Coaching Lineage: The Application of Network Theory to Power-5 Coaching Trees

Dissertation

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

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2020

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Abstract

There are many factors to consider when analyzing the success of a coach. Previous research into the coaching profession has primarily focused on the psychological, educational, and strategical elements of a coach (Gordon, 2017; Hedlund, Fletch, Pack, & Dahlin, 2018; Kim, Lee, & Kang, 2019; Koschmann, 2019; Lee, Chelladurai, & Kim, 2015). Very little research has been done considering the role that networks and relationships may play in effecting outcomes related to coaching and how coaches acquire their human and social capital. Network theory has become an emerging and innovative theoretical framework used for analyzing the various types of relationships which occur in sport (Quatman & Chelladurai, 2008). One specific area of sport which would benefit from a better understanding of the network is in college football, particularly the National Collegiate Athletic Association's (NCAA) Football Bowl Subdivision (FBS) Power-5 Conferences. Therefore, the purpose of this study is to conduct an in-depth exploratory analysis which examines the role of networks at one of the most important levels of sport, in order to help researchers understand what network structures exist and how these structures operationalize the spread of human and social capital in the network of Power-5 coaches.

Dedication

I would like to dedicate the work I perform on this dissertation to a variety of people. First, I would like to dedicate this dissertation to my Mom (Sandy), my Dad (Bob), and my Brother (Taylor). I love them all very much and they are very important to me and have helped push me to and through all of my accomplishments in life. I would also like to dedicate this to all of the friends and colleagues I have worked with at Marquette University and The Ohio State University. Specifically, I want to thank and dedicate this dissertation to Dr. Sean Dahlin, Dr. Chad Gerber, Dr. Mark Beattie, Dr. Jim Evans, Dr. Daniel Wray, Dr. Rick Bailey, Makena Lynch, Duncan Johnston, Jonathan Howe, Ashley Ryder, Shea Brgoch, Evan Davis, Moe Samad, Donta Ingram, Javonte Lipsey, Derek Walton and Prince Moody who have all helped me out significantly in some manner and have played a key role in my life at Ohio State. I want to thank and dedicate this dissertation to the outstanding undergraduate students I have had the opportunity to teach here at The Ohio State University within our undergraduate program. I would also like to thank and dedicate the work of this dissertation to Dr. Brian Turner, Dr. Leeann Lower-Hoppe, Dr. Shirley Yu, Dr. Catherine Quatman-Yates, Dr. Kwame Agyemang, and last but not least, and most importantly, to the greatest adviser of all time, Dr. Donna Pastore. Thank you so very much.

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Fields of Study

Major Field: Graduate Program in Kinesiology, Sport Management

Table of Contents

List of Tables

List of Figures

Chapter 1. Introduction

Power 5 Coaches

The National Collegiate Athletic Association's (NCAA) Football Bowl Subdivision (FBS) is the highest level of competition in intercollegiate athletics (Roy et al., 2008). College football at the FBS level, particularly in the Power-5 Conferences, is more than a sport as it is a significant part of the American culture at these programs, impacting students, faculty, alumni, and friends of the university (Roy et al., 2008). The Power-5 Conferences refer to institutions who are members of and compete in the Big Ten Conference, Atlantic Coast Conference (ACC), the Pac 12 Conference, the Big 12 Conference, and the Southeastern Conference (SEC). One of the most important stakeholders in all of these programs is the head coach. Good coaches are considered very valuable commodities due to the financial benefits, recruiting abilities, social network improvements, and the prestige they may provide an organization or institution (Tracy et al., 2018).

Power-5 head coaches have a considerable impact on the programs they lead and are a critical component to that institution's business (Tracy et al., 2018). Because a college football program is one of the main economic drivers at these Power-5 institutions, head football coaches are typically among the most well-compensated employees at both the state level and among all of the coaching professions (Fischer-

Baum, 2013). Despite over 85% of college presidents believing that college football coaches are overpaid (Wieberg et al., 2009), college football coaches are consistently rewarded because of their on-field success, as well as their ability to persuade donors and boosters, which all contributes to increased revenues (Humphreys & Mondello, 2007; Inoue, Plehn-Dujowich, Kent, & Swanson, 2012). They are also valued for their political and social skills and abilities to recruit talented players and coaches to their programs (Magnusen et al., 2014; Treadway et al., 2014). This political skill and capital also allow coaches to develop important and extensive professional connections and networks within the industry (Treadway et al., 2014). Because of their value and importance in completing all of these tasks, the perks of being a coach may include large contracts with an average salary of $1.75 million per season and receiving other incentives such as private vehicles and country club memberships (Tracy et al., 2018).

