (i.e., network) on changes in the outcome variables over the fixed time frame. In basic analyses, the descriptive statistics and paired *t*-test were reported to see whether the changes of the outcome variables occurred between Time 1 and Time 2.

Exposure. For the influence model, exposure is defined as the degree of being exposed to others and their attributes, which can be quantitatively modeled as $(\sum_{i'=1, i\neq i'}^{n_{i'}} w_{ii'} y_{i't-1})/n_{i'}$ in order to estimate the effect of network on outcome variables. $w_{ii'}$ indicates extent of relation (i.e., frequency of interaction) between *i* (nominator) and *i'* (nominee), as perceived by *i* (i.e., a network metrics). $y_{i't-1}$ is nominee's previous attribute at Time 1. The sum of the relation is divided by $n_{i'}$, which is the number of *i'* (nominee) of *i* (nominator) for normative effect (i.e., mean) because every nominator has different number of nominees. This exposure is a variable of each nominator for the effect of interaction with friends nominated. This all exposure was divided into four exposures to separately account for exposures in a same (or different) team and shared activity: 1) exposure of friends in a same team with at least one shared activity, 2) exposure of friends in a same team with no other shared activities beside sport participation, 3) exposure of friends in different teams with at least one shared activity, 4) exposure of friends in different teams with no other shared activities beside sport participation.

Although the four different exposures were hypothesized to be identified, shared activity was not accounted for because of higher correlations between the exposures, which cause multicollinearity in multiple regression. For instance, correlation between Exposure 1 and Exposure 2 were .91, .73, .70, and .99 for academic achievement, academic efficacy, student identity, and physical appearance respectively. Correlation between Exposure 3 and Exposure 4 were .81, .79, .97, and .92 for college aspiration, college expectation, student identity, and physical ability. Instead only exposure in a same team and exposure in different team were considered for the analyses,

Influence Models. Two ordinarily least square (OLS) regressions were employed to examine the effect of the exposures with control variables as follows:

$$y_i = \beta_0 + \beta_1(\text{prior}_i) + \beta_2(\text{all exposure}_i) + \beta_3(\text{others' edu. expec.}_i)$$

$$+\beta_4 \mathrm{D}_{1i} + \cdots + \beta_{24}\mathrm{D}_{21i} + e_i$$

$$y_i = \beta_0 + \beta_1(\text{prior}_i) + \beta_{2-1}(\text{same team exposure}_i)$$

$$+\beta_{2-2}(\text{different team exposure}_i) + \beta_3(\text{others' edu. expec.}_i)$$

$$+\beta_4 \mathrm{D}_{1i} + \cdots + \beta_{24}\mathrm{D}_{21i} + e_i$$

The dependent variable (y_i) is a measure of an outcome for a person (*i*) at Time2. The β_0 is the intercept. β_1 is the effect of prior status of nominators on the outcome variables, which controls for a student's original status on the outcome variables. It allows us to examine a specific effect of exposures on changes over the fixed time (from Time1 to Time2), not confounded with the prior status of the outcome variables. β_2 is the effect of all exposures from all ties regardless of team membership. This all-exposure was separated into two exposures from ties in same teams (β_{2-1}) and ties from different teams (β_{2-2}). β_3 was set as a controlling variable (average of significant others' educational expectation at Time2). Also, to control team's variance (i.e., teams' different characteristics), 21 dummy variables (D_{1i}-D_{21i}) for specific team involvement were entered in the model, while the Boys and Girls bowling team set as a reference group (see Table 2.3 for the specific dummy variables).

Multilevel Influence Models. In order to account for team effect on changes in the outcome variables, random slope and intercept multilevel modeling was integrated with the influence model of a social network analysis. The extent of the exposures varies randomly across team (i.e., only same team exposure) because of the team characteristics, such as team size, popularity, season, revenue generating, and traditions (state championship banner), coach's regard for academics, and team's norm for task- and social-cohesion (e.g., this team is a more socially cohesive team). The teams' average of coach's regard and task- and social-cohesion were specified as predictors at the team level. The three multilevel influence models were as follows:

Model 1 (Unconditional models) was specified to examine the proportion of variance of the outcome variables explained by the team level variance.

Student Level: $y_{ij} = \beta_{0j} + e_{ij}$

Team Level: $\beta_{0j} = \gamma_{00} + \mu_{0j}$

Model 2 (Conditional models with level1-predictors) was specified to examine the effect of same team exposure with randomized intercepts and slopes at Team 2. Only the intercept, β_{0j}, and slopes, β_{2j}, at the student level were modeled with random effect, which are the μ_{0j} and μ_{2j}. The γ_{00} and γ_{20} indicate the fixed effects for the intercept and slopes of same team exposure.

Student Level:

$$y_{ij} = \beta_{0j} + \beta_1(\text{prior})_{ij} + \beta_{2j}(\text{same team exposure})_{ij}$$
$$+\beta_3(\text{different team exposure})_{ij} + e_{ij}$$

Team Level:

$$\beta_{0j} = \gamma_{00} + \mu_{0j}$$
$$\beta_{2j} = \gamma_{20} + \mu_{2j}$$

Model 3 (Conditional models with predictors at both levels) was specified to examine the fixed effects of intercept (γ_{00}), same team exposure (γ_{20}), team-level predictors (γ_{01}), and cross level interactions between same team exposure and team level-predictors (γ_{21}). The team-level predictors were P1 (team size), P2 (popularity), P3 (season), P4 (revenue), P5 (tradition), Q (coach's regard for academics), R (task-cohesion), and S (social-cohesion). Due to multicollinearity, each team-level predictor was entered in each model. The μ_{0j} and μ_{2j} are for the random effects of intercept and slope (same team exposure). The e_{ij} is the residual.

Student Level:

$$y_{ij} = \beta_{0j} + \beta_1(\text{prior})_{ij} + \beta_{2j}(\text{same team exposure})_{ij} \\ +\beta_3(\text{different team exposure})_{ij} + e_{ij}$$

Team Level:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{team} - \text{level predictor})_j + \mu_{0j}$$
$$\beta_{2j} = \gamma_{20} + \gamma_{21}(\text{team} - \text{level predictor})_j + \mu_{2j}$$

Results

Basic Statistics

Two-hundred and ninety-one and 242 student athletes in 22 athletic teams of one high school completed the first and second survey respectively (see Table 2.1 & 2.2 for the participants' distributions). Table 2.6 and Table 2.7 show the descriptive statistics and paired *t*-test result of the outcome variables. When subtracting Time 1 from Time2, academic achievement, academic efficacy, academic identity, and athletic identity were increased from Time 1 to Time 2, indicated by the negative signal (-), while college expectation/ aspiration and physical ability/ appearance were decreased with the positive signal (+). Among them, significant changes were found in college aspiration (.052), academic identity (-.122) physical ability (1.115), and appearance (.684). Specially, the mean differences of physical appearance and ability were almost 10 times less than the corresponding standard errors.

For the exposure, three different exposures were calculated, all-exposure, same team-exposure, and different team-exposure. The all-exposure is the mean of the product between relates (i.e., frequency of interaction with nominees) and nominees' attribute at Time 1 (i.e., values of outcome variables at Time 1). It was separately identified as same team-exposure (with same team members) and different team-exposure (with different team members). Table 2.8 shows the descriptive statistics of the exposures. The paired *t*-tests were conducted for the outcome variables to see the difference between same team-exposure and different team-exposure (Table 2.8). Except for athletic identity, same team-exposure was significantly higher than different team-exposure, which means that the student athletes were more exposed to friends in a same team. This exposure is the product of frequency of interaction and friends' attribute.

Basic Influence Models

To examine the effect of exposure (i.e., influence of social network) without considering variance at team level, two OLS regression models were tested, in which a mean of all types of interaction were used for the exposures. The first model included only all-exposure (β_2), while same (β_{2-1}) and different team-exposure (β_{2-2}) were included in the second model for each outcome variable (Table 2.9).

The prior status (β_1) was modeled to control its effect on the outcome variables at Time 2 in order to examine the effect of the exposures on changes of the outcome variables from Time 1 to Time 2. And, the 21 dummy variables were entered in the models to control team's variance. It makes a stronger claim on the effect of the exposures. Except for physical appearance, the prior statuses had significant effects on the outcome variables of Time 2. However, the physical appearance was significantly influenced by its all-exposure (.192). Also, the different-team exposure was a significant predictor (.124). The effect of all-exposures was not significant with respect to its effect on changes of the other outcome variables. For academic efficacy, a significant, positive effect of different team-exposure (.082) was found at .08 level ofα, which magnitude was about 9 times less than the effect of the prior (.69).

In sum, these results were made by the overall interaction (i.e., mean of five types of interaction). The overall interaction with friends positively affects the perception on physical appearance, which is mostly from interactions with friends in a different team. Also, the interaction with friends in a different team positively influenced change of their efficacious feeling on academics.

Table 2.10 shows the two OLS regression models with a specific type of interaction (c.f., Table 2.9). For instance, the exposure for academic identity was modeled only by a network question (i.e., How often do you interact with the referred friend on academic topics?), while a network question only on athletic topics was used for athletic identity.

Using a specific type of interaction for the exposures, the positive effects of all-exposure were significant on academic achievement (.062, $p<.05$), college aspiration (.094, $p<.05$), physical ability (.145, $p<.08$), and physical appearance (.20, $p<.01$), which were respectively 18, 6, and 1.5 times less than their prior status, except for physical appearance. In addition, the changes in academic achievement (.038) and physical appearance (.16) were positively influenced by different team-exposure.

In sum, using a specific type of interaction, I found somewhat different results than using an overall interaction as a mean of all type of interactions. Specifically, the specific interactions about academic or athletic topics with all referred friends, regardless team involvement, had positive influences on changes of academic achievement, college aspiration, and perceived physical ability and appearance. The interaction about academic or athletic topics with friends in different teams also had positive impact on the change of academic achievement and perceived physical appearance only.

Multilevel Influence Models

Multilevel modeling approaches were integrated into the basic influence models to partition the variance of the outcome variables into student-level and team-level variances (Model 1), and to examine the effects of student-level (Model 2) and team-level predictors (Model 3) onto the outcome variables.

The result of Model 1 (unconditional models) shows the intraclass correlation coefficient (ICC), which indicates the proportion of team-level variance, μ_{0j}^2 to the total variance, $\mu_{0j}^2 + e_{ij}^2$ (Table, 2. 11). A common rule of thumb is to model predictors (i.e., random slope) at Level-1 and Level-2 when ICC of the null model is greater than 0.05. Among the outcome variables, only academic achievement, athletic identity, and physical ability and appearance exceeded the criteria of .05, however, the conditional multilevel modeling (Model 2 & Model 3) was conducted for the all outcome variables to examine the effect of the exposures (i.e., fixed effects of group-level factors) after controlling for team-level variance.

In Model 2, predictors at student-level, such prior status and same team- and different team-exposure, were added with random intercept and slope to examine the fixed and random effects of the predictors. In Model 3, each predictor (i.e., characteristic of a team) at team-level was added separately into Model 2 to examine the fixed and random effects of the predictors at student- and team- level, and cross level interaction. The all-exposure was not included in the models because a specific team that a student and a referred friend belonged to could not be identified. A likelihood ratio test was conducted to test whether the effect of same team-exposure varied across team for each of the outcome variables. However, no significant effects were found for all of the outcome variables, which led to the decision not to interpret the random effects of teams on the intercept and slope of the linear relationship. The fixed effect of same team-exposure (γ_{20}), different team-exposure (β_3), predictor at team-level (γ_{01}), and its cross-level interaction (γ_{21}) were focused for the results of multilevel modeling (Model 2 and Model 3).

For academic achievement, the team size (-.004) negatively influenced academic achievement (Table 2.12a). After accounting for the task cohesion as the team level predictor, same team exposure was significant (-.136) and its cross-level interaction with task cohesion was also significant (.020) (Table 2.12g). These results indicated that the effect of same team-exposure negatively affected academic achievement, which was positively moderated by team's task cohesion.

For academic efficacy, participating in a winter season sport[1] had negative effect on the change of academic efficacy from Time 1 and Time 2 (-1.12), which was positively moderated by same team-exposure (.059) (Table 2.13c). Also, participating in a revenue generating sport had negative effect on academic efficacy (-.82) (Table 2.13d). These results indicated that participation in a revenue generating and winter season sport had negative effect on academic efficacy; however peer interactions in their team moderated the negative effect on academic efficacy.

College aspiration and expectation appeared to be positively related to different team-exposure. With exception of team size, after accounting for each team-level predictor (Table 2.14b-h), different team-exposure positively affected the change of the

[1] Data collected during the winter season. So participation in a winter season sport may mean the current season.

aspiration from Time 1 to Time 2 (.042~.047). For college expectation, the magnitudes of the positive effect of different team-exposure was .028, .026, and .030 after accounting for the team size, popularity, and coach's regard for academic respectively (Table 2.15a, b, f). These relationships were not found in Model 2 (Table 2.9 & 2.10).

While academic identity was significantly influenced by same team- and different team-exposure, none of significant relationships were shown in athletic identity. Same team-exposure negatively affected the change of academic identity from Time 1 to Time 2 after accounting for team size (-.059), winter season (-.041), revenue (-.047), task cohesion (-.38), In Table 2.16a-h, different team exposure positively affected the change of academic identity from Time 1 to Time 2 after accounting for each team-level predictors. The magnitude of the coefficient was from .031 to .038. Other fixed effects were not significant for academic identity. These results meant that interactions with same team members and friends in a different team were negative and positive sources of academic identity respectively.

Only when task cohesion was accounted for as a team-level predictor for physical ability (Table, 2.18g), same team-exposure at the individual level (-.85), and task cohesion at the team level (-.30) negatively affected the perception of physical ability while their cross-level interaction (.12) positively moderated the negative effect. This result meant that as interaction with team members in a team, which was more oriented to task, negatively influenced the perception of physical ability. None of the effects were significant for physical appearance (Table 2.19a-h).

In summary, there were significant fixed effects at both levels for the outcome variables, except for athletic identity and physical appearance. The same team-exposure had a negative effect on academic achievement and identity, and the perception of physical ability, while the different team-exposure positively influenced college aspiration and expectation, and academic identity. Among the team-level factors, team size was a negative factor for academic achievement; participating in a revenue generating sport of winter season was a negative factor for academic efficacy; task cohesion was a negative factor for physical ability. With respect to the moderating effect of team-level factors (i.e., cross level interaction), task cohesion of teams positively moderated the effect of same team-exposure on academic achievement. For academic efficacy, the cross level interaction between participating in winter season sports and same team-exposure was a positive factor. The negative effect of same team-exposure on physical ability was moderated by the cross-level interaction with task cohesion.

Discussion

Study I examined the effect of interaction with peers in groups of student athletes on educational outcomes using the influence model of social network analysis. The variables were collected longitudinally to provide greater rigor of the test of the effect of social interaction by controlling their initial status (Frank, 1998). The findings suggest that student athletes form peer relationships as part of participating in a sport in high school, which is influential on positively shaping educational outcomes.

Student athletes in high school formed social ties, not only with same team members, but also with other team members, regardless team membership. Overall they formed more social ties with other team members, except for the sideline cheerleading team (see Table 2.4 & 2.5. for same team-degree and different team-degree). This degree indicates the average number of friends in a same and different team. Due to more opportunities and time to make friendships among a larger pool of students in other structures of school, such as class, school bus, cafeteria etc., it makes sense that athletes make more friends with students who play different sports from their own. However, when considering they have less time and opportunities to form friendships within their own sport, the result for the sideline cheerleading team is interesting. They made more social ties within the team, which means that cheerleading creates a more socially bonded team. This result has concurrence with a study that used a mixed gender-dance program for one year in 23 classrooms of primary and secondary schools in Berlin, Germany (Zander, Kreutzmann, Mettke, & Hannover, in revision). Zander et al. found that the social ties for collaboration and sympathy increased over time after the dancing program. Because dance represents the performance part of cheerleading (Grindstaff & West, 2006), it is probable to infer the activities promote more socially bonded team culture by creating a clique within a team. This result is also consistent with the findings of Cohen (1977), and Urberg, Degirmencioglu, Tolson, and Halliday-Scher (1995) for peer network of adolescents, which reported that a larger percentage of female students' friendship list had a same social affiliation. This convergence may suggest that female students, who are involved in performing aesthetic physical activity, not like playing basketball on a female team, create a clique within a team. Also, the nature of the cheerleading team (i.e., cheer leading team mostly does not have the inter-team competitions) may play a role on this differences.

The focal hypothesis was on the effect of social interaction with peers in changing educational outcomes embedded in social capital theory. That is, peers in a social context of athletic participation were hypothesized as a form of social capital in school for their educational experience. I found that academic achievement, efficacy, and college aspiration were increased by the interaction with peers in athletic teams, which is a function of frequency of interaction and peers' attribute. For instance, as one interacts more frequently with peers who have a higher aspiration for going to college, one's own college aspiration is expected to increase when other factors are held constant.

With respect to the improvement of academic achievement through the function of peer interaction without considering the team-level factors (see Table 2.10), the finding reinforces the streamline of research on peer social capital and educational achievement (e.g., Angrist & Lang, 2004; Burke & Sass, 2008; Carrell, Fullerton, &

West, 2009; Lavy, Silva, & Weinhardt, 2009), which highlights the important role of peers in school. Unfortunately, the effect of peer interaction in a same team was not significant, but the specific interaction regarding academics with peers in different teams was a positive factor in improvement of academic achievement, which indicates that rather than being on a same team, athletes socialize more with peers on different teams regarding academic achievement. Despite the caution placed on interpretation (i.e., self-reported G.P.A.), this may show a mediating mechanism in the relationship between athletic participation and academic achievement, which has been investigated mostly for the direct positive relationship by correlation and regression (e.g., Marsh & Kleitman, 2003; Miller, Melnick, Barnes, Farrell, & Sabo, 2005; Rees & Sabia, 2010). However, in relation to the team-level factors, team size negatively influenced academic achievement, and participating in a revenue generating- and (or) winter season-sport[2] was a negative factor for academic efficacy.

With respect to increases of academic efficacy, the effect of overall interaction with peers in a different team was significantly positive (see Table 2.9). Similar to academic achievement (see Table 2.10), peers in different teams were more influential in shaping efficacious beliefs for schoolwork. Although no significant effect from peers in a same team was found, this result may extend the theory of modeling in self-efficacy by using social network analysis. Bandura (1986) theorized that observation of a model can strengthen or weaken the likelihood that the observer will adopt the model's belief in the future. The theory of modeling has been tested mostly by experiments as controlling and intervening a setting, in which an experimental group has a protocol for subjects to

[2] Winter sport may be interpreted as sport in season because the data collected during the winter season.

observe manipulated models with higher or lower levels of self-efficacy (e.g., Schunk, Hanson, & Cox, 1987; Schunk & Zimmerman, 1996). However, the generalization of the results from those experiments may have limitations for a random setting in school. Students not only observe, but also actually interact with peers in school. That is, the process of modeling a peer (i.e., observing), which is a source of development of self-efficacy, is a part of social interaction with a peer. Thus, it is probable to suggest social interaction, including modeling, is a source of students' sense of self-efficacy in academics. When interacting with a peer, the peer's attribute can be observed and simultaneously transmitted to an adolescent through interaction. The influence model of a social network analysis provides a quantitative insight for the transmission by social interaction, including modeling.

The limitations of this study guide future considerations. Firstly, this study did not include the general body of students that might be in the network. The network measure was limited to those who were enrolled in an athletic program. Thus the distinction could not be made between peers in athletic teams and those not in any athletic team. It is worthwhile to see the difference in the effect of peers from the two different groups due to the popularity of athletic participation in high school. The National Federation of State High School Association (NFHA) reported that more than 55.5 % of all high school students played sports during the 2010-2011 school year (Koebler, 2011).

Secondly, this study did not account for reciprocal relationship because the analysis used an ego-centric matrix, which cannot distinguish between reciprocal and one-directional relationship. The impact of reciprocal relationships may be stronger than one direction. In calculating 'exposure', adding an additional weight, such as quality of relationship, by asking how much the interaction with a referred friend is valuable (adaptable), or ranking the degree of closeness among referred friends, may be a good idea to more validly evaluate the impact of interaction.

Thirdly, it is common to see students playing more than one sport in high school. Unfortunately, this study did not statistically model students who were involved in multiple athletic teams. Only major one team that they referred was considered as their team-involvement; however there were 40% of samples, who reported they were involved with two or three athletic teams regardless season. Hypothetically, the social relationship is expected to be stronger if peers play two or more sports together, which leads a challenging question on how to statistically model the complex sociometrics.

Lastly, it is arguable that more competitive teams foster negative effects on academics. A valid quantification on competitiveness of teams as a team characteristic is needed to test the arguable statement

In light of the paucity of current studies on the influence of peers in athletic teams on educational achievement factors, this study fills an important gap for the relationship between athletic participation and educational experience in a school setting. This study provides another viewpoint on athletic programs in school, which can be a social context wherein students make social ties. The ties act as resources that student athletes may access and benefit education in different places, such as the classroom, as well as in gyms or fields, which is supported by Coleman (1988)'s argument that social capital developed in one environment can be applicable in another where both agents (i.e., peer network) exist.

Therefore, these results provide evidence that athletic participation promotes academic success through peer relationship in athletic teams. The effect is not huge given a short period time of this study, but it would be accumulative if they interacted for a long period time, when holding other variables are fixed, because the amount of interaction is a weight of exposure in the influence model. But in real settings, the effect may be saturated over time. So, the influence model requires a longitudinal design with multiple data collection points to see whether (or when) the effect is accumulative or saturated.

Moreover, the study provides indirect insight that athletic participation is not a negative determinant at least as a form of peer social capital, which is in conflict with a notion that athletic participation is a time-consuming activity that detracts from time spent on education (Eide & Ronan, 2001).