Coaches are also one of the most important stakeholders in the sport industry because they play an essential role in helping players to perform to the best of their abilities in order to help a team win (Koschmann, 2019). Coaches are responsible for motivating their team, building character in their players, and teaching players on the proper techniques and strategies in order to achieve their maximum performance and win (Feltz et al., 1999). In addition to on-field success, a good coach-athlete relationship leads to positive outcomes such as the long-term and holistic development of an athlete (Nash et al., 2011) and gaining a strong self-efficacy (Jackson et al., 2009). Considering the impact Power-5 coaches have on their programs and on their players, it is necessary to

conduct further research on these individuals which critically explores where successful Power-5 coaches come from.

Previous Research of Power-5 Coaches

Previous research on Power-5 coaches has focused on a variety of topics which consider the different effects a good coach can have on the institution. Research has considered how vital coaches are to their programs by looking at the important role they play through social media for promoting and marketing their program via relationship marketing and social media platforms (Zimmerman et al., 2016). Ultimately, these coaches have great power and abilities to represent their program in a positive light, and send positive information and promotional messages to fans, recruits, donors and other stakeholders (Zimmerman et al., 2016). However, research has also shown that the reach and popularity of college football coaches is best determined by the program's prestige rather than the coach's on-field success and size of the school's fan base (Jensen et al., 2014). Therefore, successful coaches employed by historically successful programs are more likely to have a positive impact on the fan base via their social media use, and coaches at less historically successful programs will have to work harder and possess greater social skill in order to engage the fan base.

Other studies have looked at the effect that a coach can have on building a successful program through recruiting (Caro, 2012; Dumond et al., 2008; Langelett, 2003; Wieberg, 2003). Recruiting demands much financial investment from the athletic department (Wieberg, 2003), which highlights the importance of hiring a coach who can effectively utilize those resources to provide the program with a high return on

investment through the acquisition of talent. Winning, and the on-field success of a head coach also play an important role in recruiting, as coaches who are able to prove early on-field success are able to experience greater success in recruiting, which helps with continued on-field success in subsequent seasons (Dumond et al. , 2008). Establishing on-field success and recruiting success early helps a coach and program maintain an edge over other programs in their institution's conference through continuous success, which creates a lack of competitive balance for the remainder of the conference (Dumond et al., 2008). In order for a coach to have success, not only must they have the political skill to lobby players to join their program (Magnusen et al., 2014), but research shows they must also have the financial support of the athletic department to go out and recruit, as institutions who devote the right amount of resources to recruiting are going to have high on-field success (Caro, 2012).

Because coaches are one of the most significant stakeholders to a Power-5 program, they are also more likely to be the victims of ritual scapegoating, where they are fired as the result of poor team performance (Dohrn et al., 2015). Furthermore, research shows that the overall performance of a team is likely to improve following a leadership succession, thus illustrating the importance of coaches as leaders in performance outcomes (Dohrn et al., 2015). This is the result of a new coach bringing their passion for coaching the sport, as this passion along with their interpersonal behavior predict autonomous and supportive behaviors towards the players on their team (Kim et al., 2019).

However, Johnson et al. (2013) finds that coaching changes may have adverse effects on another important component of a college football program, the academic performance of the student-athletes. Their research shows that APR scores in the year of a coaching change are significantly lower than the average APR scores for the rest of the Power-5 institutions, which is important for leaders and decision-makers of Power-5 programs to consider (Johnson et al., 2013).

Considering the financial, on-field, and academic outcomes associated with hiring the right coach, these decision-makers must devote the appropriate amount of time, resources and knowledge into the best hiring practices of head coaches, as making the wrong decision can give a program a significant set-back in all of these areas. If an athletic department wants to make the best hiring decision which provides immediate success in the areas of recruiting, on-field performance, and marketing, they must understand what skills and abilities a coaching candidate has to offer a program, and how coaches are going to acquire this capital. Understanding the coach's past, their sources of human and social capital, and the social influences on these individuals will help administrators in the decision-making process.

Human Capital

The skills and abilities a coach has are likely to be acquired via their human capital and social capital experiences. Human capital describes the knowledge an individual has and comes from such sources as education and on-the-job training (Becker, 1962). Human capital theory historically shows that someone's earnings and job position positively increase with the more human capital they acquire (Becker, 1962;

Mincer, 1974). Applying human capital to coaching, a coach who has more years of experience in coaching and more experiences working in a variety of positions on a coaching staff, are going to acquire more knowledge and experience which they can apply to their current head coaching position (Wicker et al., 2016). Age (Fogarty et al., 2015) and number of years working for a particular organization (Fogarty et al., 2015) also measure human capital.