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Chapter III: PEER SELECTION IN ATHLETIC TEAMS (STUDY II)

Introduction

Research on peer relationships in adolescence has two phases: (a) peer influence (e.g., depicted in Study I) and (b) peer selection (i.e., how students construct their peer group) (Frank, 1998; Ryan, 2000, 2001). In peer selection, students choose peers to interact with in school based on their similar attributes (Frank & Fahrbach, 1999; Robins, Elliott, & Pattison, 2001; Ryan, 2001). This process is embodied in a social network analysis that governs why students choose to affiliate with particular peers, and how these interaction patterns influence their experience in school. However, no prior research has examined how student athletes construct their peer group by an analytical frame of social network analysis (i.e., selection model of social network analysis). Thus, it is worthwhile to investigate the process of peer selection in athletic teams for their academic success because student athletes spend more time with peers, who have the same interest in playing a sport, beyond a required school curriculum, and develop their own tight bonds and sub-cultures (Broh, 2002; McNeal, 1995; Philips & Schafer, 1971; Schneider & Stevenson, 1999). In this regard, in Study II, I investigated the function (or process) that governs why students select particular peers within a group of student athletes, as emphasizing the similarity of peers' attributes.

Research has documented that peer groups of adolescence exhibit similarity on personal attributes, and that adolescents are significantly similar to their friends with regard to behaviors, attributes, and personality (Gillford-Smith & Brownell, 2003). This tendency to affiliate with similar peers is called *homophily*, which refers to the tendency for people to have ties with people who are similar to themselves in socially significant ways. It is considered as the principle of the formation of personal relationships (Frank, Muller, & Muller, 2013).

Homophily of peer group in adolescence has been found in demographical attributes, such as gender and race, which affect the selective formation of social relationships (Lomi, Snijders, Steglich, & Torlo, 2011; Mollica, Gray, & Trevino, 2003; Moolenaar, 2010). Women tend to have more homophilious relationships than men (Frydenberg & Lewis, 1993; Mehra, Kilduff, & Brass, 1998), and both men and women were found to select men as their network to achieve their goals and acquire information (Aldrich, Reese, & Dubini, 1989). Also, African-Americans were more likely than whites to seek out racial homophily (Ibarra, 1993; Mollica et al., 2003). However, adolescents do not form their peer network only by these predetermined background characteristics (Frank et al., 2013).

Not only limited to background characteristics, homophilious relationships also have been found in various behavioral characteristics and personal attributes of adolescents. For example, homophily of peer group has been reported in smoking, drinking, and drug use (Cohenn, 1977; Ennett & Bauman, 1994; Urberg, Luo, Pilgrim, & Degirmncioglu, 2003; Urberg, Tolson, & Degirmencioglu, 1998). And, homophily in relation to academics in school has been found in academic achievement (Epstein, 1983), college aspirations (Epstein, 1983; Hallinan & Williams, 1990), time investment for homework (Cohen, 1977), and engagement in school (Kindermann, 1993). However, these studies addressed above were conducted by correlation analysis with cross-sectional data. Using a correlational approach, it is unclear to whether similarity is a result of peer selection or peer influence (Lomi et al., 2011; Ryan, 2000, 2001). That is, homophily involves a two-part process of peer relationship (i.e., peer selection and peer influence). Students in school could select peers because of similarity, which also could be the result of peer socialization. This ambiguity calls for a longitudinal design to predict changes in outcome variables, as controlling for the initial status, and selection process, which is considered fixed over the time interval (Frank, 1998; Ryan, 2000, 2001). For instance, using a longitudinal design, Lomi et al. (2011) found that students who have attained similar levels of academic performance are more likely to form social ties with each other, and also low performing students have a much higher tendency to choose other low-performing students as friends.

More specifically for these homophily, Frank et al. (2013) employed the selection model of social network analysis, and used the data from Adolescent Health and Academic Achievement (AHAA) and the National Longitudinal Study of Adolescent Health (Add Health) in order to study how adolescents form their peer group and which factors are associated with those friendship formations. For formation of new friends in high school, Frank et al. estimated the effect of the following independent variables: homophily (race, gender, parental education, age, GPA), structural constraints (grade level), micro friendship structures (mutual friends), shared activities (sports, academic, arts), course overlap (extent of course overlap), and local positions (membership in same local position). Frank et al. defined the clusters of students who took sets of courses together as local positions, which memberships are identified by an algorithm developed by Field, Frank, Schiller, Riegle-Crumb, and Muller (2006) for identifying non-overlapping clusters from affiliate networks. As the result, Frank et al. found local positions was the strongest predictors in the model, along with other significant predictors, such race, GPA, grade level, and number of mutual friends. Interestingly, the coefficient for common sports played was nearly zero, but they noted that for common extracurricular activities, such as, sport, academic, and arts, prior friendship (e.g., Wave I) was controlled to test the effect on changes from Time I and Time 2 in friendship, which might reduce coefficients (Frank et al, 2013).

Also, the research literature on peer acceptance provides insight regarding factors (similarity/ homophily) that predict the process of peer selection. Peer acceptance and selection have a common origin of peer network and conceptual overlap (Gifford-Smith & Brownell, 2003; Master & Furman, 1981). The complement to peer selection is peer acceptance. To be part of a peer group requires selecting peers and being accepted by peers. Peer acceptance (or sociometric popularity) refers to the general degree of liking by the peer group, which is usually measured by sociometric procedures. Students are given a list of the limited (or unlimited) number of randomly selected names of classmates, and for each name, they are asked to respond to the question, for instance "how much would you like (or dislike) to be in school activities with this person?" This assessment is used to create a continuum of social preference score ranging from well-accepted to rejected, or categories of sociometric status, such as popular, rejected, neglected, controversial, and average status (e.g., Bukowski, Pizzamiglio, Newcomb, & Hoza, 1996; de Bruyn & Cillessen, 2006; Lubbers, Van Der Werf, Kuyper, & Offringa, 2006; Wentzel, 1991; Wentzel & Erdley, 1993).

With this measurement, correlational studies have showed consistent results that popular students are more cooperative, helpful, and sociable, and demonstrate better leadership skills (Wentzel, 2005). Peer acceptance is also related to academic achievement; the popular status is positively related to successful academic achievement (i.e., standardized test score) and low level of acceptance to academic difficulty (Buhs & Ladd, 2001; Wentzel, 2005; Wentzel & Caldwell, 1997). Similarly, literature in sport supports the association of athletic ability and competency (which can be observable by peers in athletic teams) with popularity during adolescent years (e.g., Adler, Kless, & Adler, 1992; Buchanan, Blankenbaker, & Cotten, 1976; Vannatta, Gartstein, Zeller, & Noll, 2009; Weiss & Duncan, 1992). However, this sociometric methodology does not account for data dependency because the nominated individuals have an aggregated rating score (i.e., this is used as a popularity variable correlated with their personal attribute), which eliminates the dependent information on the nominated individuals (Wellman & Frank, 2000). That is, such an aggregated score cannot identify (or model) a specific score of a specific rater.

The nature of network data is not independent. The social ties can be formed either from *i* to *i’* or from *i’* to *i*. Such dependencies are accounted for in P_1 models of selection (Fienberg, Meyer, & Wasserman, 1985). However, this model specifies only the set of relationships among the dyad (i.e., direct relationship only between two) as the unit of analysis. It does not account for dependencies among pairs outside the dyad, for example, there may be multiple nominees (i'_{1-k}), but they may not indicate *i* as their network. A new estimation approach for theses conditioned models has been developed based on maximization of the pseudo-likelihood (Frank & Strauss, 1986; Strauss & Ikeda, 1990), which shows that estimates from a logit model can be used to obtain estimates while conditioning the relation between each pair of people on the relation between every other pair of people in the network (see Frank, 1998 for review). This approach enables us to model “whether two people are friends as a function of the number of friends they have in common, the number of friends of friends they have in common, and so forth.” (Frank, 1998, p. 195). Frank (1998) suggested this statistical model and procedure be used to establish whether given factors are linked to how individuals construct their social contexts (i.e., referring friends), and to differentiate among factors (i.e., multiple homophily) that affect how students construct their peer network by using a logistic regression.

In addition, the integration of multilevel models and the selection model of social network analysis has been suggested to characterize individual- and group- level characteristics, as well as the interaction of them (Frank, 1998). It seems reasonable to apply the multilevel framework into the selection model because nominators are nested in nominators. This integrated model enables us to account for the variance of nominators’ characteristics onto the effect of homophily in constructing peer networks.

Friendship forms within social constraints created by structural institutes (i.e., school, classroom, athletic team, etc.), in which adolescents have opportunities to choose their social interaction (Frank et al., 2013; Zeng & Xie, 2008). Research on peer selection has been conducted almost exclusively in school; however no prior study has focused on groups of student athletes, in which they may select peers to engage in relationship for their academic success given the similarity of peers in athletic groups in school. By reviewing literatures on homophily and peer acceptance among students in high school, it was hypothesized that characteristics of high school student athletes affect forming friendship in their teams. Therefore, the purpose of Study II was to examine the homophily effect of the academic and athletic characteristics of student athletes (i.e., academic achievement, academic efficacy, college aspiration/ expectation, academic/athletic identity, perception of physical appearance/ ability, and attitude toward their team), their demographics (i.e., gender, race, and grade level), and effect of shared other activities and course overlap to select peers to interact with in groups of student athletes in school for their academic success. Further, the network data are ego-centric in which an ego (nominator) is a focus of analysis to be accounted for in terms of how an ego chooses alters (nominees). The data do not include a dyadic network. Thus, ties are independently nested in an ego. By specifying the conditional variance at two levels (i.e., tie and ego) using a random intercept multilevel model, the effects of the predictors in peer selection were evaluated by odd ratio of logistic regression.

Method

Participants and Procedures

Data were collected from a local high school in which approximately 500 students are enrolled, and 350 students play at least one sport for the school. The school has a total of 22 athletic teams regardless season. After getting approvals from the athletic director of the school and the University Committee on Research Involving Human Subjects (UCRIHS), the meeting with all student athletes was made in an auditorium for data collection. The data were collected longitudinally to examine the social interaction during a certain period and control the initial status on the outcome variables. The first data set was collected in the beginning of 12-13 Winter season (i.e., the first week of November), and the second data set was collected in the end of 12-13 Winter season (i.e., the fourth week of February). Participants were told that they would receive $5 by completing the two surveys. Two-hundred and ninety-one and 242 student athletes completed the first and second survey respectively. Table 2.1 shows participants' distribution on each team. This distribution is based only on the primary sports team reported by them regardless of season (i.e., one belongs to one sport team). There were students who reported multiple sports in the two surveys (137 and 91 respectively).

Two-hundred and thirteen student athletes completed the both surveys, 79 and 29 completed only the first survey and second survey respectively. Three-hundred and twenty-one student athletes participated in at least one survey, among which 82.5% are White. The distributions of gender and school years are in Table 2.2.

Dependent Variable

Our dependent variable was dichotomous from the network data at Time 2, taking a value of 1 if nominator (*i*) indicates nominee (*i'*) as a friend in the group of athletes, 0 otherwise in ego-central network for all pairs between nominators and nominees. Only ego-centric data were treated because reciprocity is difficult to interpret (Frank et al., 2013). The all-possible pairs are 47,525, in which 745 were tied (i.e., coded as 1) at Time 2.

Independent Variables

Demographic Information: Gender, race, team, and grade level, were collected. These are the predetermined factors of peer relationship (Frank et al., 2013). These variables are dichotomous, taking a value of 1 if pairs were same in this demographic information, 0 otherwise. Among pairs, about 38 %, 10%, and 53% were same gender, team, and race, respectively.

Prior Network at Time 1. This dummy variable (1= tied and 0= not tied at Time 1) was used for the first selection model as a predictor, while for the second selection model, I conditioned our samples by selecting only those who did not have a friendship at Time 1, using this variable, which enables to model how predictors affect forming new friendships over the time frame (Frank et al., 2013). The number of ties at Time 1 was 1,025. About 2% of all pairs in Time 2 were identifies as the prior friendship.

Courses and Other Extracurricular Activities. Friendship can be formed in various school activities, such as same course taking, art club, and academic clubs (Frank et al., 2013), which need to be set as predictors of friendship. Participants were asked to list courses that they were taking, and choose extracurricular activities in the list of extracurricular activities obtained from the National Longitudinal Study of Adolescent Health (Add Health): French Club, German Club, Latin Club, Spanish Club, Book Club, Computer Club, Debate team, Newspaper, Honor Society, Student Council, Yearbook, Drama club, band, Chorus or Choir, Orchestra. Beside athletic team enrollment, the numbers of shared extracurricular activities and overlapped courses were set as predictors. The means of the number of shared extra activities and overlapped courses were 14. 80 (SD=1.12) and 3.78 (SD=2.69).

Similarity in Attributes. The absolute value of the difference in attributes Time 1 between all pairs was used to represent similarity of between pairs for their attributes. The attributes included grade level, academic achievement/ efficacy, college aspiration/ expectation, academic/ athletic identity, perception of coach's regard for academics, physical appearance/ ability, and task/ social cohesion. The descriptions on the measures for the abovementioned variables are in Chapter 2. The descriptive statistics of the similarity are in Table 3.1. The larger value indicates less similar attributes between pairs.

Data Analysis and Statistical Model

Basic (Single level) Selection Models. The selection model of a social network analysis was employed to examine how to construct the peer network of student athletes in high school. It is based on logistic regression in which the dependent variable is dichotomous (tie: 1 or 0). Also, the dependent variables described above were entered in the following model. $w_{ii't1 \rightarrow t2}$ represents the presence of a social tie at Time 2 between nominator (*i*) and nominee (*i'*), and π_{0-19} indicate the effects of the independent variables to forming the ties. For instance, the larger coefficient of similar grade level (π_5), the more we would infer that similar grade level affects forming peer networks. In addition, the prior network (π_1) was removed to model the tendency of forming new networks in the second (single level) model, as removing Time 1 networks in Time 2 network.

$$\log\left(\frac{p[w_{ii't1\rightarrow t2}=1]}{1-p[w_{ii't1\rightarrow t2}=1]}\right)=\pi_0+\pi_1\text{prior networks}_{ii't1}$$
$$+\pi_2\text{same gender}_{ii't1}+\pi_3\text{same team}_{ii't1}+\pi_4\text{same race}_{ii't1}$$
$$+\pi_5-\left|\text{grade}_{it1}-\text{grade}_{i't1}\right|$$
$$+\pi_6-\left|\text{academic acheivement}_{it1}-\text{academic acheivement}_{i't1}\right|$$
$$+\pi_7-\left|\text{aspiration}_{it1}-\text{aspiration}_{i't1}\right|$$
$$+\pi_8-\left|\text{expectation}_{it1}-\text{expectation}_{i't1}\right|$$
$$+\pi_9-\left|\text{coach regard}_{it1}-\text{coach regard}_{i't1}\right|$$
$$+\pi_{10}-\left|\text{others}'\text{edu. expe.}_{it1}-\text{others}'\text{edu. expe.}_{i't1}\right|$$
$$+\pi_{11}-\left|\text{academic efficacy}_{it1}-\text{academic efficacy}_{i't1}\right|$$
$$+\pi_{12}-\left|\text{athletic identity}_{it1}-\text{athletic identity}_{i't1}\right|$$
$$+\pi_{13}-\left|\text{academic idenity}_{it1}-\text{academic identity}_{i't1}\right|$$
$$+\pi_{14}-\left|\text{physical appearance}_{it1}-\text{physical appearance}_{i't1}\right|$$
$$+\pi_{15}-\left|\text{physical ability}_{it1}-\text{physical ability}_{i't1}\right|$$
$$+\pi_{16}-\left|\text{task cohesion}_{it1}-\text{task cohesion}_{i't1}\right|$$

$$+\pi_{17} - \left|\text{social cohesion}_{it1} - \text{social cohesion}_{i^{'}t1}\right|$$

$$+\pi_{18}\text{number of shared activity}_{ii^{'}t1\rightarrow t2}$$

$$+\pi_{18}\text{number of course overlap}_{ii^{'}t1\rightarrow t2}$$

Multilevel Selection Model. To account for nominators' characteristic, which cannot be modeled with the single-level model, a multilevel modeling (i.e., ties are nested in nominators) was applied into the selection model described above. Model 1 (Null Model) was specified as follows without any predictors and Model 2 was specified with Level-1 predictors with random intercept. Finally, the characteristics of nominators were added in Model 2 for Model 3 as follows:

At tie level:

$$\log\left(\frac{p\left[w_{ii^{'}t1\rightarrow t2} = 1\right]}{1 - p\left[w_{ii^{'}t1\rightarrow t2} = 1\right]}\right) = \pi_{0i} + \pi_{1i}\text{prior networks}_{ii^{'}t1}$$

$$+\pi_{2i}\text{same gender}_{ii^{'}t1} + \pi_{3i}\text{same team}_{ii^{'}t1} + \pi_{4i}\text{same race}_{ii^{'}t1}$$

$$+\pi_{5i} - \left|\text{grade}_{it1} - \text{grade}_{i^{'}t1}\right|$$

$$+\pi_{6i}$$

$$- \left|\text{academic acheivement}_{it1} - \text{academic acheivement}_{i^{'}t1}\right|$$

$$+\pi_{7i} - \left|\text{aspiration}_{it1} - \text{aspiration}_{i^{'}t1}\right|$$

$$+\pi_{8i} - \left|\text{expectation}_{it1} - \text{expectation}_{i^{'}t1}\right|$$

$$+\pi_{9i} - \left|\text{coach regard}_{it1} - \text{coach regard}_{i^{'}t1}\right|$$

$$+\pi_{10i} - \left|\text{others}^{'}\text{edu. expe.}_{it1} - \text{others}^{'}\text{edu. expe.}_{i^{'}t1}\right|$$

$$+\pi_{11i} - \left|\text{academic efficacy}_{it1} - \text{academic efficacy}_{i^{'}t1}\right|$$

$$+\pi_{12i} - \left|\text{athletic identity}_{it1} - \text{athletic identity}_{i^{'}t1}\right|$$

$$+\pi_{13i} - \left|\text{academic idenity}_{it1} - \text{academic identity}_{i^{'}t1}\right|$$

$$+\pi_{14i} - \left|\text{physical appearance}_{it1} - \text{physical appearance}_{i^{'}t1}\right|$$

$$+\pi_{15i} - \left|\text{physical ability}_{it1} - \text{physical ability}_{i^{'}t1}\right|$$

$$+\pi_{16i} - \left|\text{task cohesion}_{it1} - \text{task cohesion}_{i^{'}t1}\right|$$

$$+\pi_{17i} - \left|\text{social cohesion}_{it1} - \text{social cohesion}_{i^{'}t1}\right|$$

$$+\pi_{18i}\text{number of shared activity}_{ii^{'}t1\to t2}$$

$$+\pi_{19i}\text{number of course overlap}_{ii^{'}t1\to t2}$$

At ego level:

$$\pi_{0i} = \beta_{00} + \beta_2\text{gender}_i + \beta_5\text{grade}_i\ \beta_6\text{academic achievement}_i$$

$$+ \beta_7\text{aspiration}_i + \beta_8\text{expectation}_i + \beta_9\text{coach regard}_i$$

$$+ \beta_{10}\text{others educational expectation}_i + \beta_{11}\text{academic efficacy}_i$$

$$+ \beta_{12}\text{athletic identity}_i + \beta_{13}\text{academic identity}_i$$

$$+ \beta_{14}\text{physical appearance}_i + \beta_{15}\text{physical ability}_i$$

$$+ \beta_{16}\text{task cohesion}_i$$

At the tie level, $w_{ii^{'}t1\to t2}$ represents whether *i* and *i'* talked over the time interval, from Time 1 (t1) to Time 2 (t2), which can be transformed the logit model. The dependent variable (i.e., the log odds) expresses for the probability to select peers to interact with. π_{0i} represents an intercept and π_{1i} is the effect of the prior network at Time 1. π_{2i-17i} represent the homophily effects of variables of interest, where students choose peers in relations with similar attributes, which include, as variables of interests in the model, gender, team, race, grade level, academic achievement (GPA), college aspiration and expectation, perception on coach's regard for academics, others' educational expectation, academic efficacy, athletic and student identities, physical appearance and ability, and task- and social-cohesion. For example, academic acheivement_{it1} represents the academic achievement of *i* at Time 1 and academic $\text{acheivement}_{i't1}$ is the academic achievement of *i'* at Time 1. Also, π_{18i} and π_{19i} represent the effects of the number of shared activities and course overlap between *i* and *i'* over the period time.

At ego level (*i*), β_{00} is the average intercept across egos, and μ_{0i} is the unique increment or decrement to the intercept (random intercept). β_2, and β_5 through β_{17} are the fixed effect of nominators' characteristics.

Results

Basic Selection Models

The two basic selection models were used to test how students' demographics and attributes affect forming friendships. It is based on a logistic regression with a dichotomous dependent variable (i.e., 1=tied and 0=not tied) along with independent variables (e.g., same demographics and similar attributes) at Time1.

The result of the first selection model is presented in Table 3. 2. The significant predictors (i.e., more than twice standard error) for forming peer networks among student athletes in a high school were the prior friendship, same gender, same team, similarity in grade level, academic achievement, college aspiration, perception of coach's regard on academics, athletic identity, perception of physical appearance, and number of shared extra activities.

The X-standardized coefficients show the relative importance of Xs. Similarity in grade level was the strongest factor of friendship formation. The coefficient of 3.97 indicates that as a 1 standard deviation increases in similarity of grade level at Time 1, 3.97 increase in the log odds of getting tied at Time 2. The next stronger predictors were same gender (1.55), and prior network (1.48). Similarity in academic achievement (1.25), same team (1.22), and similarity in perception of coach's regard for academics (1.20) were also stronger predictors. Relatively speaking, similarity in athletic identity (.86), college aspiration (.81), and number of shared extra activities (.79) showed smaller effects on forming friendships. Interestingly, race and number of courses overlapped were not significant factors to be tied among student athletes.

To model forming new friendship over the fixed time frame between Time 1 and Time 2, the prior 492 ties at Time 1 were removed in the data. Only 492 were tied and coded as 1 in the dependent variable.

The result was similar to the first model. Similarity in grade level is the most influential to form new friendships. The coefficient of 5.48 indicates that as a 1 standard deviation increases in similarity of grade level, 5.48 increase in the log odds of getting new ties during the time frame. Same gender (1.63), same team (1.25), similar in academic achievement (1.33), college aspiration (.82), athletic identity (.82), and the number of shared extra activities (.79) were significant predictors to form new friendships.

Compared to the first selection model, same race changed to a significant factor, while similarity in physical appearance became a non-significant factor, which indicates that same race (e.g., cultural background and similar origins) is more influential in making a new friend during the short period (i.e., 4 months) than their perception of physical appearance. Having a similar level of perception of their own physical appearance is affective for continuing their relationship rather than making a new friend in athletic groups in a high school.

In summary, student athletes in a high school form and keep their friendships by structural components of high school (grade level, athletic team, and extra activities), demographics (gender and race), and other attributes (academic achievement, athletic identity, and college aspiration).

Multilevel Selection Model

The results of Model 1, 2, and 3 are shown in Table 3.4. ICCs (intraclass correlation) of the Models are .05, .11, and .04, respectively. 5% of the total variance in the propensity to become a tie (y) is attributable to unobservable nominator's characteristics (Model 1). The added predictors at tie-level led to increases in Level-2 variance, resulting in 11% of the between-variance to the total variance. The Level-2 variance in Model 3 decreased with Level-2 predictors (i.e., nominators' characteristics), which has 4% of the between-variance in the total variance. The log likelihood for Model 1, 2, and 3 are -3276.8581, -1045.3852, and -1027.90, respectively. Model 2 and Model 3 showed a huge difference, however, a likelihood ratio (LR) test was performed for the model comparison between Model 2 and Model 3 as follows: LR = 2(-1027.90 - -1045.38) = 36.96 on 14 of *d.f.*, $p<.05$. The LR test indicates Model 3 is more parsimonious to interpret the parameters of the fixed effects of Level 1 and 2, which enables us to make a claim that the effect of similarity is not associated with the characteristics of nominators. That is, it is possible to interpret the effect of homophily regardless the characteristics of nominator. A single-level selection model uses a score of similarity between a nominator and a nominee for a characteristic, but cannot model a characteristic of nominators (e.g., a nominator is higher and the other nominator is lower).

The result of Model 3 (Table 3.4) can be compared to the single-level selection model (Table 3.2) in order to see the changes after accounting for nominators' characteristics. First, gender (1=male and 2=female) and grade level were significant factors at Level-2, which means that students upper-level grades and females tend to make more ties. Among Level-1 predictors, prior network, and same demographics (i.e., gender, and team) were consistently positive predictors. However, the direction of the effect from similarity in grade level, academic achievement, aspiration, and coach's regard were changed from negative to positive for aspiration, and from positive to negative for the others. Also, their change of the direction occurred in Model 2. In addition, the effects of race, college expectation, academic efficacy, athletic identity, physical appearance, and shared activities changed to non-significant effects in Model 3.

As the result of Model 3, in holding constant of nominator's characteristics, the effect of prior network (4.05) and same gender (.87) and team (.44) in demographics were positively significant to become a tie, which indicates that the chances to become social ties are greater if athletes are same gender, and play the same sport. Among the other characteristics, the similarity in grade level (-1.47), academic achievement (-.70), coach's regard (-.22) was negative, which indicates that as the chances are greater for social ties as the similarities are smaller. However, the chances for social ties are greater if the similarity in aspiration is larger.

In summary, while accounting for nominators' characteristics, student athletes in high school tend to choose friends to interact with when they are same gender, and have similar orientation for going a college. They also form friends who are different (not similar) in grade level, academic achievement, and perception toward their coach.

Discussion

Based on the selection model of social network analysis, the aim of Study II was to explore factors for student athletes to select peers on the basis of homophily, which assumed that similarity between peers plays a role in forming a peer network in given a time period. The sociometric data (i.e., referring a friend) were measured both at Time 1 and Time 2 over the winter season, which was a dependent variable in the selection model (i.e., logistic regression). The findings were based on selecting new friends (forming new networks) given the time period since the peer networks at Time1 was controlled and removed.

Homophily theories suggested that “similarities between adolescents and their friends are due to youths’ initial tendencies to affiliate with friends who already possess similar behavioral proclivities and like-minded attitudes (i.e., selection effects).” (Brechwald & Prinstein, 2011, p. 166). This study provided clear evidence of homophily effect in selecting peers among student athletes, for example, gender, team involvement, college aspiration, and number of shared other activities were positive predictors (see Model 3 in Table 3.4), which means student athletes seek similar friends in terms of gender, team membership, college aspiration, and seeking same other activities. Among them, gender showed the strongest homophilious effect, while aspiration, other activity, and same team involvement relatively showed in order of the effect. This result is consistent with the previous research that has documented that adolescents are similar to their peers in behaviors, attributes, and demographic background.

However, unexpectedly, the present findings showed that student athletes also seek friends who are not similar in grade level and academic achievement. This result contrasts with a general agreement on tendency to choose similar peers to interact with (Kiesner, Kerr, & Stattin, 2004), and the recent empirical studies using the analytical frame of a social network analysis. Frank et al., (2013) used a national longitudinal data, and showed similarities in grade level and academic performance were strong predictors of friendship formation. Also, Lomi et al. (2011) found that students who have attained similar levels of academic performance are more likely to form social ties with each other, especially for lower performing students. Perhaps because athletic teams consist of athletes from multiple grade levels and are not formed along academic performance lines, athletes are more comfortable in seeking friends outside their own grade level and academic performance category.

Moreover, the present study also did not provide evidence for importance of same race in selecting new peers; rather, processes of social selection among student athletes operate across race. Racial homophily has consistently been found as a significant contributor to the development of social networks (McPherson, Smith-Lovin, & Cook, 2001; Shurm, Cheek, & Hunter, 1988). Frank et al. (2013) also found racial homophily as a strong factor in peer selection in school with empirical data. That is, adolescents are more likely to form friends with peers who have the same ethnicity background, however, I found student athletes also develop peer relationships across race, which shows a positive benefit of athletic participation with respect to cross-racial friendships. Kawabata and Crick (2008) showed cross-racial friendships were associated with positive development in a school setting, such as social adjustment (i.e., relational inclusion and leadership). Also they found that European American students displayed a higher frequency of cross-racial/ethnic friendships than African American children, and Latino children exhibited a lower frequency of these friendships. Abound, Levy, and Oskamp (2000) contented that cross-racial friendships may be optimal dyads for cooperation, emotional security, and intimate exchange in school. In this sense, it may be possible to regard athletic participation as a school activity, beyond a classroom setting, that increases chances to make cross-racial friendships.

The discrepancy between this study and the major features of research on homophily effect on developing peer relationships is probably the result of the characteristic of my samples. This study sampled only student athletes, who were limited to select peers only among student athletes in the survey. These results may limit generalizing to the whole body of students, but they may show different characteristics of a specific group (i.e., student athletes) in terms of developing peer relationships within a system of athletic programs. This unique finding about 'wider range' of peer relationship of student athletes, not limited to seeking homophilious relationship, provides insight for the development of peer relationship and athletic participation during adolescence. One possible theoretical explanation is that athletic programs offered by schools constitute a social context (Smith, 2003), and establish a structural constraint (i.e., being in a same place, such as gyms), in which student athletes explore new friends with similar interest and preference (Frank et al., 2013). In this regard, Smith (2003) suggested a term 'sport social context' that may foster positive social relationship and developmental outcomes of youths.

There are some limitations with respect to analysis and interpretation. First, only independent similarity between a pair of samples in attributes and demographics was considered as the bases of analysis. So, the dynamics of interpersonal relationships need to be further considered in forming new peer networks. For instance, we may make a new friendship via our prior networks, in which homophily is dependent on our prior networks. Second, dyadic relationship was not accounted for in this study. However, it would be interesting to compare factors to predict bi-directional and single-directional relationships, which can be addressed by adding a variable for the reciprocal relationship and further controlling for nominee's characteristics. Finally, the team-level characteristics were not accounted for in this study, which suggests a future study regarding the dynamics of peer relationship within a specific group, such as an athletic team. Multilevel modeling with three levels (i.e., individuals < clique < team) enables us to investigate why someone selects a specific team member to interact with for a certain purpose, such social or task in a team.

Although there are some limitations, this study shows the process of forming peer networks among student athletes, which contributes to the groundwork regarding the association between athletic participation and development of peer relationships. A context where adolescents participate in physical activity may enhance the quality of peer relationship (Smith, 2003). In attempt to better understand peer relationships in physical activity contexts, the application of the selection model of a social network analysis used in this study will be a useful model in terms of the process of peer selection as Smith (2003) suggested.

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Chapter IV: THE PSYCHOMETRICAL EVALUATION OF STUDENT INTERACTION (DEPTH OF INTERACTION) MEASURES – APPLICATION OF GRADED RESPONSE MULTILEVEL ITEM RESPONSE THEORY (STUDY III)

Introduction

Student interaction in school has been indicated as a key component of the educational process which as been studied under *Social Capital Theory*, however, it is difficult to find a clear and precise definition of student interaction (Anderson, 2003). Social capital is defined as resources that individuals may access and accumulate through social interactions (Coleman, 1988, 1990; Frank & Yasumoto, 1998). In this regard, peer is a type of relation that may provide resources that can be applied to educational outcomes.

More specifically, Bourdieu (1985) described social capital as the aggregate of actual and potential resources that an individual has access to through social ties. Generally, there are two components, structure (embeddedness) and available resources (contents) of social capital (Vanhoutte & Hooghe, 2009). Also, Lin (2001) made a distinction between the *access* through network and the action-related *use* of social capital. Access refers to an individual's collection of potential resources, while use refers to actions. That is, social ties are channels for information and resources flow within embedded structures with respect to social capital. This suggests research should focus on the resources available through social relations (i.e., information or material exchange; Coleman, 1990). In measuring peer social capital, for example, what do student discuss with their peers and ask for within their school social network.

Since there are a large number of different definitions and descriptions of social capital in a given social context, and general standardized direct measures do not exist, various types of measures (or indicators) have been used previously in social science, economics, and business (Vanhoutte & Hooghe, 2009). First of all, attitudinal measures of social capital, within socialization, social support, and trust, have been used as manifestation of social capital in its own way. King and Furrow (2004) defined a three-dimensional model of social capital, social interaction, trust, and shared vision, using structural equation modeling, using attitudinal measures, such as Parent and Peer Trust subscales from the Inventory for Parent and Peer Attachment (e.g., my parent trust my judgment; Armsden & Greenberg, 1987), Family-Shield Shared Activity Scale (e.g., how often do you do something active together like playing sports?; Furstenberg et al., 1999), and a subscale of the American Institutes for Researcher's Community Assessment Instrument (e.g., many of my personal values are shared by my parents/friends/ other adults in the community; Royal & Rossi, 1996). Particularly in school settings, self-reported questionnaires have been used, which provide general information about students' evaluations of group interaction (e.g., whether students find explanations to be understandable or helpful) (Webb, 1982). Rugutt and Chemosit (2009) assessed attitudes about student-student relations, using the following 6 items: 1) I make friendships with other students. 2) I know other students. 3) I do favors for members of this class. 4) Students help me with my learning. 5) I help other class members who are having trouble with their work. 6) In this class, I am able to depend on other students for help. This attitudinal component of social capital is generally measured by a questionnaire indicating the degree to which one believes people are trustworthy in general. These questions ask subjective feelings about individuals' general attitude toward social relationship, and have seldom been tested in relation under specific social ties (Vanhoutte & Hooghe, 2009).

In addition to measuring attitude, social capital of students has been measured by a variety of indicators in education, such as number of siblings, parental education, parental involvement in school, parent-child discussion, etc. in family, and participation in religious and sporting activities, number of school changes, and number of organizations belonged to, etc, in community (e.g., Hao & Bonstead-Burns, 1998; Israel, Beauliew, & Hartless, 2001; McNeal, 1999; Muller & Ellison, 2001; Smith-Maddoz, 1999; Sun, 1999). However, Stanton-Salazar (2001) suggested that these conventional measures (e.g., number of parents, parent-child discussion, etc.) are poor and unreliable indicators of social capital, and they give little information about dynamics of relationships or quality of the interaction. This type of measures also cannot be tested under specific social ties.

Measures of social capital showed draw on network analysis that has been developed to measure aspects of social relations. The method of 'Name Generator' (McCallister & Fischer, 1978) has been used, which requires identifying names with whom an individual interacts, for example 'With whom do you talk about your personal matters?' Such measures can be used for egocentric analysis (Van der Gaag & Snigiders, 2005) or extended to include indicators, such as size, intensity (i.e., frequency of contacts), diversity of network (i.e., number of friends who have different characteristics), and density (Vanhoutte & Hooghe, 2009). But these extensions focus only on the structural part of social capital. Also, Lin, Fu, and Sung (2001) have developed ‘Position Generator’ as a measurement technique for social capital with a list of job related resources. This method measures access through network members to occupation, seen as representing social resource collections based on job prestige. Range of accessed prestige, highest accessed prestige, and number of different positions accessed are indicators of the social capital. However, it does not contain specific information of their social structure (i.e., names of their networks). These methods have referred only to social structure of their relationship, not the actual resources that may become available through their social network.

With emphasis on resources, Van der Gaag and Snigiders, (2005) developed ‘Resource Generator’, which asks about access to a fixed list of resources, each representing collection of social capital in several domains of general life. Van der Gaag and Snigiders defined social capital as latent traits using IRT analysis. Resource Generator has a list of resources that question the availability of each of these resources checked by measuring the tie through which the resources are accessed, indicated by the role of these ties (family members, friends, or acquaintances). The questions begin with a stem ‘Do you know anyone who…’ followed by a list of resources, such as ‘can help when moving house’, ‘can give advice on matters of law’, ‘can repair a car’, etc.

In light of identifying and analyzing specific ties, social network analysis can be one to quantify the flow of resources through social ties. For instance, Frank, Muller, and Muller (2013) analyzed friendship nomination from sociometric data because they have the potential to convey resources, and found that nomination were affected by common course takings, homophily (e.g., race, age, GPA, etc.), and a structural constraint (e.g., grade level). The sociometric data only provides dichotomous information only about ‘quantity (i.e., 1 or 0) of the interaction with whom one endorsed’, such as who his/her friends are (i.e., network ties), or how often they interact regarding a certain matter (i.e., quantity of their interaction). This limited information suggests the following questions: ‘what topic do students talk with their social ties?’, ‘what resources (or contents) actually flow through social ties for students in school?’, and ‘which ties have more deep interaction?’

Although teachers’ social capital is not the focus of this study, studies by Penuel, Riel, Krause, and Frank (2009), and Sun (2011) inform us on how to measure flows through social relations within network theory. Penuel et al. used a social network analysis, combined with qualitative data, to analyze structure and resources of teachers’ interactions as social capital; Sun (2011) applied Rasch based-multilevel item response theory (Kamata, 2001; Kamata, Bauer, Miyazaki, 2008) to estimate the psychometric properties of interaction among teachers who responded to a social network survey based on dichotomous items (yes or no) with respect to instructional tasks (e.g., doing mathematics problems together, discussing students’ work, sharing instructional materials, and so on.). Also, Sun estimated the depth of interaction (i.e., a latent trait of item response theory), and discussed the possibility of use of polytomous items, such as the partial credit model (PCM) and rating scale model (RSM).

Similar to Sun, this study investigated the potential use of multilevel Rasch based-PCM and RSM (Bacci & Caviezel, 2011) to evaluate a measurement for social interaction used in Study I, and further estimated the depth of interaction, defined as the propensity of endorsing collaborative relationships regarding academic, athletic, social, and emotional interactions. The depth of interaction is the latent trait estimated by the measurement model, which indicates the likelihood to be connected to friends, and is a form of social capital based on Lin (2001)'s definition of social capital. The estimated depth of interaction indicates individuals' propensity with respect to being connected to peers, and higher propensity indicates higher potential to carry resource through social ties.

A combined model from Multilevel Modeling and IRT is useful when the effects of multilevel covariate on a latent trait need to be estimated. A combined model allows us to analyze covariates at the different levels that affect the latent trait; it yields a more accurate standard error estimate (Maier, 2001). Also, the total variance of the latent trait is decomposed into level-specific variance of a latent trait (Fox, 2005). For example, items are nested in students, which are nested in schools. Personal characteristics (e.g., concentrating skill on exams) at student-level, and types of schools (e.g., public or private) at school-level are related to the person ability.

Several kinds of multilevel structure of IRT have been proposed. For dichotomous response data, Kamata (2001) proposed the multilevel formulation of Rasch model as a hierarchical generalized linear model. Maier (2001) defined a Rasch model with a hierarchical model imposed on the person parameters but without additional covariates. Also, Fox and Glas (2001, 2003) used a normal ogive model to estimate two item parameters in multilevel structure, with covariates on both levels. For dichotomous response data, Maier (2002) developed the partial credit hierarchical measurement model with Gibbs sampling and used the Netropolis-Hastings algorithm to estimate the parameters of the model. Natesan, Limbers, and Varni (2010) defined graded response multilevel model, using cumulative logit model. Also Bacci and Caviezel (2011) demonstrated the multilevel 2PL-partial credit model, partial credit, and rating scale model with empirical data.

Due to the nested structure of network data (i.e., items are nested in ties within nominators), it is logical to adopt the analytical frame of multilevel IRT onto network data to diagnose the psychometrical quality of the instrument used to collect empirical data for social network of students. Specifically, Sun (2011) addressed benefits of use of multilevel IRT in network data. First, it can estimate latent traits at different levels simultaneously, such as the depth of student interaction between a pair at tie-level, and the extent to which a student is embedded in the network at ego-level. Second, it can accommodate dependencies in the nested structure. Responses at item-levels are dependent (i.e., items are correlated within a tie) on ties, which are also dependent on egos (nominators), but they are conditionally independent across ties and egos. Third, it can proportion the total variance and covariance into separate components at the item-, tie-, and ego-levels, which helps more accurate estimation for standard error. Lastly, the measurement model can be combined with predictors and covariates at any level to increase the power of analysis (Sun 2011).

Therefore, the purpose of Study III was to conduct a psychometrical evaluation for the social interaction measure in Study I using multilevel item response theory, and to estimate the latent trait, which is defined as the depth of interaction. For the application (i.e., external validity) of the latent score estimated by a measurement model, which represents the depth of interaction between nominators and nominee, the influence model (Study I) was used to investigate the difference of using the raw score (i.e., sum or mean) of interaction and the standardized score of the depth of interaction.

Method

Participants and Instrument

I used the network measure used in Study I and Study II, which was collected from student athletes in a local high school over two time periods (i.e., in the beginning and ends of 12-13 Winter season). Approximately, 350 students played at least one sport for the school. Two-hundred and ninety-one and 242 student athletes completed and reported 1,179 and 855 ties in the first and second network measure, respectively. In the network measure, they were asked to refer their friends' names on their team and other teams whom they are interacting with, and rate how often they interact with about five types of contents, such as general, academic, athletic, social, and emotional topics. The degree of the interaction between egos (nominators) and alters (nominees) were assessed using a 5-point Likert scale, 1 = 'Daily', 3 = 'Weekly', and 5= 'Monthly'. The following is the list of five items:

1) How often do you interact with this friend in general?
2) How often do you interact with this friend on academic topics (exam, projects, classes, etc.)?
3) How often do you interact with this friend on athletic topics (sports skill, practices, game schedule and strategies, etc.)?
4) How often do you interact with this friend on social topics (other friends, social events, parties, etc.)?
5) How often do you receive emotional support from this friend?

Analytic Strategy and Measurement Model

Before performing the IRT analysis, I needed to confirm a latent dimension of the five items, for which exploratory and confirmatory factor analyses were performed. Also, reliability was checked under the classical testing theory and item response theory.

In addition, single-level IRT models for polytomous items, such as the 2-parmeter partial-credit model (2PL-PCM; Muraki, 1992), partial-credit model (PCM; Master, 1982), and rating scale model (RSM; Andrich, 1978), were used to select the best goodness of fit of a measurement model by comparing Akaike's information coefficient (AIC), Bayesian information coefficient (BIC), and a likelihood ratio test (i.e., chi-square difference).

Then, the multilevel frame was added into the selected measurement model because the analytic framework is under an ego-centric network structure, which does not model reciprocal relationships. The unique characteristics of an ego-centric network that assume independence across egos and relative independence across ties within each ego's network make of a generalized multilevel model plausible for the network measure. That is, items (level 1 is item-level) are nested in social ties (level 2 is tie-level), which are nested in egos (level 3 is ego-level).