Analysis of Power-5 coaches' career attainment show that career attainment is best predicted by coaching experience rather than affiliation or playing experience (Tracy et al., 2018), thus human capital matters for coaches who want to obtain a head coaching opportunity. Inoue et al. (2012) found that coaches with greater human capital tend to receive larger maximum compensation packages. Considering that the acquirement of human capital which leads to career attainment is longitudinal in nature and occurs over the course of someone's professional development, it is important to consider the past experiences of a coach, such as the individuals they have worked with in these experiences who provided them with their human capital. Within the management literature, this is discussed via human capital management which encompasses the recruitment and development of employees in an organization (Hatch & Dyer, 2004).

The challenges, tasks, and training that a mentor may provide to their mentee (e.g. head coach to an assistant coach) are important for human capital development and the professional development of a coach (Ready et al., 2008). Human capital is cultivated via the interpersonal interactions which take place within an organization (Mahoney & Kor, 2015). These interactions are important as human capital development is positively linked

to increasing an employees' value and uniqueness (Lin et al., 2017). Barros and De Barros (2005) found that human capital and social capital indeed go hand-in-hand with each other, as individuals who acquire human capital are likely going to have to do this through means of social capital, and social capital is acquired through means of acquiring human capital in these interpersonal interactions within work environments.

Social Capital

Social capital is critical for the development of a Power-5 coaches' career as they are looking to create connections and build a reputation amongst other members of the Power-5 coaching community. Social capital arises from dense interactions with members of relational networks (Bourdieu, 1986; Bourdieu & Wacquant, 1992). Social capital can better explain the access and flow of resources, particularly human capital variables such as knowledge and information, between a group of individuals (Bourdieu & Wacquant, 1992). Sport management research has found that career earnings are a function of both human capital and social capital (Barros & De Barros, 2005).

The application of social capital into sport management has found that it has a significant impact on community strength and social inclusion in team environments (Collins, 2004; Seippel, 2006). Community strength provides members of a team with the opportunity for engagement and cohesion (Harvey et al., 2007). This community strength allows for better working conditions for both players and coaches as they will develop motivation, emotional stability, as well as gain access to specific knowledge and moral support (Csikszentmihalyi et al., 1993; Rosso, 2015; Timson-Katchis & Jowett, 2005; Williams & Reilly, 2000).

In the Power-5, higher levels of social capital are linked positively to job attainment and career advancement because of the value that relationships provide coaches within their professional development (Cunningham & Sagas, 2004). Thus, creating an expansive network is vital for a college coach hoping to attain a Power-5 head coaching position (Tracy et al., 2018).

Network Theory

An innovative approach for analytically describing an expansive network can be accomplished through the use of network theory (Quatman & Chelladurai, 2008). It offers the unique ability to critically evaluate the networks of individuals within a variety of disciplines (Feng et al., 2019; Quatman & Chelladurai, 2008; Sadayappan et al., 2018; Simpson et al., 2012; Sinke et al., & Otte, 2016). Through various methodologies, network theory can answer questions pertaining to social order and how autonomous individuals can combine to create enduring and functioning societies (Borgatti et al., 2009).

Network theory provides researchers with explicit formal statements and measures of social structures describing the properties of a network and its influence on society (Wasserman & Faust, 1994). Quatman and Chelladurai (2008) assisted in the push to bring network theory into a sport management context in their conceptual piece which discusses how organizational behavior in sport management aligns with the principles and conceptual framework of network theory. In an organizational setting, network theory can be used to understand cooperation, competition, and conflicts (Stern, 1996). Perfecting the study of networks in sport may also help understand persistent

social issues in athletics, such as the underrepresentation of minority populations, and coaching burnout (Nixon, 1993; Quatman & Chelladurai, 2008). Thus, further research applying network theory to the web of connections formed between important stakeholders in sport is necessary.

The application of network theory is common in scholarship looking at organizational behavior (Granovetter, 1973; Hulsheger et al., 2009; Kanter, 1988; Krackhardt, 1992; Lin, 2001; Perry-Smith & Shalley, 2003). Employees are embedded within the network of their organization but will likely have some connections with members outside of this in-group as well (Hulsheger et al., 2009). The strong ties that members of an organization form with their in-group can provide them with important information, resources, support and inspiration (Granovetter, 1973; Kanter, 1988; Krackhardt, 1992; Lin, 2001; Perry-Smith & Shalley, 2003). Connections to individuals outside of the organization are important because they provide access to new, innovative, and diverse ideas (Perry-Smith & Shalley, 2003). This aligns with the seminal theory of weak ties as established by (Granovetter, 1973). Coaches will develop many stronger relationships within their organization but will also develop weak ties with other coaches as they build up their social and human capital.