For this ego-centric network data, multilevel 2PL-PCM (Bacci & Caviezel, 2011) were adapted to fit the data and to simultaneously estimate item characteristics and the depth of interaction, as controlling for variance of tie- and ego-level. Bacci and Caviezel showed the transformation of generalized 2PL-PCM (Muraki, 1992) to logit-linear function for model specification of specify model multilevel data as follows:

Level 1-model (item level):

$$P\left(Y_{ijk} = m \middle| \theta_{0jk}, \theta_{00k}\right)$$

$$= \frac{exp\left[\sum_{k=0}^{m} \lambda_i \left(\theta_{0jk} + \theta_{00k} - (\beta_i + \tau_{ik})\right)\right]}{1 + \sum_{l=1}^{M-1} exp\left[\sum_{k=0}^{l} \lambda_i \left(\theta_{0jk} + \theta_{00k} - (\beta_i + \tau_{ik})\right)\right]}$$

$$i = 1, \dots, I; \qquad m = 0, \dots, M; \qquad j = 1, \dots, n; \qquad h = 1, \dots, H$$

$$logit\left[P(Y_{ijh} = m)\right] = \gamma_{0ijh} + \left(\gamma_{1ijh} + \gamma_{imjh}\right) \cdot I_{ijh}$$

Level-2 model (tie level):

$$\gamma_{0ijh} = \lambda_i \cdot \left(\gamma_{00h} + \theta_{0jh}\right)$$

$$\gamma_{1ijh} = \lambda_i \cdot \gamma_{1i0h}$$

$$\gamma_{imjh} = \lambda_i \cdot \gamma_{im0h}$$

Level-3 model (ego level):

$$\gamma_{00h} = \gamma_{000} + \theta_{00h}$$

$$\gamma_{1i0h} = \beta_i$$

$$\gamma_{im0h} = \tau_{im}$$

The combined model of the three levels:

$$logit\left[P(Y_{ijh} = m)\right] = \lambda_i \cdot \left[\gamma_{000} + \left(\theta_{0jh} + \theta_{00h}\right) - (\beta_i + \tau_{im}\right]$$

where Y_{ijh} represents the responses to item *i (i=1,…,I)* from ties (*j=1,…,n*) within ego network (*h=1,,,H*); θ indicates the level of the latent trait (depth of interaction) of ego, which is divided into two random effect, θ_{0jh}at level 2 (i.e., deviation of the latent variable θ for tie *j* in ego *h*), and θ_{00h} at level 3 (i.e., deviation of the latent variable for ego *h* from average of the population). They are assumed to be normally distributed with mean equal to 0 and constant variance. β_i indicates the average difficulty of the item i^{th} item; a threshold difficulty parameter (τ_{im}) indicates the scoring in the m^{th} category rather than $(m\text{-}1)^{th}$ to item *i*; λ_i indicates the discrimination of item *i*. γ_{0ijh} is the random intercept where γ_{1ijh} is the slope of the i^{th} item, and γ_{imjh} is the slope of the m^{th} category of the i^{th} item. γ_{000} is the intercept of γ_{00h} at level 3. The sum of the residuals at Level 2 and 3 ($\theta_{0jh}$and θ_{00h}, respectively*)* was defined as the estimate of the depth of interaction to represent the latent trait of tie *j* nominated by ego *h* in ego-centric network data (c.f., Sun 2011). The PCM and RSM, which are special cases of 2PL-PCM, can be obtained by imposing λ_i = 0 for each item *i* and λ_i= 0 and τ_{im}= τ_m for each item *i*, respectively.

For the estimation procedure, Bacci and Caviezel suggested to firstly use numerical integration method (e.g., Breslow & Clayton, 1993; Breslow & Lin, 1995; Pinheiro & Bates, 1995; Skrondal & Rabe-Hesketh, 2004) because of the fact that the marginal likelihood function obtained by integrating out the random effects in multidimensional integrals. Then, they suggested using maximum marginal likelihood with suitable algorithms, such as Newton-Raphson and Fisher Scoring in terms of direct optimization method, and EM as an indirect optimization method.

For the application of the latent trait score (i.e., the depth of interaction) obtained by the measurement model, the result of the influence model (Study I) was compared to see the difference in the estimated coefficients of the exposure when using the latent score versus the mean of frequency.

Results

Preliminary Analysis: Dimensionality and Reliability

The five items on general, academic, athletic, social, and emotional topics measured interaction among friends with a 5-point Likert scale, ranging from 1 (Daily) to 5 (Monthly). However, the values reversely coded to indicates a larger value means more frequent (i.e., 1=Monthly and 5=Daily). Table 4.1 shows the descriptive statistics of the five items. The means of interaction on general and social topics were higher than other topics, and all responses were negatively skewed.

To test if the five items were converged onto a latent factor (i.e., interaction), an exploratory factor analysis was firstly performed, which revealed an Eigenvalue of 2.19 for a one-factor model. Also, a confirmatory factor analysis was performed to confirm a one-factor model and check the model fit. Table 4.2 shows the standardized factor loadings with standard errors. The item on social topics was the greatest predictor (.84), while the item on academics was the lowest (.55). The one-factor model was confirmed with the following fit index: χ^2 (5) = 30.26, p<.000, CFI=.978, TLI=.955, RMSEA=.080 (90% CI: .055 ~ .110), and SRMR=.024. It sufficed Hu and Bentler (1999)'s cut-off values, which are CFI and TLI >.95 and RMSEA and SRMR < .08. The coefficient of determination (*R-squared*) is .837. In addition to the factor analysis, the unidimensionality of the five items was also tested by DIMTEST[3] (Stout, 1987; Nandakumar, Yu, Li, & Stout, 1998), which is used to decide whether the data satisfy the assumption of a unidimensional model based on the item response theory. This test

[3] Poly-DIMTEST is more appropriate for the polytomous items; however the author has no access to the program. Instead, the author dichotomized the items by each item's mean, and used DIMTEST to check the nuances of the unidimensionality as suggested by committee.

uses two subtests, an assessment subtest (AT) and a partitioning subtest (PT), in which the null hypothesis is that the appropriately selected AT and PT are under a same dimension. The selection can be done either by the program using explorative factor analysis or by the user. Since the number of items should be at least 20 for the explorative factor analysis (Stout, Nandakumar, Junker, Chang, & Steidinger, 1992), I selected AT (item 1, 4, and 5) and PT (item 2 and 3) based on bivariate correlations between the items and a subjective judgment (Table, 4.3). The item 2 and 3 asked about more specific interaction on academics and athletics; however item 1, 4, and 5 indicated interactions in general. Also, the correlations between item 1 and 4 (.43), and item 4 and 5 (.50) were relatively higher than the other correlations. The test results were TL= 1.63, TGbar= 1.72, T=-.08, and *p*=.53, which did not warrant rejecting the null hypothesis (i.e., AT and PT are under one latent dimension). Other selecting combinations did not show sufficient evidence to reject the null hypothesis as well. Thus, the unidimensionality of the five items was confirmed both by the classical testing theory and item response theory.

For the reliability of this measure under the classical testing theory, *Cronbach's* alpha of the test scale is .79 (Table, 4.4). In addition, item-test correlation and inter-item covariance for all items are larger than .64.

Multilevel 2PL-PCM

In Table 4.5, the result of LR test showed significant differences between 2PL-PCM and PCM. PCM was also significantly different from RSM. This result suggested that 2PL-PCM is the most parsimonious model than the other two models to fit the data, which allows estimating respectively threshold difficulty and discrimination parameters of the five items. The reliability of a set of the five items under 2PL-PCM is .60, which was obtained by Samejima (1994)'s formula as followed:

$$\rho_{\theta\hat{\theta}} = \frac{\sigma_{\theta}^{2}}{\sigma_{\hat{\theta}}^{2}} = \frac{\sigma_{\hat{\theta}}^{2} - (SEM)^{2}}{\sigma_{\hat{\theta}}^{2}} = \frac{.0167^{2} - .0112^{2}}{.0167^{2}} = .60$$

The LR test between multilevel 2PL-PCM and 2PL-PCM (2 times of the difference of the two log likelihoods) provided chi-square of 3798.88 (df = 4), which rejected the null hypothesis (i.e., the two models are equivalent). This result warranted that multilevel 2PL-PCM is the more acceptable and parsimonious measurement model for this empirical data. Finally, the multilevel 2PL-PCM was selected to estimate the latent trait of the depth of interaction, while accounting for variances at tie- and ego-level.

Table 4.6 provides the coefficients and standard errors estimated by the multilevel 2PL-PCM. The coefficients are the estimated step parameters for item *i* (β_i) and category *j+1* (τ_1), which indicates relative difficulty of each step needed to transition from one category to the next within an item. In Item 1, the transition from category 3 to category 4 is the most difficult (3.48), and the transition from category 4 to category 5 is the least difficulty (1.71); In Item 2, the transition from category 3 to category 4 is the most difficult (1.11), and the transition from category 2 to category 3 is the least difficult (.26); In Item 3, the transition from category 4 to category 5 is the most difficult (1.34), and the transition from category 2 to category 3 is the least difficult (.23); In Item 4, the transition from category 4 to category 5 is the most difficult (4.04), and the transition from category 1 to category 2 is the least difficult (.78); In item 5, the transition from category 4 to category 5 is the most difficult (1.85), and the transition from category 1 to category 2 is the least difficult (.29). Overall, respondents felt the difficulty of endorsing category 4 (More than Weekly) and 5 (Daily).

The discrimination parameter is interpreted as “the degree to which categorical responses vary among items as a latent trait changes” (Muraki, 1992, p. 162). Among the five items, while fixing to 1 for Item 1 for model specification, item 4 (1.697) has the biggest discrimination ability (i.e., steepest slope), which distinguishes the most effectively between individuals with different levels of the latent trait. Item 2 (.341) showed at least ability to discriminate individuals with different levels of the depth of interaction.

The depth of interaction is defined as the sum of $\theta_{0jh}$and θ_{00h}, which represent the estimated latent trait of tie *j* nominated by ego *h* in an ego-centric network data. The range of the depth of interaction was from -3.63 to 2.66 with a mean of .08 and a standard deviation of 1.09 in a conventional scale of IRT models. To shift this scale in a positive manner for interpretation, I added 5 to the estimated latent, which gave the range from 1.37 to 7.66. Figure 4.1 shows the distributions of the shifted scale of the depth of interaction (Mean=5.08, SD=1.09, Min.=1.37, Max.=7.66, Skewness=.19, Kurtosis=.24). Figure 4.2 is the distribution of the mean of the raw frequency on the five items (Mean=3.99, SD=.95, Min.=1, Max.=5, Skewness=-1.01, Kurtosis=.72). The distribution of the latent score (depth of interaction) shows a normal distribution although the distribution of the mean of the raw frequency is not, which shows a negatively skewed distribution with a standard criterion of ± 1 of Skewness and Kurtosis.

The Application of the Latent Score on the Depth of Interaction

This part of the analysis was to compare the results of influence models in Study I and the results of influence models when using the estimated latent score for $w_{ii'}$, which indicates the extent of relation between *i* (nominator) and *i'* (nominee). The correlation between the latent score and the raw mean of frequency was high (.88, *p*<.001).

Comparing the magnitude of the influence in the two models (Table, 4.7), the all-exposure (β_2 and $\beta_2 L$) was very similar in all variables, except for academic identity. When using the latent score, each magnitude in academic achievement, college aspiration and expectation, and athletic identity was little increased, while decreased in academic efficacy, and physical ability and appearance. The academic identity showed considerable increases, and the signal was changed from (-) to (+) when using the latent score, which is rooted in the changes in the different team-exposure. In the different team-exposure, the changes to positive influence were observed in academic achievement, college aspiration, and academic identity, while athletic identity was changed to negative influence.

In summary, the network measure with the five items was confirmed with a one-latent factor model for student interaction. In the single level comparison of IRT models, 2PL-PCM was found to be more parsimonious, which determined the use of multilevel 2PL-PCM as a measurement model for this data. The measurement model was psychometrically acceptable, and the latent trait (depth of interaction) was estimated, which was highly correlated with a raw mean of interaction frequency. However, the latent score was normally distributed, but the raw mean was not, which was negatively skewed. Applying the latent score in the influence model showed a considerable change in academic identity for the all-exposure. Also for the different team-exposure, many changes occurred in academic achievement, college aspiration, and identity. The effect in academic identity was changed to positive while athletic identity was changed to negative.

Discussion

In an attempt to validate a measurement for social network, I applied multilevel item response theory to network data in order to account for the difference in items and the nested data structure (i.e., items are nested within ties, which are further nested in nominators). Multilevel 2PL-PCM was selected to estimate the latent trait at Level 2 (tie) and Level 3 (nominators), and their sum ($\theta_{0jh}$and θ_{00h}) was hypothetically defined as depth of student interaction. Moreover, I demonstrated the application of the latent depth of interaction using the influence model (Study I), which conventionally uses a raw score (i.e., sum or mean of interaction), to model 'exposure' for each nominator. As Sun (2011) suggested, this study contributes to the development of a measurement model of polytomous network data, which contains the degree of interaction (i.e., frequency of discussing) as well as dichotomous occurrence of interaction.

One feature of IRT is that the estimated latent trait is normally distributed, which is continuous on a common IRT scale. In this study, the distribution of the latent depth of interaction was normal while the mean of frequency showed a negatively skewed distribution. Despite of a lot of observations near a category of 5 (i.e., everyday interacting with all ties about all topics), the index of skewness was not very large because of a larger sample size, which is supported by *central limit theorem* stating that when sample size is sufficiently large, the sampling distribution of a random variable is well approximated by a normal curve, even when the population distribution is not itself normal (Devore & Peck, 1997). Therefore, the scale transformation into a common IRT scale (i.e., a standardized scale) yields a normal distribution of the trait, which surpasses using the traditional methods, such as the mean of frequency of interaction, because Individuals may refer only a few friends with whom they are interacting very frequently in a real setting. Also, it is possible to equate multiple survey instruments and put different estimates for the same tie on the same scale for comparing the depth of interaction across ties using equivalent survey instruments (Sun, 2011).

As an application, I incorporated the latent depth of interaction into modeling the exposures in the influence model of social network analysis (see Table 4.7). The magnitude of the coefficients slightly decreased, but the considerable change occurred in the coefficients of all-exposure in college expectation, academic and athletic identity, which is the consequence of the score calibration by the IRT model although they are not statistically different (i.e., paired *t*-test). The interpretation of the coefficients by the latent depth of interaction is more valid due to features of IRT models in calibrating raw scores. An IRT model postulates that a single continuous factor underlies responses, and this factor is subject to error of each item; an estimated latent score is dependent on item characteristics (de Ayala, 2009). In conjunction of IRT and a network measurement, Van der Gaag and Snijder (2004) also point out the caution of using raw information on a very low or a very high frequency of responses, and claim that IRT yields a better representation of a set of items and their associations than factor analysis.

There are limitations guiding future studies. This measurement model is well-suited to ego-centric network data, which assumes that egos are independent. That is, egos are not related each other, but related to nominees and corresponding items. Therefore, this measurement model does not account for reciprocal relationships between egos. This limitation suggests developing a measurement model to account for the dependency of egos because the estimated depth of interaction may be different when egos have a dyadic interaction. The depth of interaction between egos may be expected to be higher when they have dyadic ties.

This measurement model has not been extended for covariates. Covariates can be added in Multilevel IRT models to explain more variance at different levels and see their effect on the latent trait (Maier, 2001; Sun, 2011). This point suggests a mathematical development of polytomous multilevel IRT models to add covariates at different levels, which potentially reduce the standard errors (Maier, 2001).

Conceptually, the negatively skewed data indicate that few subjects selected little interaction for some nominees, which was coded as 1 (monthly interaction), however, considering the context of school, students come to school every day and have more chances to interact often with friends, not like adults' interactions for professional development (e.g., teaching workshop). Because adolescents tend to spend more time with peers for socialization (Fuligni, Yip, & Tseng, 2002; Richards, Crowe, Larson, & Swarr, 1998), the category about the monthly interaction arises a question if inclusion of little interaction is appropriate for adolescents as an indication of their friends and networks. From adolescents' perspective, little interaction, for instance once in a month, may not be included to define a social network of adolescents.

Finally, this study used only five items about social interaction in school, such as talking about academics and athletics. They may be too broad to capture students' interactions. Thus, measuring items can be further detailed in terms of interaction with peers in school, which will require a lot of time for subjects to complete the questions for each referred peer. It may yield biased information with missing data, but it will have merit to have more items because the number of items is related to test information, which represents reliability of a test in IRT. The test information is the sum of items' information (de Ayala, 2009). More items lead to more reliability of a whole test. It is also probable to select items demonstrating more information for a specific range of a trait level because information varies by a trait level. Moreover, various latent constructs can be formed depending on a research question, such as depth of interaction on courses or athletics. For future studies, I suggest the following dimensions and items based on literature reviews on student interaction and social capital in school (e.g., Furstenberg, Cook, Eccles, Elder, & Sameroff, 1999; King & Furrow, 2004):

Contents-related

Sharing materials for courses

Discussing what you have learned in courses

Discussing what you expect to learn in courses

Discussing your progress in courses

Asking what you did not understand in contents of courses

Motivation-

Discussing your class engagement

Discussing your attitude in courses

Discussing your motivation in courses

Discussing your interest in courses

Task-

Talking about exam/ quiz

Talking about homework

Talking about group projects

Classroom Environment-

Talking about classroom settings.

Talking about classroom organization.

Talking about classroom policy.

Talking about course schedule

Faculty-

Talking about teachers' leadership

Talking about teachers' instructional strategy

Talking about teachers' behavior

Talking about teaching methods

Talking about ways to interact with students

Athletic-

Talking about your coach's leadership style.

Talking about your team's schedule.

Talking about team's practice/ training.

Talking about team's competition

Talking about sport skill improvement

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CHAPTER V: CONCLUSION AND IMPLICATION OF THIS DISSERTATION

By conducting a series of three studies, this dissertation enriches the understandings of educational consequences of athletic participation with emphasis on peers who participate together in athletic programs. Study I provides evidence that social interactions with peers on a same team and different teams positively influence student athletes' academic related variables, such as academic achievement. Study II provides information regarding personal attributes used in forming peer networks. Multiple sources play the role in initiating peer relationships. Student athletes form peer networks based not only on similar attributes, such as gender, team membership, and college aspiration, but also different attributes in grade level and achievement.

Taken together, these results imply that an athletic program is a social institution in which students produce and distribute social capital not only for athletics but also for academics. Similarly, Frank, Muller, and Muller (2013) emphasized an emergent cluster of course-taking pattern as social institution to formulate *'local position'* where students develop peer relationships. Attending the same social institutions, such as courses and sports, provides more time for students to be in a same place and share personal and group norms and values, which facilitates effective peer relationships. The effective peer relationships, which are formed in athletic programs, are a form of social capital that student athletes can access for their academics.

These implications add more weight to the value of athletic participation on education in school. There has been an ongoing debate to unpack the causal factors and actual mechanisms of the athletic participation/education value relationship (Hartmann, 2008). That is, athletic participation facilitates social relationships throughout t which students can develop capitals to achieve their goals in school both for academic and athletic success. This optimistic outcome by athletic participation for academic and athletic success is aligned with the mission of the National Collegiate Athletic Association (“Academics”, 2013), which is an organization established to create an atmosphere to pursue a balance of academic and athletic excellence in school.

In addition to educational consequences of athletic participation, this study contributes to the argument that sport participation facilitates social relationships. In this regard, Smith (2003) suggested a term ‘*sport social context’*, and Hills (2007) argued as follows:

> *“Physical education represents a dynamic social space where students experience and interpret physicality in contexts that accentuate peer relationships and privilege particular forms of embodiment. It represents a distinctive area within schools with regard to its focus on the body and physical skills and its unique opportunities for social interactions between peers.*” (p. 317-318).

These quotes, along with this study, provide insights that sport participation is a source for students in high school to build peer relationships. However, the study leaves a question on how peer relationship is positive for athletes’ well-being in high school. How athletic programs are designed and delivered by coaches, athletic directors, and community is critical to making a positive impact on peer relationships formed in school and athletic programs on athletes’ well-being.

Methodologically, the statistical models of social network analysis provide a prospective analytical frame for socialization, peer relationship, social network, and group dynamics in the psychosocial aspect of sport. The influence and selection model of social network analysis can be more extensively utilized in sports to assess the effect of social network in terms of attitude, emotion, cognition, and behavior of individuals fluctuated by interpersonal relationship and interaction. Also, the IRT-based measurement model for the polytomous network data, as far as I am aware, is the first attempt, which enriches issues on measurements in conjunction with social network analysis.

Finally, this dissertation provides a policy-related implication that athletic participation, as an extracurricular activity, is not detrimental with respect to development of adolescents. Instead, it ameliorates social relationships with peers in school, which is a social capital for adolescents to achieve their goals for academic, social, and physical wellbeing in school and future. However, these findings and implications can only be generalized to religiously based-private high schools due to the sample's characteristics of this study. Public and private schools have different figures with respect to individuals (students, parents, teachers, and administrators), academics, educational aspiration, and economics (Altonji, Elder, & Taber, 2005), which may result in differences of peer relationship in school. In public (urban or rural) schools, student athletes may represent different patterns in initiating and capitalizing peer relationship for academics.

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APPENDICES

APPENDIX A: Tables

Table 2.1. Participants' distributions on teams

	Fall Sports	N	n_1	n_2
1	Football (Varsity, JV, Freshmen)	150	32	22
2	Boys Tennis(Varsity, JV)	20	22	16
3	Boys Soccer (Varsity, JV)	30	19	5
4	Boys & Girls Cross Country (Varsity, JV)	20	26	21
5	Girls Volleyball (Varsity, JV & Freshmen)	45	23	13
6	Girls Golf (Varsity, JV)	15	3	2
7	Sideline Cheer Team (Varsity, JV)	20	18	13
8	Girls Swimming & Diving (Varsity)	20	3	4
	Winter Sports			
9	Boys Basketball (Varsity, JV, Freshmen)	45	31	26
10	Hockey (Varsity)	30	1	1
11	Boys Swimming & Diving (Varsity)	15	3	3
12	Boys & Girls Bowling (Varsity, JV)	10	0	0
13	Girls Basketball (Varsity, JV & Freshmen)	45	22	22
14	Competitive Cheer Team (Varsity, JV)	20	6	4
15	Boys Wrestling	20	7	6
	Spring Sports			
16	Baseball (Varsity, JV, Freshmen)	45	11	12
17	Boys & Girls Track & Field (Varsity)	40	9	10
18	Boys Golf(Varisty, JV)	20	7	2
19	Softball (Varsity, JV, Freshmen)	45	6	10
20	Girls Tennis (Varsity, JV)	15	10	9
21	Girls Soccer (Varsity, JV)	25	8	10
22	Boys & Girls Lacrosse (Varsity)	25	4	9

Note. N is the total number students on team. n_1 and n_2 are the numbers of students who completed the first and second survey respectively.

Table 2.2. Gender and school years of samples in the first and second survey.

	Freshman	Sophomore	Junior	Senior
Male	39 (38)	55 (45)	38 (24)	31 (18)
Female	46 (42)	36 (38)	20 (18)	24 (15)

Note. The numbers in parenthesis indicate the number of samples in the second survey.

Table 2.3. Teams' characteristics and norms

	Fall Sports	Size	Pop.	Sea.	Tra.	Rev.	CoR.	Task	Social
1	Football (D_1)	150	1	0	1	1	5.58	7.59	7.25
2	Boys Tennis (D_2)	20	4	0	1	1	5.13	6.46	5.93
3	Boys Soccer (D_3)	30	3	0	0	0	5.05	7.12	6.93
4	Boys & Girls Cross Country (D_4)	20	7	0	0	0	5.8	7.76	8.27
5	Girls Volleyball (D_5)	45	2	0	0	0	5	7.13	6.99
6	Girls Golf (D_6)	15	5	0	1	1	6.33	8.82	8.46
7	Sideline Cheer Team (D_7)	20	6	0	0	0	6.13	7.74	7.58
8	Girls Swimming & Diving (D_8)	20	8	0	0	0	5.33	8.01	7.82
	Winter Sports								
9	Boys Basketball (D_9)	45	1	1	1	1	5.64	7.36	7.05
10	Hockey (D_{10})	30	4	1	1	1	1	6.81	8.25
11	Boys Swimming & Diving (D_{11})	15	6	1	0	0	6	6.81	7.63
12	Boys & Girls Bowling (reference)	10	7	1	0	0	0	0	0
13	Girls Basketball (D_{12})	45	2	1	1	1	5.72	6.13	6.21
14	Competitive Cheer Team (D_{13})	20	8	1	0	0	6.33	7.80	7.05
15	Boys Wrestling (D_{14})	20	3	1	1	1	5.28	7.93	7.31
	Spring Sports								
16	Baseball (D_{15})	45	2	0	1	0	5.45	7.42	7.13
17	Boys & Girls Track & Field (D_{16})	40	1	0	1	1	6.22	7.39	7.11
18	Boys Golf (D_{17})	20	3	0	1	0	6.14	7.64	6.99
19	Softball (D_{18})	45	4	0	0	0	5	6.71	6.45
20	Girls Tennis (D_{19})	15	5	0	1	0	5.7	7.24	7.00
21	Girls Soccer (D_{20})	25	7	0	0	0	6	6.82	6.13
22	Boys & Girls Lacrosse (D_{21})	25	6	0	0	0	5.66	7.06	6.45

Note. Size=total number of students on each team; Pop.= the order of popularity; Sea. = season (1=winter season & 0=other seasons); Rev. = revenue (1=revenue generating team & 0=others); Tra.=tradition (1=state championship banner & 0=no banner); CoR.=coach's regard on academics; Task= average of task-related cohesion; Social=average of social-related cohesion.

Table 2.4. The descriptive statistics of the network at time1.

	Sports Team	n_1	Total tie	Ave. degree	Ties in same team	Same team-degree	Ties in different team	different team-degree
1	Football	32	119	3.71	64	2	55	1.72
2	B. Tennis	22	60	2.73	21	0.95	39	1.77
3	B. Soccer	19	67	3.53	27	1.42	40	2.10
4	B. & G. Cross Country	26	120	4.62	67	2.58	53	2.04
5	G. Volleyball	23	116	5.04	46	2	70	3.04
6	G. Golf	3	13	4.33	4	1.33	9	3
7	Sideline Cheer Team	18	112	6.22	78	4.33	34	1.89
8	G. Swim. & Diving	3	15	5	8	2.66	7	2.33
9	B. Basketball	31	95	3.06	30	0.97	65	2.10
10	Hockey	1	4	4	3	3	1	1
11	B. Swim. & Diving	3	12	4	7	2.33	5	1.67
12	B. & G. Bowling	0	0	0	0	0	0	0
13	G.Basketball	22	105	4.77	24	1.09	81	3.68
14	Competitive Cheer Team	6	34	5.67	8	1.33	26	4.33
15	B. Wrestling	7	34	4.86	10	1.43	24	3.43
16	Baseball	11	35	3.18	12	1.09	23	2.09
17	B. & G.Track & Field	9	50	5.56	11	1.22	39	4.33
18	B. Golf	7	21	3	1	0.14	20	2.86
19	Softball	6	24	4	8	1.33	16	2.67
20	G. Tennis	10	34	3.4	14	1.4	20	2
21	G. Soccer	8	35	4.38	15	1.88	20	2.5
22	B. & G. Lacrosse	4	17	4.25	1	0.25	16	4

Note. B.=Boys. G.=Girls n_1 is the number of nominators in each team. Average degree is the average number of nominees, which is obtained by dividing the total ties with n_1. Same team-degree is the average number of nominees within a same team, while different team-degree is the average number of nominees outside of a same team (the number of ties in a same team or other teams is to be divided by the number of nominators).

Table 2.5. The descriptive statistics of the network at time 2..

	Sports Team	n_2	Total tie	Ave. degree	Ties in same team	Same team-degree	Ties in different team	different team-degree
1	Football	22	103	3.22	59	1.84	44	1.38
2	B. Tennis	16	46	2.09	15	0.68	31	1.41
3	B. Soccer	5	21	1.11	11	0.58	10	0.53
4	B. & G. Cross Country	21	76	2.92	34	1.31	42	1.62
5	G. Volleyball	13	52	2.26	25	1.09	27	1.17
6	G. Golf	2	5	1.67	0	0	5	1.67
7	Sideline Cheer Team	13	73	4.06	44	2.44	29	1.61
8	G. Swim. & Diving	4	18	6	6	2	12	4
9	B. Basketball	26	77	2.48	22	0.71	55	1.77
10	Hockey	1	6	6	1	1	5	5
11	B. Swim. & Diving	3	7	2.33	2	0.67	5	1.67
12	B. & G. Bowling	0	0	0		0	0	0
13	G.Basketball	22	74	3.36	29	1.32	45	2.05
14	Competitive Cheer Team	4	14	2.33	12	2	2	0.33
15	B. Wrestling	6	26	3.71	8	1.14	18	2.57
16	Baseball	12	36	3.27	14	1.27	22	2
17	B. & G.Track & Field	10	32	3.56	11	1.22	21	2.33
18	B. Golf	2	6	0.86	1	0.14	5	0.71
19	Softball	10	35	5.83	9	1.5	26	4.33
20	G. Tennis	9	34	3.4	12	1.2	22	2.2
21	G. Soccer	10	38	4.75	13	1.63	25	3.13
22	B. & G. Lacrosse	9	21	5.25	2	0.5	19	4.75

Note. B.=Boys. G.=Girls n_2 is the number of nominators in each team. Average degree is the average number of nominees, which is obtained by dividing the total ties with n_1. Same team-degree is the average number of nominees within a same team, while different team-degree is the average number of nominees outside of a same team (the number of ties in a same team or other teams is to be divided by the number of nominators).

Table 2.6. Descriptive statistics of outcome variables at Time1 and Time2.

	Variables (Time1)	N	Mean	SD	Skewness	Kurtosis
1	Academic achievement	225	3.63	.41	-1.62	6.91
2	Academic efficacy	289	4.27	.66	-1.14	4.91
3	College expectation	286	4.84	.47	-3.75	22.40
4	College aspiration	285	4.86	.41	-3.42	16.43
5	Academic identity	280	4.96	1.02	-.38	2.62
6	Athletic identity	284	4.87	1.15	-.22	2.54
7	Physical ability	284	5.61	.68	.08	2.66
8	Physical appearance	284	5.19	.65	.59	3.23
	Variables (Time2)	N	Mean	SD	Skewness	Kurtosis
1	Academic achievement	199	3.66	.36	-1.36	5.02
2	Academic efficacy	240	4.32	.67	-1.11	4.76
3	College expectation	234	4.83	.54	-3.82	20.59
4	College aspiration	233	4.81	.56	-3.78	19.37
5	Academic identity	231	5.01	1.06	-.20	2.53
6	Athletic identity	231	4.94	1.16	-.34	2.82
7	Physical ability	235	4.48	1.34	-.32	2.63
8	Physical appearance	235	4.45	.84	-.10	2.99

Table 2.7. Paired t-test of outcome variables

	Variables	N	Mean-D	SE-D	*t*	*p*
1	Academic achievement	153	-.018	.01	-1.74	.08
2	Academic efficacy	211	-.047	.03	-1.38	.16
3	College expectation	208	.004	.028	.17	.86
4	College aspiration	208	.052	.027	1.93	.05
5	Academic identity	204	-.122	.053	-2.28	.02
6	Athletic identity	204	-.020	.044	-.46	.64
7	Physical ability	206	1.115	.100	11.15	.00
8	Physical appearance	206	.684	.074	9.14	.00

Note. Mean-D is the mean difference between Time1 and Time2 (Time1-Time2); SE-D is the difference of standard errors.

Table 2.8. Descriptive statistics of three exposures, and paired t-test between same and different team-exposure.

Variables	*All-exposure*			*Same team-exposure*			*Different team-exposure*		
	n	M	SD	n	M	SD	n	M	SD
Academic achievement**	184	14.98	3.16	107	15.34	3.18	144	16.94	4.31
Academic efficacy**	202	17.11	4.11	115	17.83	4.04	144	16.94	4.31
College expectation**	201	19.31	4.15	115	20.09	3.88	143	18.98	4.37
College aspiration**	201	19.48	3.98	115	20.17	3.89	143	19.19	4.24
Academic identity*	201	19.63	4.90	116	20.29	5.04	143	19.33	5.46
Athletic identity	200	19.51	5.51	115	20.63	5.39	143	19.03	6.03
Physical ability**	201	22.44	4.72	114	23.06	4.67	144	22.17	5.14
Physical appearance*	201	20.59	4.42	114	21.09	4.33	144	20.23	4.60

Note. M=mean; SD=standard deviation; n is the number of cases, which are different for each exposure because all-exposure included all ties, but one may have either the same team-exposure or different team-exposure. The result of the paired t-test between same and different team-exposure were indicated by asterisk (*: p<.05, **: p<.01).

Table 2.9. Regression models of the outcome variables (y) with overall interactions

y	n	β_0	β_1	β_2		β_3	R^2
				$\beta_{2\text{-}1}$	$\beta_{2\text{-}2}$		
Academic achievement	127	.37(.13)	.93(.02)**	.03(.003)		.08(.01)**	.90
	138	.45(.09)	.93(.02)**	-.011 (.001)	.029 (.001)	.07(.01)*	.90
Academic efficacy	175	.69(.30)	.68(.05)**	.071(.007)		.94(.05)	.55
	182	.96(.28)	.69(.05)**	.045 (.003)	.082 (.003)+	.042(.06)	.52
College aspiration	172	.78(.42)	.66(.08)**	.077(.007)		-.12(.05)*	.42
	180	1.1(.42)	.67(.08)*	-.009 (.00)	.011 (.00)	- .11(.05)+	.40
College expectation	172	1.6(.37)	.67(.05)**	-.040(.006)		.038(.04)	.41
	180	1.6(.35)	.67(.05)**	-.025 (.002)	-.041 (.002)	.033(.04)	.40
Academic identity	171	2.9(.44)	.74(.05)**	-.002(.01)		-.15(.09)*	.52
	179	2.3(.41)	.74(.05)**	-.018 (.005)	.035 (.005)	-.14(.09)*	.5
Athletic identity	170	.73(.56)	.79(.04)**	.015(.009)		-.00(.08)	.69
	179	.76(.51)	.78(.04)**	.067 (.004)	-.041 (.004)	.00(.08)	.69
Physical ability	172	2.6(1.3)	.16(.17)*	.066(.02)		-.09(.16)	.13
	180	3.3(1.1)	.17(.16)*	.016 (.008)	.023 (.008)	-.12(.16)*	.12
Physical appearance	172	2.3(.88)	.06(.11)	.192(.014)*		.06(.11)	.12
	64	3.9(.70)	.09(.10)	.001 (.005)	.124 (.006)+	.05(.10)	.09

Note. The exposures were obtained with overall interaction (i.e., average of all type of interactions). The β_0 is the intercept; β_1 is the effect of the prior status; β_2 is the effect of all exposures from all ties; β_3 was set as a controlling variable; $\beta_{2\text{-}1}$ and $\beta_{2\text{-}2}$ is the effect of exposure from ties in a same team and different team. The coefficients are standardized values, except for intercept. The coefficients of the 21 dummy variables (D_1 through D_{21}) are not presented in this table for less importance of interpretation. + (p<.08); *(p<.05); **(p<.01)

Table 2.10. Regression models of the outcome variables (y) with a specific type of interaction

y	n	β_0	β_1	β_2		β_3	R^2
				β_{2-1}	β_{2-2}		
Academic achievement	127	.37(.13)	.93(.02)**	.062(.002)*		.08(.02)**	.91
	127	.43(.10)	.93(.03)**	.012 (.001)	.038 (.001)+	.08(.01)**	127
Academic efficacy	175	.77(.35)	.68(.05)**	.054(.006)		.09(.06)	.55
	175	.77(.34)	.68(.06)**	.082 (.003)	.075 (.003)	.09(.05)	175
College aspiration	172	.81(.48)	.66(.08)**	.094(.005)*		-.11(.05)+	.42
	172	.83(.48)	.68(.08)**	.067 (.002)	.022 (.002)	-.12(.04)+	172
College expectation	172	1.6(.37)	.67(.05)**	.01(.004)		.03(.04)	.40
	172	1.6(.36)	.67(.05)**	.012 (.002)	-.047 (.002)	.03(.05)	172
Academic identity	171	2.8(.53)	.73(.05)**	.068(.009)		-.15(.09)*	.52
	171	2.9(.43)	.74(.05)**	-.016 (.005)	.038 (.005)	-.15(.09)*	171
Athletic identity	170	.62(.54)	.78(.04)**	.067(.007)		-.01(.09)	.70
	170	.80(.53)	.79(.05)**	.045 (.004)	-.039 (.005)	-.01(.086)	170
Physical ability	172	2.6(1.2)	.15(.17)*	.145(.014)+		-.08(.17)+	.15
	172	3.0(1.3)	.16(.17)**	.014 (.008)	.048 (.009)	.-.09(.17)+	172
Physical appearance	172	2.5(.86)	.07(.11)	.20(.011)**		.08(.11)	.12
	172	2.9(.85)	.09(.11)	.05 (.005)	.16 (.006)*	.07(.11)	172

Note. The exposures were obtained with overall interaction (i.e., average of all type of interactions). The β_0 is the intercept; β_1 is the effect of the prior status; β_2 is the effect of all exposures from all ties; β_3 was set as a controlling variable; β_{2-1} and β_{2-2} is the effect of exposure from ties in a same team and different team. The coefficients are standardized values, except for intercept. The coefficients of the 21 dummy variables (D_1 through D_{21}) are not presented in this table for less importance of interpretation. + ($p<.08$); *($p<.05$); **($p<.01$)

Table 2.11. Model 1: Null multilevel (unconstrained) models of the outcome variables

	n	γ_{00}	μ_{0j}	e_{ij}	ICC
Academic achievement	153	3.69	.090(.04)	.351(.02)	.06
Academic efficacy	180	4.35	.110(.08)	.617(.03)	.03
College expectation	189	4.86	.016(.18)	.448(.02)	.00
College aspiration	189	4.83	.090(.04)	.499(.02)	.03
Academic identity	189	4.96	.197(.11)	1.00(.05)	.04
Athlete identity	178	4.83	.381(.11)	.996(.05)	.13
Physical ability	192	4.54	.379(.14)	1.25(.06)	.08
Physical appearance	192	4.48	.193(.09)	.837(.04)	.05

Note. ICC = intraclass correlation coefficient

Table 2.12a. Model 2 and 3 for academic achievement with team size for the team level

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.83**	.023	.792**	.040
Same team exposure γ_{20}	-.000	.001	-.004	.007
Different team exposure γ_{30}	.001	.001	.000	.005
Team size (P1) γ_{01}			-.004*	.001
Cross Level Interaction				
Same team exposure X P1 γ_{21}			.000	.000
Constant γ_{00}	.658**	.083	.895**	.178
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.002	.008	.009
SD (constant) μ_{0j}	.006	.021	.079	.129
SD (Residual) e_{ij}	.101**	.006	.099**	.015

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.12b. Model 2 and 3 for academic achievement with popularity for the team level

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.83**	.023	.760**	.046
Same team exposure γ_{20}	-.000	.001	.010	.011
Different team exposure γ_{30}	.001	.001	.000	.005
Popularity (P2) γ_{01}			.056	.039
Cross Level Interaction				
Same team exposure X P2 γ_{21}			-.002	.002
Constant γ_{00}	.658**	.083	.649**	.207
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.002	.001	.007
SD (constant) μ_{0j}	.006	.021	.071	.122
SD (Residual) e_{ij}	.101**	.006	.105**	.013

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.12c. Model 2 and 3 for academic achievement with winter season for the team level

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.83**	.023	.787**	.046
Same team exposure γ_{20}	-.000	.001	.004	.006
Different team exposure γ_{30}	.001	.001	.000	.005
Winter season (P3) γ_{01}			.081	.199
Cross Level Interaction				
Same team exposure X P3 γ_{21}			-.007	.011
Constant γ_{00}	.658**	.083	.747**	.212
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.002	.002	.006
SD (constant) μ_{0j}	.006	.021	.115	.105
SD (Residual) e_{ij}	.101**	.006	.094**	.013

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.12d. Model 2 and 3 for academic achievement with revenue for the team level

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.83**	.023	.749**	.049
Same team exposure γ_{20}	-.000	.001	-.000	.007
Different team exposure γ_{30}	.001	.001	.001	.005
Revenue (P4) γ_{01}			-.228	.176
Cross Level Interaction				
Same team exposure X P4 γ_{21}			.010	.010
Constant γ_{00}	.658**	.083	.960**	.223
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.002	.001	.009
SD (constant) μ_{0j}	.006	.021	.067	.144
SD (Residual) e_{ij}	.101**	.006	-.999	.035

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.12e. Model 2 and 3 for academic achievement with tradition for the team level

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.83**	.023	.776**	.045
Same team exposure γ_{20}	-.000	.001	.005	.012
Different team exposure γ_{30}	.001	.001	-.000	.005
Tradition (P5) γ_{01}			-.062	.005
Cross Level Interaction				
Same team exposure X P5 γ_{21}			-.000	.017
Constant γ_{00}	.658**	.083	.803**	.274
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.002	.020	.014
SD (constant) μ_{0j}	.006	.021	.332	.221
SD (Residual) e_{ij}	.101**	.006	.103**	.015

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.12f. Model 2 and 3 for academic achievement with coach's regard for academics for the team level

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.83**	.023	.759**	.043
Same team exposure γ_{20}	-.000	.001	.021	.084
Different team exposure γ_{30}	.001	.001	.000	.004
Coach's regard for academics (Q) γ_{01}			-.057	.262
Cross Level Interaction				
Same team exposure X Q γ_{21}			-.003	.015
Constant γ_{00}	.658**	.083	1.474	1.474
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.002	.001	.001
SD (constant) μ_{0j}	.006	.021	.108	.105
SD (Residual) e_{ij}	.101**	.006	.103**	.015

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.12g. Model 2 and 3 for academic achievement with task cohesion for the team level

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.83**	.023	.779**	.046
Same team exposure γ_{20}	-.000	.001	-.136+	.082
Different team exposure γ_{30}	.001	.001	.001	.005
Task cohesion (R) γ_{01}			-.291	.190
Cross Level Interaction				
Same team exposure X R γ_{21}			.020+	.011
Constant γ_{00}	.658**	.083	2.76*	1.377
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.002	.013	.011
SD (constant) μ_{0j}	.006	.021	.243	.169
SD (Residual) e_{ij}	.101**	.006	.104**	.014

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.12h. Model 2 and 3 for academic achievement with social cohesion for the team level

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.83**	.023	.781**	.046
Same team exposure γ_{20}	-.000	.001	-.061	.069
Different team exposure γ_{30}	.001	.001	.001	.005
Social cohesion (S) γ_{01}			-.145	.163
Cross Level Interaction				
Same team exposure X S γ_{21}			.009	.009
Constant γ_{00}	.658**	.083	1.699	1.157
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.002	.016	.013
SD (constant) μ_{0j}	.006	.021	.270	.209
SD (Residual) e_{ij}	.101**	.006	.106**	.015

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.13a. Model 2 and 3 for academic efficacy with team size at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.703**	.049	.605**	.080
Same team exposure γ_{20}	.007	.004	-.006	.018
Different team exposure γ_{30}	.008*	.003	.009	.013
Team size (P1) γ_{01}			-.005	.004
Cross Level Interaction				
Same team exposure X P1 γ_{21}			.000	.000
Constant γ_{00}	1.15**	.223	1.867**	.492
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.011**	.004	.005	.013
SD (constant) μ_{0j}	.063	.061	.147	.244
SD (Residual) e_{ij}	.408**	.022	.340**	.035