Fundamental concepts of the structures of relationships involved in network theory in an organizational setting consider the strength of ties between individuals, the brokerage of information, closure, and centrality. The strength of ties is measured simply through weak ties, which are relationships formed with individuals outside of a dense network of workers who are not as socially involved, and strong ties, which are close

acquaintances or friends formed inside of a dense network (Granovetter, 1983). Individuals in a network who occupy brokerage positions, bridge the gap between unconnected parties (Burt, 1992; Gould & Fernandez, 1989). Being a broker in a network is very valuable as these individuals have a diverse array of knowledge (human capital) which they possess and can provide a team or organization (Balkundi, Wang, & Kishore, 2019). Broker's fill structural holes, which are gaps in information flows between individuals, or clusters of individuals in a network (Ahuja, 2000; Burt, 2017).

Closure in a network indicates a very tight group of individuals forming relationships and can be expressed simplistically as "the friend of a friend is a friend" (Cranmer et al., 2019). Because of this closure, the individuals involved are likely to have few partners in common rather than many partners in common. Finally, centrality illustrates the popularity of a node, because as a central figure in the network they are going to have many different connections formed between different figures in the network (Cranmer et al., 2019). Application of these structural phenomena to the network of FBS coaches, will help researchers and practitioners understand the cultivation of knowledge/information (human capital) and relationships (social capital), and what are the most important characteristics to possess.

Statement of the Problem

Considering the importance of Power-5 coaches and their human and social capital, it is important to understand the relationships and the nuances of the relationships in a network of Power-5 coaches for making the correct decision in hiring a head coach. A better understanding of who coaches form working relationships with, and how human

and social capital may be exchanged within the network via those relationships will help researchers and practitioners understand the key brokers of coach-specific human and social capital. This information is vital for understanding what types of relationships and network structures are important to look for in a coaching candidate, as well as help those individuals understand the role of mentor/mentee relationships in the coaching profession.

Utilizing network theory is the most logical and useful means to accomplish this through as the corresponding methodologies of network theory can inherently help researchers and practitioners learn the mechanisms and processes which are involved in the interactions within network structures (Borgatti & Halgin, 2011). This can help sport management practitioners identify the usefulness of particular relationships (social capital), whether they are inter- or intra-organizational, and the human capital they provide a coach. An analysis of the relationships, and any themes or trends which exist in the coaching network, can provide researchers and practitioners with a better idea of how those relationships can translate to success as a Power-5 head coach.

Rationale

Applying the framework of network theory to coaching is intuitive because coaching is largely a social activity (Occhino et al., 2013). With any social activity, understanding the influences on individual outcomes requires consideration of social environments (Katz et al., 2018). Networks significantly influence behavior within individuals, teams, and organizations (Kilduff & Tsai, 2003). These influences in coaching can include any tactical, technical, or leadership strategies that comprises of

their human capital. The right influences in a social environment can help a coach learn, while the wrong influences may thwart an individual coach's development (Mallett, 2010).

Comprehension of the relational ties and the patterns of those ties is important because they will explain a wide spectrum of outcomes and phenomena (Scott, 2000; Wasserman & Faust, 1994). Understanding the coaches' network will help Power-5 institutions during the decision-making process of hiring a new coach, because it will provide them more consistent data explaining the capital of a coach and help them avoid any irrational hiring trends or fads. Both coaches and Power-5 programs must utilize the network during the very competitive process of filling a head coaching opening (Tracy et al., 2018). Sport is a good empirical setting for examining organizational practices and labor market phenomena, including the hiring practices and succession of head coaches, because of the unique combination of human and social capital which exists at this level (Soebbing et al., 2015). Therefore, because of the aforementioned importance of head coaches at Power-5 institutions, making the right decision in the hiring-process is critical, and correct use of network data will be crucial for making the right decision.

Purpose

The purpose of the present study is to perform an exploratory analysis into the networks of National Collegiate Athletic Association (NCAA), Division I Football Bowl Subdivision (FBS), Power-5 coaches. There are two aims to the present study. The primary aim will be to gather data and construct the network for the most recent cohort of Power-5 head coaches, and to identify the structures which exist in this network. The

second aim is to discern what roles these structures have on predicting the success of a head coach, as measured through their win percentage. Completing this exploratory study will provide coaches and practitioners with an understanding of which type of relationships form and how these relationships benefit an individual coach and a Power-5 institution.

Objectives and Research Questions

The primary objectives to be investigated in this study are the specific structural characteristics of the Power-5 coaches' network. This will consider the overall density of the network (or simply how closely connected people are connected in a network), the centrality of the network (key individuals who most people tend to form connections with), the closure of the network, as well as brokerage (individuals who fill structural holes and tie together two clusters of connections). The researcher will then use these structural findings in the context of Power-5 coaches, such as the role of mentor/mentee relationships, the diversity of mentorship, and being a broker in a network to consider how these characteristics have influenced the success of these coaches through their on-field performance and winning percentage.

This study looks to answer the following research questions:

RQ1: What type of patterns for centrality and structural holes exist in the whole-network?

RQ2: How do patterns for centrality and structural holes correlate with the on-field success of a Power-5 coach?

Chapter 2 of this dissertation will provide a comprehensive review of the literature related to network theory, the coaching profession, Power-5 coaches, and issues in the Power-5 coaching profession. Chapter 3 will provide an overview of the methodological approach which will be utilized in this study. Chapter 4 will discuss the data collection process and the results, while Chapter 5 will discuss the major findings, implications and directions for future research.

Chapter 2. Review of Literature

Introduction

This literature review will focus on previous research about Power-5 coaches, social capital, human capital, network theory, and network theory in sport management. It is necessary to review the progression of research in these topics, as it will assist in identifying the voids in the literature which the present study seeks to address while also explaining how past research has assisted in the design and methodology of the present study. At the conclusion of the review of literature, these theories will be synthesized together to properly address the research questions for the present study.

FBS Coaches

The first chapter introduced the variety of reasons highlighting the importance of Power-5 coaches to their athletic program. Among these reasons are the financial benefits they provide an athletic department and institution, the ability to help with marketing and publicity, their recruiting abilities, and the on-field success they provide for a program (Humphreys & Mondello, 2007; Inoue, et al., 2012; Tracy et al., 2018). This body of literature focuses on the background of research which has been completed on these key stakeholders and the hiring practices of institutions looking for a head coach.

Critical for Business

Power-5 coaches are vital stakeholders at any institution which possesses a Power-5 program, as the Power-5 is widely considered the highest level of competition within intercollegiate football at the Division-I level (Roy et al., 2008). Much of the past literature has compared Power-5 head coaches to CEOs (Berkowitz et al., 2010; Fogarty et al., 2015; Grant et al., 2013; Holmes, 2011; Smith & Kuntz, 2013). Garnering this comparison is the fact that there is public distaste with the compensation packages given to coaches (Brady et al., 2012) and that coaching expectations and publicity are on similar levels to that of corporate CEO's (Brainard, 2009). Another reason why coaches are also comparable to corporate CEO's is because of the high expectations which are placed on them.

Being the premier level of competition, revenues generated by Power-5 programs are large and continuously growing. Winning football programs fill stadiums and create high amounts of publicity which generates TV and marketing revenue (Maxcy, 2013). Institutions will use this logic to justify the rate at which Power-5 coaches are paid (Farmer & Pecorino, 2010; Fogarty et al., 2015). Winning games, attending bowl games, recruiting top athletes, increased donations, state appropriations and student admission rates and guiding student-athletes to academic success are all objectives credited to a Power-5 coach which contributes to a high return on investment for Power-5 institutions and their athletic departments (Alexander & Kern, 2010; Humphreys & Mondello, 2007; Grant et al., 2013; Greenberg & Smith, 2007; Rhoads & Gerking, 2000; Toma & Cross, 1998).

Power-5 coaches are often promoted as being the "faces" and representatives of their programs (Fischer-Baum, 2013; Greenberg & Smith, 2007; Sanderson, 2013; Vint, 2013). Because they may be the faces of the program, their presence and personality can have significant impact on social media and the overall marketing of the program (Zimmerman et al., 2016). This is important as many key stakeholders, including college recruits, players, and fans, will utilize social media (Megargee, 2014). Thus, their presence on social media can have a significant impact on their ability to recruit top athletes (Megargee, 2014). The presence of FBS coaches on social media are particularly effective at football programs with a high amount of prestige (Jensen et al., 2014) as these programs tend to have very passionate fan bases. The most important social media website to create a presence on is Twitter, as these key stakeholders frequently use Twitter and are able to experience two-way interaction with the coaches (Jensen et al., 2014). Because of the importance of finding a coach who is marketable and can garner a high return on investment, researchers and practitioners must conduct careful research which considers identifying the best coaching candidates.

Hiring Practices

Past research on the hiring practices of coaches has mostly focused on the effects of coaching changes and leadership succession (Cannella & Rowe, 1995; Dohrn et al., 2015). Within leadership succession, specific consideration has been given to common sense theory - where replacing a failing leader has a positive impact on organizational performance, vicious cycle theory – which holds that coaching change will have an immediate negative effect, and ritual scapegoating theory – that leadership change has no

effect on outcomes because performance failures are falsely attributed to the leader (Dohrn et al., 2015). Evidence suggests that high-revenue Power-5 programs fall victim to ritual scapegoating, and that coaches should be given the appropriate amount of time to implement their program (Dohrn et al., 2015). This suggests that not giving the coach enough time or resources to grow the program could result in an endless cycle of hiring and firing coaches without substantial improvements to the on-field success. Soebbing and Washington (2011) found evidence supporting the vicious cycle theory, that team performance decreased following the firing of a coach.