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.13b. Model 2 and 3 for academic efficacy with popularity at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.703**	.049	.603**	.080
Same team exposure γ_{20}	.007	.004	.018	.023
Different team exposure γ_{30}	.008*	.003	.010	.013
Popularity (P2) γ_{01}			.130	.101
Cross Level Interaction				
Same team exposure X P2 γ_{21}			-.004	.005
Constant γ_{00}	1.15**	.223	1.135**	.506
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.011**	.004	.009	.013
SD (constant) μ_{0j}	.063	.061	.032	.239
SD (Residual) e_{ij}	.408**	.022	.339**	.035

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.13c. Model 2 and 3 for academic efficacy with winter season at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.703**	.049	.625**	.081
Same team exposure γ_{20}	.007	.004	-.005	.015
Different team exposure γ_{30}	.008*	.003	.006	.013
Winter season (P3) γ_{01}			-1.124*	.488
Cross Level Interaction				
Same team exposure X P3 γ_{21}			.059*	.027
Constant γ_{00}	1.15**	.223	1.778**	.460
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.011**	.004	.021	.015
SD (constant) μ_{0j}	.063	.061	.185	.287
SD (Residual) e_{ij}	.408**	.022	.338**	.036

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.13d. Model 2 and 3 for academic efficacy with revenue at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.703**	.049	.596**	.080
Same team exposure γ_{20}	.007	.004	-.011	.017
Different team exposure γ_{30}	.008*	.003	.011	.013
Revenue (P4) γ_{01}			-.829+	.434
Cross Level Interaction				
Same team exposure X P4 γ_{21}			.038	.024
Constant γ_{00}	1.15**	.223	1.987**	.493
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.011**	.004	.014	.013
SD (constant) μ_{0j}	.063	.061	.035	.250
SD (Residual) e_{ij}	.408**	.022	.335**	.035

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.13e. Model 2 and 3 for academic efficacy with tradition at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.703**	.049	.623**	.080
Same team exposure γ_{20}	.007	.004	-.003	.019
Different team exposure γ_{30}	.008*	.003	.008	.013
Tradition (P5) γ_{01}			-.416	.470
Cross Level Interaction				
Same team exposure X P5 γ_{21}			.012	.025
Constant γ_{00}	1.15**	.223	1.791**	.504
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.011**	.004	.009	.060
SD (constant) μ_{0j}	.063	.061	.112	1.355
SD (Residual) e_{ij}	.408**	.022	.344**	.038

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.13f. Model 2 and 3 for academic efficacy with coach's regard for academics at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.703**	.049	.669**	.088
Same team exposure γ_{20}	.007	.004	-.053	.210
Different team exposure γ_{30}	.008*	.003	.007	.015
Coach's regard for academics (Q) γ_{01}			-.183	.735
Cross Level Interaction				
Same team exposure X Q γ_{21}			.011	.038
Constant γ_{00}	1.15**	.223	2.276	4.099
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.011**	.004	.000	.025
SD (constant) μ_{0j}	.063	.061	.098	.460
SD (Residual) e_{ij}	.408**	.022	.393**	.012

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.13g. Model 2 and 3 for academic efficacy with task cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.703**	.049	.604**	.081
Same team exposure γ_{20}	.007	.004	-.093	.170
Different team exposure γ_{30}	.008*	.003	.011	.013
Task cohesion (R) γ_{01}			.015	.428
Cross Level Interaction				
Same team exposure X R γ_{21}			.013	.023
Constant γ_{00}	1.15**	.223	1.424	3.043
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.011**	.004	.027	.030
SD (constant) μ_{0j}	.063	.061	.474	.507
SD (Residual) e_{ij}	.408**	.022	.345**	.038

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.13h. Model 2 and 3 for academic efficacy with social cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.703**	.049	.606**	.080
Same team exposure γ_{20}	.007	.004	-.099	.118
Different team exposure γ_{30}	.008*	.003	.010	.013
Social cohesion (S) γ_{01}			-.062	.316
Cross Level Interaction				
Same team exposure X S γ_{21}			.014	.016
Constant γ_{00}	1.15**	.223	2.012	2.223
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.011**	.004	.016	.030
SD (constant) μ_{0j}	.063	.061	.332	.467
SD (Residual) e_{ij}	.408**	.022	.341**	.036

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.14a. Model 2 and 3 for college aspiration with team size at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.852**	.078	.499**	.208
Same team exposure γ_{20}	.000	.003	-.046	.027
Different team exposure γ_{30}	.001	.002	.047*	.021
Team size (P1) γ_{01}			-.013	.008
Cross Level Interaction				
Same team exposure X P1 γ_{21}			.000	.000
Constant γ_{00}	.675+	.385	2.538**	1.096
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.007**	.003	.001	.000
SD (constant) μ_{0j}	.016	.044	.098	.078
SD (Residual) e_{ij}	.350**	.019	.538**	.054

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.14b. Model 2 and 3 for college aspiration with popularity at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.852**	.078	.527**	.216
Same team exposure γ_{20}	.000	.003	.006	.039
Different team exposure γ_{30}	.001	.002	.042*	.020
Popularity (P2) γ_{01}			.100	.192
Cross Level Interaction				
Same team exposure X P2 γ_{21}			-.005	.008
Constant γ_{00}	.675+	.385	1.290	1.342
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.007**	.003	.027	.026
SD (constant) μ_{0j}	.016	.044	.787	.607
SD (Residual) e_{ij}	.350**	.019	.514**	.056

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.14c. Model 2 and 3 for college aspiration with winter season at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.852**	.078	.597**	.215
Same team exposure γ_{20}	.000	.003	-.007	.023
Different team exposure γ_{30}	.001	.002	.049*	.020
Winter season (P3) γ_{01}			1.121	.877
Cross Level Interaction				
Same team exposure X P3 γ_{21}			-.043	.040
Constant γ_{00}	.675+	.385	1.050	1.130
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.007**	.003	.018	.021
SD (constant) μ_{0j}	.016	.044	.628	.457
SD (Residual) e_{ij}	.350**	.019	.501**	.052

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.14d. Model 2 and 3 for college aspiration with revenue at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.852**	.078	.597**	.220
Same team exposure γ_{20}	.000	.003	-.027	.028
Different team exposure γ_{30}	.001	.002	.044*	.021
Revenue (P4) γ_{01}			-.388	.851
Cross Level Interaction				
Same team exposure X P4 γ_{21}			.017	.038
Constant γ_{00}			1.646	1.178
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.007**	.003	.021	.022
SD (constant) μ_{0j}	.016	.044	.677	.487
SD (Residual) e_{ij}	.350**	.019	.515**	.053

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.14e. Model 2 and 3 for college aspiration with tradition at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.852**	.078	.593**	.220
Same team exposure γ_{20}	.000	.003	-.017	.029
Different team exposure γ_{30}	.001	.002	.044*	.021
Tradition (P5) γ_{01}			.097	.883
Cross Level Interaction				
Same team exposure X P5 γ_{21}			-.001	.039
Constant γ_{00}	.675+	.385	1.390	1.206
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.007**	.003	.021	.022
SD (constant) μ_{0j}	.016	.044	.678	.477
SD (Residual) e_{ij}	.350**	.019	.514**	.052

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.14f. Model 2 and 3 for college aspiration with coach's regard for academics at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.852**	.078	.499**	.207
Same team exposure γ_{20}	.000	.003	-.110	.292
Different team exposure γ_{30}	.001	.002	.047*	.020
Coach's regard for academics (Q) γ_{01}			-.776	1.174
Cross Level Interaction				
Same team exposure X Q γ_{21}			.017	.053
Constant γ_{00}	.675+	.385	6.096	6.599
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.007**	.003	.024	.022
SD (constant) μ_{0j}	.016	.044	.658	.505
SD (Residual) e_{ij}	.350**	.019	.509**	.052

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.14g. Model 2 and 3 for college aspiration with task cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.852**	.078	.544**	.215
Same team exposure γ_{20}	.000	.003	-.166	.207
Different team exposure γ_{30}	.001	.002	.044*	.020
Task cohesion (R) γ_{01}			-.528	.616
Cross Level Interaction				
Same team exposure X R γ_{21}			.021	.029
Constant γ_{00}	.675+	.385	5.366	4.402
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.007**	.003	.020	.028
SD (constant) μ_{0j}	.016	.044	.636	.636
SD (Residual) e_{ij}	.350**	.019	.515**	.057

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.14h. Model 2 and 3 for college aspiration with social cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.852**	.078	.595**	.219
Same team exposure γ_{20}	.000	.003	-.140	.172
Different team exposure γ_{30}	.001	.002	.047*	.020
Social cohesion (S) γ_{01}			-.385	.544
Cross Level Interaction				
Same team exposure X S γ_{21}			.017	.024
Constant γ_{00}	.675+	.385	4.128	3.896
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.007**	.003	.019	.023
SD (constant) μ_{0j}	.016	.044	.617	.50
SD (Residual) e_{ij}	.350**	.019	.516**	.053

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.15a. Model 2 and 3 for college expectation with team size at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.667**	.057	.783**	.111
Same team exposure γ_{20}	.000	.002	-.018	.017
Different team exposure γ_{30}	-.000	.002	.028*	.014
Team size (P1) γ_{01}			.007	.005
Cross Level Interaction				
Same team exposure X P1 γ_{21}			-.000	.000
Constant γ_{00}	1.63**	.286	.839	.676
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.002	.007	.000	.000
SD (constant) μ_{0j}	.016	.101	.000	.000
SD (Residual) e_{ij}	.322**	.018	.353**	..024

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.15b. Model 2 and 3 for college expectation with popularity at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.667**	.057	.749**	.112
Same team exposure γ_{20}	.000	.002	-.042	.025
Different team exposure γ_{30}	-.000	.002	.026+	.014
Popularity (P2) γ_{01}			-.081	.115
Cross Level Interaction				
Same team exposure X P2 γ_{21}			.003	.005
Constant γ_{00}	1.63**	.286	1.649**	.673
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.002	.007	.009	.050
SD (constant) μ_{0j}	.016	.101	.163	.894
SD (Residual) e_{ij}	.322**	.018	.356**	.042

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.15c. Model 2 and 3 for college expectation with winter season at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.667**	.057	.745**	.112
Same team exposure γ_{20}	.000	.002	-.034*	.015
Different team exposure γ_{30}	-.000	.002	.023	.015
Winter season (P3) γ_{01}			-.273	.530
Cross Level Interaction				
Same team exposure X P3 γ_{21}			.014	.025
Constant γ_{00}	1.63**	.286	1.492*	.618
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.002	.007	1.06	1.05
SD (constant) μ_{0j}	.016	.101	2.01	2.06
SD (Residual) e_{ij}	.322**	.018	.361	.357

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.15d. Model 2 and 3 for college expectation with revenue at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.667**	.057	.565**	.112
Same team exposure γ_{20}	.000	.002	-.031	.015
Different team exposure γ_{30}	-.000	.002	.023	.015
Revenue (P4) γ_{01}			-.273	.530
Cross Level Interaction				
Same team exposure X P4 γ_{21}			.014	.025
Constant γ_{00}	1.63**	.286	1.430**	.618
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.002	.007	1.06	1.05
SD (constant) μ_{0j}	.016	.101	2.01	2.06
SD (Residual) e_{ij}	.322**	.018	.361	.357

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.15e. Model 2 and 3 for college expectation with tradition at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.667**	.057	.752**	.111
Same team exposure γ_{20}	.000	.002	-.027	.019
Different team exposure γ_{30}	-.000	.002	.025	.015
Tradition (P5) γ_{01}			.107	.522
Cross Level Interaction				
Same team exposure X P5 γ_{21}			-.000	.024
Constant γ_{00}	1.63**	.286	1.24+	.693
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.002	.007	.002	.196
SD (constant) μ_{0j}	.016	.101	.048	3.65
SD (Residual) e_{ij}	.322**	.018	.359**	.040

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.15f. Model 2 and 3 for college expectation with coach's regard for academics at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.667**	.057	.695**	.116
Same team exposure γ_{20}	.000	.002	.141	.188
Different team exposure γ_{30}	-.000	.002	.030*	.014
Coach's regard for academics (Q) γ_{01}			.542	.721
Cross Level Interaction				
Same team exposure X Q γ_{21}			-.031	.034
Constant γ_{00}	1.63**	.286	-1.37	4.09
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.002	.007	.017	.022
SD (constant) μ_{0j}	.016	.101	.297	.435
SD (Residual) e_{ij}	.322**	.018	.348**	.037

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.15g. Model 2 and 3 for college expectation with task cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.667**	.057	.729**	.111
Same team exposure γ_{20}	.000	.002	.145	.133
Different team exposure γ_{30}	-.000	.002	.025	.014
Task cohesion (R) γ_{01}			.470	.368
Cross Level Interaction				
Same team exposure X R γ_{21}			-.025	.018
Constant γ_{00}	1.63**	.286	-1.80	2.62
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.002	.007	.016	.032
SD (constant) μ_{0j}	.016	.101	.170	.577
SD (Residual) e_{ij}	.322**	.018	.352	.040

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.15h. Model 2 and 3 for college expectation with social cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.667**	.057	.679**	.112
Same team exposure γ_{20}	.000	.002	.015	.107
Different team exposure γ_{30}	-.000	.002	.021	.013
Social cohesion (S) γ_{01}			.096	.336
Cross Level Interaction				
Same team exposure X S γ_{21}			-.005	.015
Constant γ_{00}	1.63**	.286	.958	2.40
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.002	.007	.013	.033
SD (constant) μ_{0j}	.016	.101	.474	.808
SD (Residual) e_{ij}	.322**	.018	.324**	.049

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.16a. Model 2 and 3 for student identity with team size at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.709**	.000	.759**	.076
Same team exposure γ_{20}	.000	.005	-.059*	.027
Different team exposure γ_{30}	.002	.005	.034*	.016
Team size (P1) γ_{01}			-.008	.009
Cross Level Interaction				
Same team exposure X P1 γ_{21}			.000	.000
Constant γ_{00}	1.48**	.276	1.85**	.703
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.012	.008	.027	.019
SD (constant) μ_{0j}	.240*	.12	.701	.412
SD (Residual) e_{ij}	.647**	.039	.596**	.057

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.16b. Model 2 and 3 for student identity with popularity at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.709**	.000	.775**	.074
Same team exposure γ_{20}	.000	.005	-.027	.036
Different team exposure γ_{30}	.002	.005	.033*	.016
Popularity (P2) γ_{01}			.010	.185
Cross Level Interaction				
Same team exposure X P2 γ_{21}			-.002	.008
Constant γ_{00}	1.48**	.276	1.275	.842
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.012	.008	.031	.019
SD (constant) μ_{0j}	.240*	.12	.749	.408
SD (Residual) e_{ij}	.647**	.039	.598**	.057

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.16c. Model 2 and 3 for student identity with winter season at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.709**	.000	.773**	.075
Same team exposure γ_{20}	.000	.005	-.041+	.023
Different team exposure γ_{30}	.002	.005	.038*	.016
Winter season (P3) γ_{01}			.282	.827
Cross Level Interaction				
Same team exposure X P3 γ_{21}			-.005	.037
Constant γ_{00}	1.48**	.276	1.31*	.619
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.012	.008	.030	.023
SD (constant) μ_{0j}	.240*	.12	.694	.506
SD (Residual) e_{ij}	.647**	.039	.615**	.059

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.16d. Model 2 and 3 for student identity with revenue at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.709**	.000	.773**	.074
Same team exposure γ_{20}	.000	.005	-.047+	.027
Different team exposure γ_{30}	.002	.005	.034*	.016
Revenue (P4) γ_{01}			-.183	.839
Cross Level Interaction				
Same team exposure X P4 γ_{21}			.018	.038
Constant γ_{00}	1.48**	.276	1.44*	.715
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.012	.008	.036	.019
SD (constant) μ_{0j}	.240*	.12	.857	.410
SD (Residual) e_{ij}	.647**	.039	.587**	.056

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.16e. Model 2 and 3 for student identity with tradition at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.709**	.000	.774**	.074
Same team exposure γ_{20}	.000	.005	-.032	.029
Different team exposure γ_{30}	.002	.005	.035*	.016
Tradition (P5) γ_{01}			.249	.853
Cross Level Interaction				
Same team exposure X P5 γ_{21}			-.003	.039
Constant γ_{00}	1.48**	.276	1.12	.753
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.012	.008	.035	.020
SD (constant) μ_{0j}	.240*	.12	.828	.419
SD (Residual) e_{ij}	.647**	.039	.594**	.057

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.16f. Model 2 and 3 for student identity with coach's regard for academics at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.709**	.000	.769**	.074
Same team exposure γ_{20}	.000	.005	.257	.278
Different team exposure γ_{30}	.002	.005	.033*	.016
Coach's regard for academics (Q) γ_{01}			1.02	1.07
Cross Level Interaction				
Same team exposure X Q γ_{21}			-0.52	.049
Constant γ_{00}	1.48**	.276	-4.33	6.06
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.012	.008	.026	.019
SD (constant) μ_{0j}	.240*	.12	.644	.426
SD (Residual) e_{ij}	.647**	.039	.603**	.058

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.16g. Model 2 and 3 for student identity with task cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.709**	.000	.766**	.071
Same team exposure γ_{20}	.000	.005	-.385*	.161
Different team exposure γ_{30}	.002	.005	.031*	.015
Task cohesion (R) γ_{01}			-1.238**	.462
Cross Level Interaction				
Same team exposure X R γ_{21}			.047*	.022
Constant γ_{00}	1.48**	.276	10.41**	3.32
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.012	.008	.000	.005
SD (constant) μ_{0j}	.240*	.12	.001	.002
SD (Residual) e_{ij}	.647**	.039	.589**	.054

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.16h. Model 2 and 3 for student identity with social cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.709**	.000	.774**	.073
Same team exposure γ_{20}	.000	.005	-.260	.176
Different team exposure γ_{30}	.002	.005	.033*	.016
Social cohesion (S) γ_{01}			-.812	.540
Cross Level Interaction				
Same team exposure X S γ_{21}			.031	.024
Constant γ_{00}	1.48**	.276	7.09+	3.80
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.012	.008	.028	.023
SD (constant) μ_{0j}	.240*	.12	.626	.491
SD (Residual) e_{ij}	.647**	.039	.595**	.057

Note. No. of observations=131; No. of groups=20. The average of observations per group=6.5 (Min.=1 & Max=15). + (p<.08); *(p<.05); **(p<.01)

Table 2.17a. Model 2 and 3 for athletic identity with team size at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.811**	.046	.794**	.083
Same team exposure γ_{20}	.006	.004	.005	.026
Different team exposure γ_{30}	-.000	.004	-.001	.015
Team size (P1) γ_{01}			.003	.008
Cross Level Interaction				
Same team exposure X P1 γ_{21}			.000	.000
Constant γ_{00}	.832**	.235	.703	.574
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.005	.010	.018	.049
SD (constant) μ_{0j}	.198	.115	.327	1.10
SD (Residual) e_{ij}	.606**	.035	.630**	.063

Note. No. of observations=171; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.17b. Model 2 and 3 for athletic identity with popularity at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.811**	.046	.819**	.082
Same team exposure γ_{20}	.006	.004	.020	.036
Different team exposure γ_{30}	-.000	.004	-.000	.015
Popularity (P2) γ_{01}			-.003	.169
Cross Level Interaction				
Same team exposure X P2 γ_{21}			.890	.007
Constant γ_{00}	.832**	.235	.898	.899
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.005	.010	.000	.000
SD (constant) μ_{0j}	.198	.115	.001	.001
SD (Residual) e_{ij}	.606**	.035	.637**	.045

Note. No. of observations=171; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.17c. Model 2 and 3 for athletic identity with winter season at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.811**	.046	.845**	.085
Same team exposure γ_{20}	.006	.004	-.001	.020
Different team exposure γ_{30}	-.000	.004	-.002	.016
Winter season (P3) γ_{01}			-.918	.806
Cross Level Interaction				
Same team exposure X P3 γ_{21}			.039	.038
Constant γ_{00}	.832**	.235	.882	.568
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.005	.010	.005	.023
SD (constant) μ_{0j}	.198	.115	.115	.495
SD (Residual) e_{ij}	.606**	.035	.634**	.062

Note. No. of observations=171; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.17d. Model 2 and 3 for athletic identity with revenue at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.811**	.046	.830**	.080
Same team exposure γ_{20}	.006	.004	-.007	.022
Different team exposure γ_{30}	-.000	.004	-.002	.014
Revenue (P4) γ_{01}			-.372	.775
Cross Level Interaction				
Same team exposure X P4 γ_{21}			.042	.035
Constant γ_{00}	.832**	.235	.839	.547
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.005	.010	.023	.026
SD (constant) μ_{0j}	.198	.115	.554	.604
SD (Residual) e_{ij}	.606**	.035	.604**	.058

Note. No. of observations=171; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.17e. Model 2 and 3 for athletic identity with tradition at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.811**	.046	.845**	.081
Same team exposure γ_{20}	.006	.004	.027	.027
Different team exposure γ_{30}	-.000	.004	.004	.016
Tradition (P5) γ_{01}			1.07	.743
Cross Level Interaction				
Same team exposure X P5 γ_{21}			-.039	.036
Constant γ_{00}	.832**	.235	-.031	.678
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.005	.010	.024	.026
SD (constant) μ_{0j}	.198	.115	.332	.571
SD (Residual) e_{ij}	.606**	.035	.628**	.062

Note. No. of observations=171; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.17f. Model 2 and 3 for athletic identity with coach's regard for academics at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.811**	.046	.923**	.083
Same team exposure γ_{20}	.006	.004	.242	.290
Different team exposure γ_{30}	-.000	.004	.004	.016
Coach's regard for academics (Q) γ_{01}			.408	1.09
Cross Level Interaction				
Same team exposure X Q γ_{21}			-.042	.051
Constant γ_{00}	.832**	.235	-2.07	6.15
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.005	.010	.035	.031
SD (constant) μ_{0j}	.198	.115	.698	.649
SD (Residual) e_{ij}	.606**	.035	.637**	.064