Similarly, studies consider other isomorphic factors that may affect the decision to hire a particular coach with the expectations of the decision makers (athletic administration), allegiances and values of the decision makers, availability of alternative candidates, and the power of the incumbent all being considered (Holmes, 2011). The pool of coaches which Power-5 institutions hire from will include both internal and external hires, with external candidates being hired from assistant or head coaching positions at other Power-5 institutions or the National Football League (NFL) (Maxcy, 2013). Once hired, Power-5 coaches make critical decisions when hiring assistant coaches and making recruiting choices (Soebbing & Washington, 2011). The leadership style a coach has will also have an impact, as research focusing on leadership theory finds that leaders (administrators and coaches) who have a transformational approach embrace change which assists in coaching turnover (Herold et al., 2008). However, regardless of the leadership style, research has also found that coaching changes will have adverse effects on the Academic Progress Rate (APR) of student athletes (Johnson et al., 2013).

This research on leadership succession further suggests the importance of looking deeper into how researchers and practitioners can better identify coaches who will have staying power at institutions in order to avoid abrupt changes which result in lower APR scores and vicious cycles in their on-field performance.

Underrepresentation of Minority Coaches

Related to the hiring practices of Power-5 coaches, previous research into Power-5 coaches examines a prominent social issue in the underrepresentation of minority coaches (Agyemang & DeLorme, 2010; Cunningham & Sagas, 2005; Lapchick et al., 2019; Singer et al., 2010; Turick & Bopp, 2016). The Institute for Diversity and Ethics in Sport (TIDES) publishes an annual report called the *Racial and Gender Report Card* (RGRC) which assesses the hiring practices of women and persons of color (Lapchick et al., 2019). The most recent report indicates that of the 130 head coaches at the FBS level, 111 of them are White males (Lapchick et al., 2019), and this disparity is an issue considering that 54.3% of the players at the Power-5 level are African-American, 39.8% are White, 2.3% are Latino, and 2.8% are Asian/Pacific Islanders (Lapchick et al., 2019). Thus, minorities are valued for their athletic prowess, but are withheld from leadership opportunities because of racist stereotypes (Singer et al., 2010).

Minority coaches face disadvantages in acquiring human or social capital because they are typically withheld from critical assistant coaching positions, which are likely to elevate them into a head coaching position (Turick & Bopp, 2016). This is commonly referred to as access discrimination, an inherent network issue. This leads to homologous reproduction of White coaches who are a part of the “old boy network” (Cunningham &

Sagas, 2005; Fink et al., 2001; Greenhaus et al., 1990). This is despite the fact that former Power-5 players, who are predominantly African American (Lapchick et al., 2019), make up the largest potential pool of coaching candidates for an open position.

Considering the background of literature in the Power-5 coaching profession which indicates such issues as identifying the most qualified coaches for an institution, making careful hiring decisions, and addressing access discrimination for certain populations in the coaching community, it is necessary to view these issues through the lens of theories related to human resource management. Human capital, social capital, and network theory have frequently been applied to the context of human resource management (Chemmanur et al., 2019; Han et al., 2019; Rosso, 2015), and a review of their literature will help address why the consideration and application of these theories to coaching can benefit the profession.

Human Capital

Human capital theory has long been used in management literature to analyze the knowledge and abilities of employees' in an organization (Lynn, 2000; Schultz, 1960). Knowledge and abilities are typically acquired via training for a particular role, leadership training and any other form of individual development within an organizational setting (Ulrich & Smallwood, 2004). Human capital theory holds that managerial abilities are not an observable phenomenon, but that it is obtained via knowledge and skills acquired through experience (Becker 1964; Holcomb et al., 2009). As employees acquire more human capital, they are more capable of performing a desired job at a higher level of efficiency (Agarwal, 1981).

In management settings, leaders of an organization who possess higher amounts of human capital can have a positive effect on the innovation input and output of the organization (Chemmanur et al., 2019; Chemmanur & Jiao, 2012). Further, because these managers have higher levels of human capital and skill, they will have a greater sense of the potential value for innovative ideas and be more willing to build an environment that fosters a tolerance for failure and growth from failure (Manso, 2011). More contemporary research looks to advance human capital theory by considering more than simply how much human capital an individual has or where they acquire it from, rather how does this human capital contribute to outcomes such as revenues or any other success related variables for the organization (Nyberg & Wright, 2015; Ployhart et al., 2014).

Various studies in sport have shown how human capital can have a positive effect on the compensation of coaches (Frick & Simmons, 2008; Inoue et al., 2012). Inoue et al. (2012) specifically looked at the human capital of college football coaches. They found that a coach's managerial ability can be measured through their knowledge, skills, and experiences and as the human capital increases, they will receive more power and base pay in their contract negotiations (Inoue et al., 2012). Studies in other sports have also shown that salaries and pay have increased for coaches with higher amounts of human capital (Frick & Simmons, 2008; Smart et al., 2008), and that managers and coaches with higher amounts of human capital tend to have greater influence over other stakeholders because of their knowledge and skills (Combs & Skill, 2003; Finkelstein & Hambrick, 1989; Grabke-Rundell & Gomez-Mejia, 2002). However, it is not enough to consider

human capital, as the ability for someone to perform a task well and acquire such human capital will depend on their relationships and interactions (Ployhart & Moliterno, 2011).

Social Capital

Generally speaking, social capital theory asserts that social capital is acquired through interactions with social actors creating rich webs of connections that facilitate the exchange of information (Barros & De Barros, 2005). These connections help actors in a competitive professional market because they can utilize them to obtain new ideas and information that influence their understanding of different phenomena (Beckert, 2010; Bourdieu, 1986; Boudieu & Wacquant, 1992). Social capital specifically consists of material and informational resources provided to someone via a particular relationship (Coleman, 1988; Lin, 2002; Morel & Coburn, 2019). Management literature considers how actors in a network must utilize these resources to achieve success in a given market by leveraging their relationships (Granovetter, 1973). Similar to human capital, robust amounts of social capital as found through large social networks, assists organizations with innovation through the ability to bring in unique and original ideas that have a chance to flourish and develop (Bandera, 2019).

Social capital theory has been considered in sport management settings as well (Atherley, 2006; Barros & De Barros, 2005; Cunningham & Sagas, 2004; Rosso, 2015). Such studies have found that social capital can be as significant as human capital for sport administrators' earnings and promotion (Barros & De Barros, 2005). Social capital has also been linked to job attainment and career advancement in sport management, because valuable relationships help an individual advance in their particular field whether

they are a coach or administrator (Cunningham & Sagas, 2004). Most of the literature on social capital in sport focuses on the perspective of the participants because of the inherent social nature of participation in sport (Atherley, 2006; Coalter, 2010; Rosso, 2015). This builds community strength, social inclusion, identity, trust and engagement (Atherley, 2006; Collins, 2004; Rosso & McGrath, 2013). Generally speaking, considerations of social capital and how relationships matter in coaching communities is absent. It is necessary to apply these concepts to the sport coaching setting considering the impact previous research has suggested this may have on the spread of innovative ideas and practices and how they can translate to organizational success.

Network Theory

Before discussing the application of network theory to the present study, it is important to understand its unique history and background. Borgatti et al. (2009) wrote an important article discussing what some consider a "confusing history" and describe the theoretical foundations of networks. Network studies assume that relationships are important in explaining the outcomes and behaviors of members of a particular network (Wasserman & Faust, 1994). In the article they mention, "Network theory provides an answer to a question that has pre-occupied social philosophy since the time of Plato, namely the problem of social order and how autonomous individuals can combine to create enduring, functioning societies" (Borgatti et al., 2009, p. 892). Jacob Moreno and Helen Jennings are considered the founders of network theory in the social sciences, as they developed the idea of "sociometry" which is the graphical representation of

someone's subjective feelings and opinions towards another individual (Borgatti et al., 2009).

Network theory is unique because there is no native theoretical focus, rather it considers a large body of theories related to interactions in a network (Borgatti et al., 2009). It assumes that the mechanisms and processes which occur in the network structure lead to certain outcomes for the actors in the network (Borgatti & Halgin, 2011). Furthermore, studies which utilize network theory considers the consequences of network variables, such as the number of ties and the centrality of an actor (Brass, 2002). Centrality is one of three key concepts frequently discussed in network theory, the other two being cohesion and structural equivalence (Liu et al., 2017). Centrality considers degree, closeness, and betweenness (Freeman, 1979). Cohesion considers the interconnections among a cluster of individuals (Liu et al., 2017). Structural equivalence isolates two or more network positions who may have similar structures (Liu et al., 2017). These concepts help to explain how connections and patterns in the connections between members of a network impact a wide array of outcomes and phenomena (Scott, 2000; Wasserman & Faust, 1994).