Note. No. of observations=171; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.17g. Model 2 and 3 for athletic identity with task cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.811**	.046	.843**	.087
Same team exposure γ_{20}	.006	.004	-.149	.230
Different team exposure γ_{30}	-.000	.004	.004	.017
Task cohesion (R) γ_{01}			-.530	.619
Cross Level Interaction				
Same team exposure X R γ_{21}			.021	.031
Constant γ_{00}	.832**	.235	4.42	4.47
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.005	.010	.013	.026
SD (constant) μ_{0j}	.198	.115	.051	.569
SD (Residual) e_{ij}	.606**	.035	.636**	.063

Note. No. of observations=171; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.17h. Model 2 and 3 for athletic identity with social cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.811**	.046	.866**	.085
Same team exposure γ_{20}	.006	.004	-.153	.201
Different team exposure γ_{30}	-.000	.004	.005	.017
Social cohesion (S) γ_{01}			-.612	.529
Cross Level Interaction				
Same team exposure X S γ_{21}			.022	.028
Constant γ_{00}	.832**	.235	4.83	3.75
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.005	.010	.019	.024
SD (constant) μ_{0j}	.198	.115	.205	.519
SD (Residual) e_{ij}	.606**	.035	.630**	.062

Note. No. of observations=171; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.18a. Model 2 and 3 for physical ability with team size at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.022	.104	.254	.270
Same team exposure γ_{20}	-.000	.005	.024	.079
Different team exposure γ_{30}	.008	.006	.013	.038
Team size (P1) γ_{01}			.040	.030
Cross Level Interaction				
Same team exposure X P1 γ_{21}			-.001	.001
Constant γ_{00}	4.24	.561	1.79	2.35
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.007	.118	.072
SD (constant) μ_{0j}	.176	.118	3.08	1.76
SD (Residual) e_{ij}	.820**	.046	1.17	1.25

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=2 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.18b. Model 2 and 3 for physical ability with popularity at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.022	.104	.225	.262
Same team exposure γ_{20}	-.000	.005	-.013	.099
Different team exposure γ_{30}	.008	.006	.016	.037
Popularity (P2) γ_{01}			-.120	.552
Cross Level Interaction				
Same team exposure X P2 γ_{21}			-.002	.021
Constant γ_{00}	4.24	.561	3.99	2.94
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.007	.108	.063
SD (constant) μ_{0j}	.176	.118	3.02	1.58
SD (Residual) e_{ij}	.820**	.046	1.13**	.118

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=2 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.18c. Model 2 and 3 for physical ability with winter season at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.022	.104	.291	.272
Same team exposure γ_{20}	-.000	.005	.021	.058
Different team exposure γ_{30}	.008	.006	.007	.038
Winter season (P3) γ_{01}			2.08	2.31
Cross Level Interaction				
Same team exposure X P3 γ_{21}			-.084	.092
Constant γ_{00}	4.24	.561	2.36	2.08
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.007	.078	.046
SD (constant) μ_{0j}	.176	.118	2.42	1.16
SD (Residual) e_{ij}	.820**	.046	1.17**	.122

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=2 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.18d. Model 2 and 3 for physical ability with revenue at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.022	.104	.271	.268
Same team exposure γ_{20}	-.000	.005	-.007	.072
Different team exposure γ_{30}	.008	.006	.008	.037
Revenue (P4) γ_{01}			.925	2.46
Cross Level Interaction				
Same team exposure X P4 γ_{21}			-.012	.095
Constant γ_{00}	4.24	.561	2.83	2.27
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.007	.093	.056
SD (constant) μ_{0j}	.176	.118	2.73*	1.39
SD (Residual) e_{ij}	.820**	.046	1.16**	.120

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=2 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.18e. Model 2 and 3 for physical ability with tradition at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.022	.104	.029	.147
Same team exposure γ_{20}	-.000	.005	-.007	.039
Different team exposure γ_{30}	.008	.006	.003	.038
Tradition (P5) γ_{01}			-2.02	1.43
Cross Level Interaction				
Same team exposure X P5 γ_{21}			.080	.055
Constant γ_{00}	4.24**	.561	3.783	2.473
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.007	.063	.043
SD (constant) μ_{0j}	.176	.118	2.05	1.36
SD (Residual) e_{ij}	.820**	.046	1.18**	.121

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=2 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.18f. Model 2 and 3 for physical ability with coach's regard for academics at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.022	.104	.254	.270
Same team exposure γ_{20}	-.000	.005	.024	.079
Different team exposure γ_{30}	.008	.006	.013	.038
Coach's regard for academics (Q) γ_{01}			.040	.030
Cross Level Interaction				
Same team exposure X Q γ_{21}			-.001	.001
Constant γ_{00}	4.24	.561	1.79	2.35
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.007	.118	.72
SD (constant) μ_{0j}	.176	.118	3.08	1.76
SD (Residual) e_{ij}	.820**	.046	1.17**	.125

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=2 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.18g. Model 2 and 3 for physical ability with task cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.022	.104	.262	.276
Same team exposure γ_{20}	-.000	.005	-.857+	.486
Different team exposure γ_{30}	.008	.006	.004	.038
Task cohesion (R) γ_{01}			-3.00+	1.69
Cross Level Interaction				
Same team exposure X R γ_{21}			.120+	.067
Constant γ_{00}	4.24	.561	24.4	12.5
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.007	.078	.055
SD (constant) μ_{0j}	.176	.118	2.49	1.42
SD (Residual) e_{ij}	.820**	.046	1.16**	.128

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=2 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.18h. Model 2 and 3 for physical ability with social cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.022	.104	.289	.269
Same team exposure γ_{20}	-.000	.005	-.571	.399
Different team exposure γ_{30}	.008	.006	.003	.038
Social cohesion (S) γ_{01}			-2.02	1.43
Cross Level Interaction				
Same team exposure X S γ_{21}			.080	.055
Constant γ_{00}	4.24	.561	17.3	10.3
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.003	.007	.063	.053
SD (constant) μ_{0j}	.176	.118	2.03	1.36
SD (Residual) e_{ij}	.820**	.046	1.18**	.123

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=2 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.19a. Model 2 and 3 for physical appearance with team size at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.249	.161	.006	.166
Same team exposure γ_{20}	.008	.008	.007	.042
Different team exposure γ_{30}	.010	.009	.009	.29
Team size (P1) γ_{01}			-.006	.011
Cross Level Interaction				
Same team exposure X P1 γ_{21}			.000	.000
Constant γ_{00}	2.89**	.899	3.79**	1.09
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.000	.001	.006	.038
SD (constant) μ_{0j}	.389*	.149	.019	.806
SD (Residual) e_{ij}	1.25**	.072	.783**	.079

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.19b. Model 2 and 3 for physical appearance with popularity at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.249	.161	-.008	.162
Same team exposure γ_{20}	.008	.008	.076	.055
Different team exposure γ_{30}	.010	.009	.023	.029
Popularity (P2) γ_{01}			.203	.246
Cross Level Interaction				
Same team exposure X P2 γ_{21}			-.012	.011
Constant γ_{00}	2.89**	.899	2.65*	1.24
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.000	.001	.026	.029
SD (constant) μ_{0j}	.389*	.149	.190	.585
SD (Residual) e_{ij}	1.25**	.072	.741**	.076

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.19c. Model 2 and 3 for physical appearance with winter season at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.249	.161	-.058	.162
Same team exposure γ_{20}	.008	.008	.016	.034
Different team exposure γ_{30}	.010	.009	.022	.029
Winter season (P3) γ_{01}			-1.26	1.23
Cross Level Interaction				
Same team exposure X P3 γ_{21}			.047	.061
Constant γ_{00}	2.89**	.899	4.01**	1.02
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.000	.001	.037	.028
SD (constant) μ_{0j}	.389*	.149	.467	.590
SD (Residual) e_{ij}	1.25**	.072	.740**	.073

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.19d. Model 2 and 3 for physical appearance with revenue at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.249	.161	-.012	.174
Same team exposure γ_{20}	.008	.008	.009	.040
Different team exposure γ_{30}	.010	.009	.009	.029
Revenue (P4) γ_{01}			-1.22	1.06
Cross Level Interaction				
Same team exposure X P4 γ_{21}			.059	.051
Constant γ_{00}	2.89**	.899	4.11**	1.13
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.000	.001	.022	.031
SD (constant) μ_{0j}	.389*	.149	.146	.663
SD (Residual) e_{ij}	1.25**	.072	.764**	.077

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.19e. Model 2 and 3 for physical appearance with tradition at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.249	.161	.012	.175
Same team exposure γ_{20}	.008	.008	.019	.043
Different team exposure γ_{30}	.010	.009	.008	.030
Tradition (P5) γ_{01}			-.711	1.12
Cross Level Interaction				
Same team exposure X P5 γ_{21}			.037	.054
Constant γ_{00}	2.89**	.899	3.79**	1.13
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.000	.001	.020	.018
SD (constant) μ_{0j}	.389*	.149	.123	.231
SD (Residual) e_{ij}	1.25**	.072	.774**	.074**

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.19f. Model 2 and 3 for physical appearance with coach's regard for academics at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.249	.161	-.018	.169
Same team exposure γ_{20}	.008	.008	-.478	.419
Different team exposure γ_{30}	.010	.009	.023	.029
Coach's regard for academics (Q) γ_{01}			-2.19	1.60
Cross Level Interaction				
Same team exposure X Q γ_{21}			.092	.075
Constant γ_{00}	2.89**	.899	15.4	9.04
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.000	.001	.020	.026
SD (constant) μ_{0j}	.389*	.149	.047	.565
SD (Residual) e_{ij}	1.25**	.072	.738**	.076

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.19g. Model 2 and 3 for physical appearance with task cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.249	.161	.011	.181
Same team exposure γ_{20}	.008	.008	-.244	.316
Different team exposure γ_{30}	.010	.009	.020	.030
Task cohesion (R) γ_{01}			-.504	.879
Cross Level Interaction				
Same team exposure X R γ_{21}			.035	.043
Constant γ_{00}	2.89**	.899	6.88	6.43
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.000	.001	.021	.036
SD (constant) μ_{0j}	.389*	.149	.186	.781
SD (Residual) e_{ij}	1.25**	.072	.776**	.078

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 2.19h. Model 2 and 3 for physical appearance with social cohesion at both levels

	Model2		Model3	
Fixed Effect	Coef.	S.E.	Coef.	S.E.
Prior status β_1	.249	.161	.001	.179
Same team exposure γ_{20}	.008	.008	-.143	.247
Different team exposure γ_{30}	.010	.009	.018	.030
Social cohesion (S) γ_{01}			-.339	.679
Cross Level Interaction				
Same team exposure X S γ_{21}			.025	.034
Constant γ_{00}	2.89**	.899	5.73	4.92
Random Effect	Est.	S.E.	Est.	S.E.
SD (slope) μ_{2j}	.000	.001	.028	.034
SD (constant) μ_{0j}	.389*	.149	.288	.735
SD (Residual) e_{ij}	1.25**	.072	.769**	.077

Note. No. of observations=172; No. of groups=20. The average of observation per group=8.6 (Min.=1 & Max=19). + (p<.08); *(p<.05); **(p<.01)

Table 3.1. Descriptive statistics of independent variables of selection models

Variables	No. of all pairs	Mean	Std. Dev.	Min	Max
Network at Time1	46897	0.02	0.13	0.00	1.00
Same gender	46897	0.38	0.49	0.00	1.00
Same team	47525	0.10	0.29	0.00	1.00
Same race	47106	0.53	0.50	0.00	1.00
Similarity of grade	33128	1.18	0.94	0.00	3.00
Similarity of GPA	21179	0.42	0.39	0.00	2.00
Similarity of aspiration	32924	0.20	0.42	0.00	2.00
Similarity of expectation	32924	0.28	0.56	0.00	3.00
Similarity of coach's regard	32964	1.43	1.13	0.00	6.00
Similarity of other's expectation	30767	0.53	0.59	0.00	5.00
Similarity of academic efficacy	33658	0.69	0.56	0.00	3.00
Similarity of athlete identity	32559	1.31	0.96	0.00	5.22
Similarity of academic identity	32559	1.19	0.88	0.00	5.00
Similarity of physical appearance	33167	0.72	0.57	0.00	3.00
Similarity of physical ability	33167	0.73	0.55	0.00	3.00
Similarity of task cohesion	33699	1.53	1.26	0.00	8.00
Similarity of social cohesion	33699	1.76	1.47	0.00	7.38
No. of shared extra activities	46897	0.05	0.21	0.00	3.00
No. of shared courses	46897	3.78	2.69	1.00	8.00

Table 3.2. Selection model for friendship network at Time2 (n=18505).

Predictors	Odds Ratio	Coef.	X-Stan. coef.	Std. Err.	z
Prior network	47.86	3.87	0.39	0.19	20.71**
Same gender	2.26	0.81	0.41	0.15	5.51**
team	2.11	0.75	0.20	0.17	4.40**
race	0.74	-0.31	-0.14	0.15	-2.11*
Si. of grade	4.28	1.45	1.35	0.12	12.44**
academic achiev.	1.94	0.66	0.21	0.23	2.84**
aspiration	0.57	-0.56	-0.23	0.19	-2.96**
expectation	1.39	0.33	0.16	0.18	1.87+
coach’s regards	1.19	0.18	0.18	0.08	2.32*
others’ edu. expec.	0.96	-0.04	-0.02	0.11	-0.38
academic efficacy	1.28	0.24	0.12	0.14	1.72
athletic identity	0.85	-0.16	-0.15	0.07	-2.17*
academic identity	0.95	-0.05	-0.05	0.08	-0.70
physical appear.	1.34	0.29	0.15	0.14	2.12*
physical ability	1.01	0.01	0.00	0.12	0.07
task cohesion	1.08	0.07	0.08	0.07	1.04
social cohesion	1.05	0.05	0.08	0.05	1.00
No. of shared other acti.	1.76	0.57	0.16	0.16	3.54**
No. of overlapped classes	1.04	0.04	0.08	0.03	1.20
Intercept	0.05	-2.95		0.30	-9.68

Note. Si.=similarity. Odd ratio = exp (coefficient). X-standardized=coefficient * SD of each variables. + (p<.08); *(p<.05); **(p<.01)

Table 3.3. Selection model for forming new friendships (Time1->Time2)

Predictors	Odds Ratio	Coef.	X-Stan. coef.	Std. Err.	z
Same gender	2.67	0.98	1.63	0.44	5.98**
team	2.45	0.90	1.25	0.45	4.92**
race	0.74	-0.30	0.87	0.12	-1.93*
Si. of grade	6.24	1.83	5.48	0.90	12.64**
academic achiev.	2.48	0.91	1.33	0.65	3.47**
aspiration	0.63	-0.46	0.8	0.12	-2.35*
expectation	1.23	0.21	1.10	0.23	1.11
coach's regards	1.14	0.13	1.14	0.09	1.65
others' edu. expec.	0.94	-0.06	0.96	0.11	-0.50
academic efficacy	1.25	0.22	1.11	0.19	1.43
athletic identity	0.81	-0.21	0.81	0.07	-2.57*
academic identity	0.94	-0.06	0.94	0.08	-0.72
physical appear.	1.32	0.27	1.15	0.20	1.83+
physical ability	1.01	0.01	1.00	0.13	0.05
task cohesion	1.04	0.04	1.04	0.08	0.55
social cohesion	1.10	0.10	1.15	0.06	1.63
No. of shared other acti.	0.82	-0.20	0.79	0.05	-3.53**
No. of overlapped classes	1.06	0.06	1.12	0.04	1.67
Intercept	0.91	0.98		0.74	-0.11

Si.=similarity. Odd ratio = exp (coefficient). X-standardized=coefficient * SD of each variables. + (p<.08); *(p<.05); **(p<.01)

Table 3.4. Multilevel analysis of selection model with network data at Time2

	Model1		Model2		Model3	
Fixed Effect-Level1	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Prior network π_{1i}			4.05**	0.20	3.97**	0.20
Same gender π_{2i}			0.87**	0.15	0.93**	0.15
team π_{3i}			0.44**	0.10	0.45**	0.10
race π_{4i}			-0.28	0.17	-0.22	0.16
Si. of grade π_{5i}			-1.47**	0.12	-1.50**	0.12
academic achiev. π_{6i}			-0.70**	0.25	-0.61*	0.26
aspiration π_{7i}			0.59**	0.21	0.67**	0.24
expectation π_{8i}			-0.25	0.19	-0.09	0.21
coach's regards π_{9i}			-0.22**	0.08	-0.22**	0.08
others' edu. expec. π_{10i}			0.07	0.12	0.10	0.12
academic efficacy π_{11i}			-0.16	0.15	-0.15	0.16
athletic identity π_{12i}			-0.15*	0.08	-0.10	0.08
academic identity π_{13i}			0.07	0.08	0.08	0.08
physical appear. π_{14i}			-0.30*	0.15	-0.25	0.15
physical ability π_{15i}			-0.01	0.13	0.00	0.13
task cohesion π_{16i}			-0.05	0.08	-0.03	0.08
social cohesion π_{17i}			-0.07	0.06	-0.06	0.06
No. of shared other acti. π_{18i}			0.46**	0.18	0.25	0.18
No. of overlapped classes π_{19i}			0.06	0.04	0.06	0.04
Fixed Effect-Level2 (nominators' characteristic)						
Gender β_2					0.48**	0.17
Grade β_5					0.34**	0.08
Academic achiev. β_6					0.39	0.28
Aspiration β_7					0.02	0.35
Expectation β_8					0.16	0.33
Coach's regards β_9					-0.02	0.09
Others' edu. expec. β_{10}					-0.02	0.15
Academic efficacy β_{11}					0.16	0.18
Athletic identity β_{12}					0.00	0.09
Academic identity β_{13}					0.09	0.08
Physical appear. β_{14}					-0.09	0.16
Physical ability β_{15}					0.09	0.14
Task cohesion β_{16}					0.00	0.10
Social cohesion β_{17}					0.05	0.08
Intercept β_{00}	-4.18**	.055	-3.93	.409	-9.40	2.11
Random Effect- Intercept	Est.	S.E.	Est.	S.E.	Est.	S.E.
Var. Level-2 μ_{0i}	.189	.052	.384	.145	.145	.106
No. of ties	36852		17766		17766	
No. of nominators	196		144		144	

Note. Si.=similarity. *(p<.05) **(p<.01).

Table 4.1. Descriptive statistics of the five items

Items on interaction	n	Mean	S.D.	Min	Max	Skew.	Kur.
General	770	4.59	.92	1	5	-2.61	9.41
Academic	839	3.75	1.38	1	5	-.80	2.36
Athletic	837	3.81	1.31	1	5	-.77	2.36
Social	834	4.14	1.19	1	5	-1.33	3.74
Emotional	831	3.67	1.47	1	5	-.68	2.00
Mean of five items	763	4.03	.92	1	5	-1.09	4.06

Table 4.2. The coefficient of one factor model

Items on interaction	Standardized coefficient	S.E.	Z
General	.65	.025	26.00***
Academic	.55	.029	37.56***
Athletic	.65	.025	26.16***
Social	.84	.018	45.56***
Emotional	.63	.025	24.82***

*** (p<.000).

Table 4.3. Bivariate correlations between the items

	1	2	3	4	5
General					
Academic	.320**				
Athletic	.286**	.249**			
Social	.434**	.311**	.389**		
Emotional	.301**	.335**	.358**	.504**	

**: *p*<.01

Table 4.4. Item-test correlation and reliability

Items on interaction	n	Item-test correlation	Average inter-item covariance	Cronbach's alpha
General	770	.69	.82	.76
Academic	839	.70	.73	.78
Athletic	837	.75	.69	.75
Social	834	.83	.64	.70
Emotional	831	.76	.67	.76
Test scale			.71	.79

Table 4.5. Comparison of single-level IRT models

Models	Log likelihood	df	AIC	BIC	LR-test
2PL-PCM	-6352.34	25	12754.69	12952.96	-
PCM	-6359.61	21	12761.22	12927.77	16.66 (4)**
RSM	-6383.57	9	12785.14	12856.31	47.92 (12)**

Note. 2PL-PCM is the 2-parameter partial-credit model. PCM is the partial-credit model. RSM is the rating scale model. 2PL-PCM is nested in PCM. PCM is nested in RSM. LR-test is the likelihood ratio test following chi-square distribution. The parenthesis is a degree of freedom for LR-test. **: p<.01. The criteria of chi-square are 13.28 and 26.22 at df=4 and df=12, respectively, at .01 of type I error.

Table 4.6. The results of Multilevel 2PL-PCM

Parameters	Coefficient	S.E.	Z
$\beta_1 + \tau_1$	2.240	.172	12.98**
$\beta_1 + \tau_2$	1.968	.340	5.79**
$\beta_1 + \tau_3$	3.481	.507	2.85**
$\beta_1 + \tau_4$	1.718	.603	2.85**
$\beta_2 + \tau_1$	.534	.105	5.08**
$\beta_2 + \tau_2$	.268	.122	2.20*
$\beta_2 + \tau_3$	1.11	.163	6.84**
$\beta_2 + \tau_4$	.070	.181	.39
$\beta_3 + \tau_1$	.533	.121	4.37**
$\beta_3 + \tau_2$	.233	.137	1.71
$\beta_3 + \tau_3$	1.169	.166	7.00**
$\beta_3 + \tau_4$	1.344	.215	6.24**
$\beta_4 + \tau_1$	.783	.209	3.74**
$\beta_4 + \tau_2$	2.302	.426	5.40**
$\beta_4 + \tau_3$	3.697	.608	6.08**
$\beta_4 + \tau_4$	4.045	.826	4.90**
$\beta_5 + \tau_1$	.294	.220	1.34
$\beta_5 + \tau_2$	.783	.251	3.12**
$\beta_5 + \tau_3$	1.669	.308	5.42**
$\beta_5 + \tau_4$	1.854	.411	4.51**
λ_1	1 (fixed)		
λ_2	.341	.060	5.68**
λ_3	.530	.097	5.46**
λ_4	1.697	.511	3.32**
λ_5	.589	.171	3.44**
Variance (tie-level)	2.034 (.637)		
Variance (ego-level)	.547 (.244)		
Fit index	Log likelihood: -4452.902 df: 30, AIC: 8965.80, BIC: 9203.72		

Note. β_i is the estimated difficulty parameters of item *i* for the lowest category. τ_j is the threshold difficulty for changing category *j* to *j+1* of each item. λ_i is the discriminant parameters (factor loadings) of item *i*. The parenthesis is the standard error of the variance of random effect at tie- and ego-level. ***(*p*<.000), **(*p*<.01), *(*p*<.05)

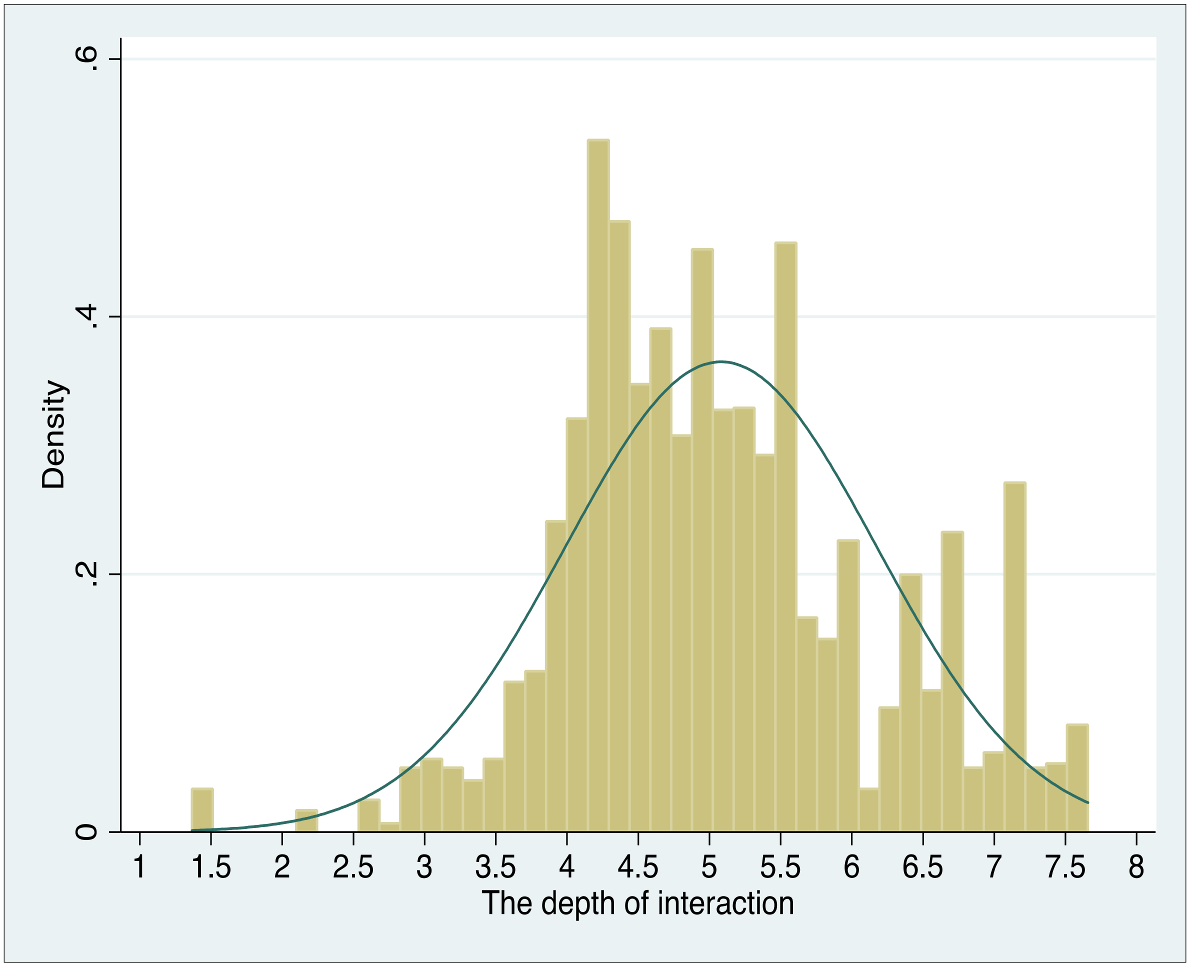
Table 4.7. Comparison of the two influence models with the raw frequency and the depth of interaction.

y	*n*	β_2		$\beta_2 L$	
		β_{2-1}	β_{2-2}	$\beta_{2-1}L$	$\beta_{2-2}L$
Academic achievement	127	.03(.003)		.033(.002)	
	127	-.011 (.001)	-.011 (.001)	-.011(.001)	.029(.001)
Academic efficacy	175	.071(.007)		.064(.006)	
	182	.045(.003)	.045(.003)	.043(.002)	.077(.002)
College aspiration	172	.077(.007)		.085(.007)	
	180	-.009(.00)	-.009(.00)	-.013(.002)	.001(.002)
College expectation	172	-.040(.006)		-.044(.005)	
	180	-.025(.002)	-.025(.002)	-.016(.002)	.-057(.002)
Academic identity	171	-.002(.01)		.014(.009)	
	179	-.018(.005)	-.018(.005)	-.013(.004)	.040(.004)
Athletic identity	170	.015(.009)		.029(.007)	
	179	.067(.004)	.067(.004)	.071(.003)	-.034(.003)
Physical ability	172	.066(.02)		.055(.016)	
	180	.016(.008)	.016(.008)	.002(.006)	.027(.007)
Physical appearance	172	.192(.014)*		.171(.012)*	
	64	.001(.005)	.001(.005)	-.017(.004)	.118(.005)+

Note. The exposures ($\beta_2, \beta_{2-1},$ and β_{2-2}) were obtained with the mean of frequencies of the overall interaction. $\beta_2 L, \beta_{2-1} L,$ and $\beta_{2-2} L$ are the exposures obtained using the latent score of depth of interaction. + (p<.08); *(p<.05); **(p<.01)

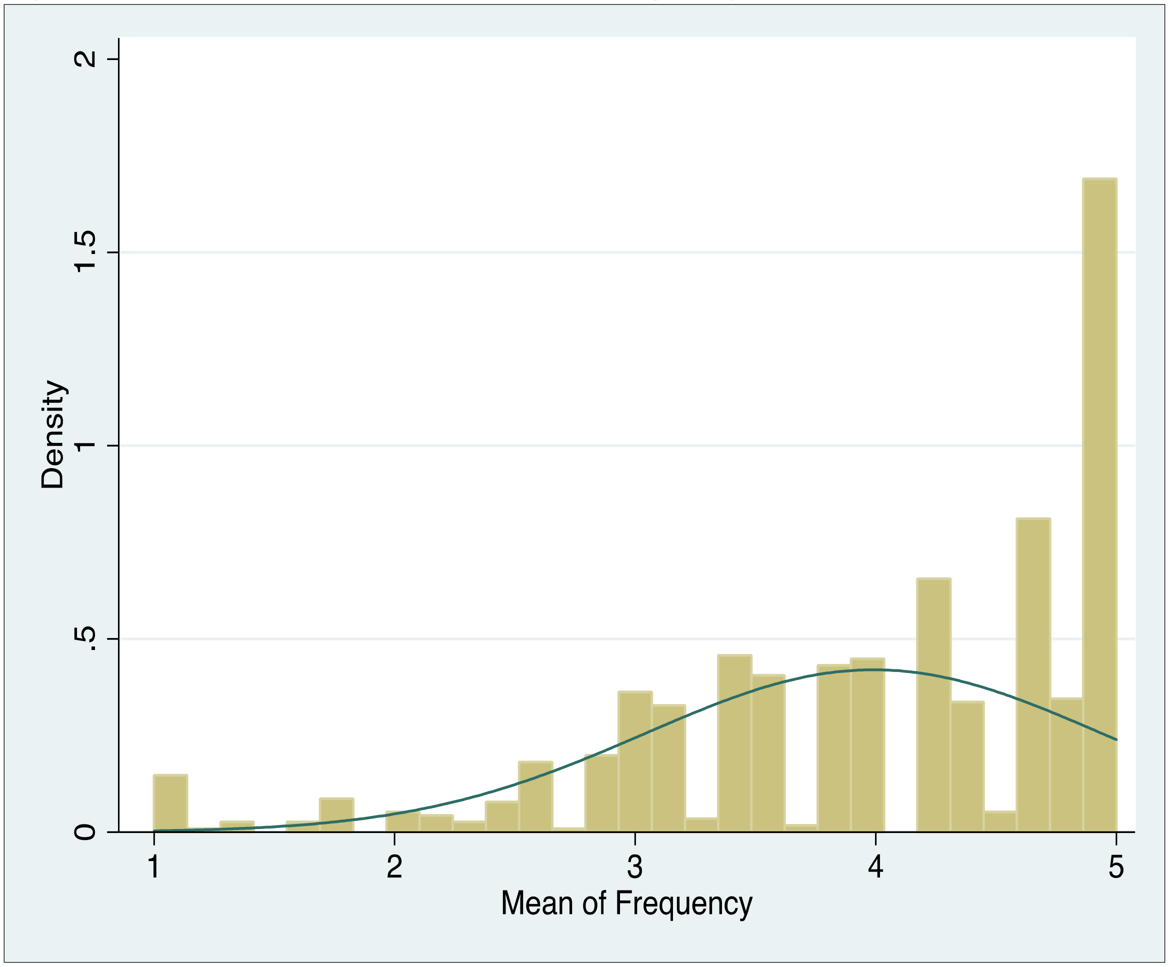
APPENDIX B: Figures

Figure 4.1. The distribution of the depth of interaction.



Note. For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this dissertation.

Figure 4.2. The distribution of the mean of frequency of interactions.



Note. For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this dissertation.

APPENDIX C: Questionnaires

Name: ____________________________
First Last

Date : ______/________/______/

E-mail: ___________________@______________

Are you (BOY/ GIRL)?

How old are you? ( ) years old

What grade are you in?
1) Freshmen 2) Sophomore 3) Junior 4) Senior

What is your race?
1) White/ Caucasian
2) Black/ African American
3) Hispanic
4) American Indian/ Alaska Native
5) Hawaiian/ Pacific Islander
6) Asian American
7) Multiracial/ Mixed ( )

What sports are you currently playing for your school? (___________)

Which level are you playing in? (_______________)

Which are you participating in? (Select all (v) that apply to you)

French Club	German Club	Latin Club	Spanish Club
Book Club	Computer Club	Debate Team	Newspaper
Society	Student Council	Yearbook	Drama Club
Band	Chorus/ Choir	Orchestra	Others

List all courses that you are taking this semester.

____

____

____

What is your current GPA? ( )

What is the highest degree that your parents hold?

1) High school
2) Trade school
3) Two year college (Associate Degree)
4) Four year college (Bachelor Degree)
5) Master degree
6) Doctoral degree
7) Others________

Others' education expectations

1. How far in school does your father want you to go after high school?

2. How far in school does your mother want you to go after high school?

3. How far in school do your teachers want you to go after high school?

4. How far in school does your coach want you to go after high school?
    1) Get a job after high school
    2) Enter a trade school
    3) Go to community college
    4) Go to four years college
    5) Go to graduate school
    6) Others________

Coach's regard for academics

1. I think my coach has a high opinion of my academic ability
    (Anchor: 1=strongly disagree through 7=strongly agree)

College aspiration

2. How much do you want to go to college?

College expectation

3. How likely is it that you will go to college?
    (Anchor: 1=low through 5=high).

Academic efficacy

1. I'm certain I can master the skills taught in class this year.
2. I'm certain I can figure out how to do the most difficult class work.
3. I can do almost all the work in class if I don't give up.
4. Even if the work is hard, I can learn it.
5. I can do even the hardest work in this class if I try.
    (Anchor: 1 = "Not at all true," 3 = "Somewhat true," and 5 = "Very true)

Academic /athletic identities

1. I consider myself an athlete (or a student).
2. I have many goals related to sport (or academics).
3. Most of my friends are athletes (or students).
4. Sport (or Academics) is the most important part of my life.
5. I spend more time thinking about sport (or academics) than anything else.
6. I need to participate in sport (or academics) to feel good about myself.
7. Other people see me mainly as an athlete (or a student).
8. I feel bad about myself when I do poorly in sport (or academics).
9. Sport (or Academics) is the only important thing in my life.
10. I would be very depressed if I were injured or could not compete in sport (or were sick or could not attend academics).

(Anchor: 1=*strongly disagree* through 7=*strongly agree*)

Self-regard on physical appearance and ability

1. How confident are you that others see you as being physically appealing?
2. Have you ever thought of yourself as physically uncoordinated?
3. When trying to do well at a sport and you know other people are watching, how rattled or flustered to you get?
4. Have you ever felt inferior to most other people in athletic ability?
5. Do you often feel that most of your friends or peers are more physically attractive than yourself?
6. When involved in sports requiring physical coordination, are you often concerned that you will not do well?
7. Have you ever felt ashamed of your physique or figure?
8. Do you often wish or fantasize that you were better looking?
9. Have you ever thought that you lacked the ability to be a good dancer or do well at recreational activities involving coordination?
10. Have you ever been concerned or worried about your ability to attract members of the opposite sex?

(Anchor: 1=*almost never* through 7=*very often*)

Social Interaction Questionnaire

<u>Directions</u>: Think about the interactions that you have with other members on your team. You may add up to TEN friends in your team. Friends in other athletic teams maybe added. Please write the first and last name of your friend with whom you are interacting (i.e., verbal communication, texting, Internet chat, Facebook, email, etc.) about you and school. If you are not sure about his or her full name, please put the initials. Also please write the sports that he or she is playing in for school.

Full name of your friend___________________________

Sports____

Did you firstly meet this friend in this season? Yes_____ No_____

1. How often do you interact with this friend in general?

2. How often do you interact with this friend on academic topic (ex, exams, projects, classes, etc.)?
3. How often do you interact with this friend on athletic topics (ex, sports skills, practice, game strategies)?
4. How often do you interact with this friend on social topics (ex, other friends, parties, social events, etc.)?
5. How often do you receive emotional support from this friend?'

Anchor: 1 ---- 2 ---- 3 ----- 4 ---- 5
Daily *Weekly* *Monthly*

APPENDIX D: STATA codes for this study

The followings are the STATA codes used in this dissertation. Please note that the specific commands are italicized. Explanations are with **. The listed variables and file names are examples.

1) Multilevel Influence Model (Study I)

- To generate 'Exposure'

use influence **Selecting a specific data file 'influence' when all files are in a same directory. The file contains nominees' data as well as nominators' and nominees' identification.

gen exposureAll_gpa=acadinter*gpa **Generating a variable of 'exposureAll_gpa' by nominees' GPA times amount of interaction with the specific nominees.

collapse (mean) exposureAll_gpa, *by (nominator)* ** Obtaining a mean of all exposures to nominees for each nominator. *(sum)* can be used instead of mean.

merge 1:1 nominator *using* T1 ** Merging nominators' Time1 data from T1 (file name). Both files, influence and T1, should have a same variable name for nominators' id to merge successfully. It creates a variable '_merge'.

to *drop if* _merge==2 ** Eliminating cases that don't have nominators' data

drop _merge **Deleting a variable '_merge' so that another merging can be performed.

merge 1:1 nominator using T2 ** Merging nominators' Time-2 data from a saved file of T2. Both files, influence and T2, should have a same variable name for nominators id to merge successfully.

drop if _merge==2 **Eliminating cases that don't have nominators' data

drop _merge ** Deleting a variable '_merge' so that another merging can be performed.

save influence_gpa ** Saving it into a different file name 'influence_gpa'

use influence_gpa ** Using the saved file 'influence_gpa'

drop if exposureAll_gpa==. ** Eliminating cases that have no exposure-data.

regress gpa2 gpaN exposureAll_gpa A B, *beta* ** Performing the basic influence model at single level. gpa2 is the dependent variable (nominators' Time 2 variable). gpaN is nominators' Time-1 variable; exposureAll_gpa is an exposure variable; A and B is control variables from nominators if necessary. *beta* is a command for standardized coefficient.

xtmixed gpa2 || team:, *covariance(unstructured) reml* ** unconditional multilevel modeling for a dependent variable 'gpa2' by a group variable 'team'

xtmixed gpa2 gpaN exposureAll_gpa || team: exposureAll_gpa, *covariance(unstructured) reml* ** Adding covariate at level-1 'gpaN'

2) Multilevel Selection Model (Study II)

To prepare data files, three different files should be properly made. 'Nominator' file contains only a list of nominators, and 'Nominee' file contains only a list of nominees. Their response data should be saved in a different file 'T1' for nominators and 'T1-2' for nominees.

- Creating a file with all possible pairs between nominators and nominees

use nominator ** to open a base file 'nominator'

cross using nominee to create all possible pairs of nominators and nominees

gen pair=10000*nominator+nominee ** to generate a variable 'pair' for an unique identification of the each pairs

duplicates drop pair, force ** to eliminate a variable ' pairs'

drop if nominator==nominee

drop if nominee==.

drop if nominator==. ** to eliminate unnecessary pairs

save nominator, replace

- Merging networks between nominators and nominees, and their variables

use nominator ** to use 'nominator' with all pairs

merge 1:1 pair using network ** to merge if pair is same in the file 'network'

gen tie=1 *if* _merge==3
replace tie=0 *if* _merge==1 | _merge==2 ** to code 1 if the merge variable is 3 (same pairs), and 0 otherwise.

drop _merge ** To eliminate the variable

merge m:1 nominator *using* T1, *keepusing*(a list of variables) ** To merge the nominators' variables from a file 'T1'

drop _merge ** To eliminate the variable *merge m:1* nominee *using* T1-2, *keepusing*(a list of variables)   ** To merge the nominees' variable a file 'T1-2'

- Generating variables for difference score of variables between nominators and nominee, and dummy code for same trait.

gen Dgrade2=*abs*(grade-grade2)   ** To create a variable for the difference of grade between nominator (grade1) and nominee (grade2)

gen samegender=1 *if* gender==gender2
recode samegender .=0   ** To create dummy variable 'samegender'. 1 is given if their gender is same.

- Running logistic regression and multilevel logistic model

logistic tie samegender Dgrade2   ** To run logistic regression with tie as a dichotomous, dependent variable 'tie'.

xtmelogit tie samegender Dgrade2 **||** nominator: samegender Dgrade **||** team:, *covariance(unstructured) mle variance*   ** To run the three level logistic regression with the level two (nominator) and level three (team)

3) Multilevel Polytomous IRT Model (Study III). For more details, see (Bacci & Caviezel, 2011; Zheng & Rabe-Hesketh, 2007)

- Data preparation

replace nominee=_n   ** not to have multiple nominees in the variable

reshape long ta, i(nominee) j(item)   **to stack item response into one response vector (ta), so that we obtain one record for each item response-nominee-nominator combination

drop if ta==.   **to eliminate missing data

gen obs=_n   ** to identify each item-nominee-nominator combination

expand 5   **to be expanded to have one row for each response category

sort nominator nominee item obs   ** to sort by nominator and nominee

- Generating the variable 'x' to contain all possible score for each item-nominee-nominator combination. The variable 'chosen' specifies the response category.

by obs, sort: gen x=_n-1
gen chosen = ta==x

```
tab item, gen(it)
```

- The design matrix for the multilevel RSM

```
gen step1 = -1*(x>=1)
gen step2 = -1*(x>=2)
gen step3 = -1*(x>=3)
gen step4 = -1*(x>=4)

foreach var of varlist it* {
gen n`var' = -1*`var'*x
}
```

- Defining the vectors of discriminant parameters

```
sort course stud item x

eq slope1: x
eq slope2: x
```

- Estimating the multilevel RSM model

```
gllamm x nit1-nit5 step1 step2 step3 step4, i(stud course) eqs(slope1 slope2)
link(mlogit) expand(obs chosen o) adapt nocons
```

- Estimating the second and third level residuals

```
gllapred res, u
estat ic
```

- The design matrix for the Multilevel PCM

```
forvalues i=1/5 {
	forvalues g=1/4 {
		gen d`i'_`g' = -1*it`i'*(x>=`g')
		}
}

sort course stud item x
```

- Defining the vectors of discriminant parameters

```
eq slope1:x
eq slope2:x
```

- Estimating the multilevel PCM

```
gllamm x d1_1-d5_4, i(stud course) eqs(slope1 slope2) link(mlogit) expand(obs chosen o) adapt nocons
```

- Estimating the second and third level residuals

```
gllapred res, u

estat ic
```

- The design matrix for the multilevel 2PL-PCM

```
forvalues i=1/5 {
	forvalues g=1/4 {
		gen d`i'_`g' = -1*it`i'*(x>=`g')
		}
}
sort course stud item x
```

- Defining the vectors of discriminant parameters

```
eq load1:x_it1-x_it5

eq load2:x_it1-x_it5
```

- Estimating the multilevel 2PL-PCM

```
gllamm x d1_1-d5_4, i(stud course) eqs(load1 load2) link(mlogit) expand(obs chosen o) adapt nocons
```

- Estimating the second and third level residuals

```
gllapred res, u

estat ic
```