Weak Tie Theory and Structural Holes

Two seminal pieces related to network theory which have been applied to studies of network studies include Granovetter's (1973) work on the "weak tie theory" and Burt's (1992) work on the structural holes approach. The weak tie theory posits that relationships and structural coherence are derived from bridges, or connections that are formed between cohesive clusters (Granovetter, 1973). Weak ties are not likely to be

individuals who are close friends or who are socially involved with one another (Granovetter, 1983). In describing weak ties, Granovetter (1983) asserts that an individual typically forms a group of very close relationships who are closely in-touch with each other. This individual could have an acquaintance who is not a part of this closely-knit group, which would be considered a weak tie (Granovetter, 1983). It is in an individual's best interests to create many weak ties, as those who have a small number of weak ties will miss out on exposure to new information and ideas, and simply be limited to the information and ideas of the acquaintances forming their close-knit group (Granovetter, 1973). Literature in business and management tend to support the theory of having strong, competent and benevolent weak ties who provide useful information (Levin & Cross, 2004).

The structural holes approach differs and holds that structural holes are "opportunities to broker information flow between people and control the projects that bring together people from opposite sides of the hole" (Burt, 2017, p. 35). Essentially, structural holes in a network setting isolate non-redundant information sources from one another (Burt, 2017). Redundant information comes from individuals who have redundant ties with all of the same actors (Ahuja, 2000). Those individuals on either side of the gap have access to different resources of information (Hargadon & Sutton, 1997). Therefore, it is important to have networks that contain many structural holes because this represents access to, "mutually unconnected partners and many distinct information flows" (Ahuja, 2000, p. 432). Someone who has structural holes will be able to broker connections between people of disconnected segments, hence increasing their social

capital (Burt, 2017). Networks with structural holes have shown to be especially beneficial in transaction markets within industry networks (Walker et al., 1997). As intuitive as this may seem, this counters what old network theorists believed, particularly Coleman (1988) who posited that network theory should consist of social structures that are dense, and form strongly connected networks.

Brokerage

Another important component of networks is brokerage. When discussing structural holes, it is also important to consider the role of brokerage (Burchard & Cornwell, 2018; Clement et al., 2018; Soda et al., 2018). Brokers are individuals positioned between unconnected actors in a network who serve to bridge the gap between the unconnected actors (Gould & Fernandez, 1989; Granovetter, 1973). The opportunity to be a broker affords an individual the opportunity to mobilize resources accessed through their ties and pursue structural opportunities afforded by their unique network position (Kellogg, 2014). This is also defined as the opportunity to collaborate and create opportunities to cooperate and integrate resources in a network (Soda et al., 2018).

Structural holes can impede the diffusion of information and other resources in a network; therefore, it may be important to have actors who are bridges that link otherwise poorly connected contacts or clusters (Burchard & Cornwell, 2018). Acting as a broker gives that individual many benefits such as gatekeeping power, access to alternative and independent contacts and other third-party benefits (Burt et al., 2013; Gould & Fernandez, 1989). While this suggests that brokerage may be a private good, other studies suggest that brokerage may be a public good because the broker's network can have

positive effects on the surrounding nodes in the network, if all of those nodes have creativity-focused roles (Clement et al., 2018; Cook, 1982; Fernandez-Mateo, 2007).

Analysis of Networks and Research Questions

It is important to match the appropriate research questions and analysis' to network theory studies. Research questions in network theory are typically categorized as opportunity-based antecedents and benefit-based antecedents (Borgatti et al., 2009). Opportunity-based antecedents focus on the opportunities and constraints put on someone in the network, and how their location in the network garners them more or less capable of accessing specific opportunities (Borgatti et al., 2009). Opportunities and constraints typically refer to the acquisition of social capital in an individual's network, or in the acquisition of partnerships in corporate relationships (Bond & Harrigan, 2011; Burt, 1992; Granovetter, 1973). Opportunity outcomes are typically the result of network measurements such as homogeneity and performance (Borgatti et al., 2009).

Homogeneity is the tendency for nodes with similar characteristics to form relationships (Cranmer et al., 2019). Performance outcomes consider a variable outcome measurement for a node based on their location in the network, such as their ability to succeed or innovate (Borgatti et al., 2009). Benefit-based antecedents are functions of the adaptation mechanism and the binding mechanism in a network (Borgatti et al., 2009). The adaptation mechanism assumes that two nodes will become homogenous because they adapt each other's social characteristics or environment, and become increasingly similar to one another (Borgatti et al., 2009). Binding mechanisms are when two nodes combine together to build a new relationship which features unique characteristics from

each other's network (Borgatti et al., 2009). In essence, this binding creates cooperation where each party involved shares the unique resources and characteristics that each other has, which is critical for understanding Burt's (1992) structural holes theory.

Applications of Network Theory

There have been a variety of subjects and disciplines which have utilized network theory. Anthropologists used network theory to construct a network of the individuals they observed and studied in complex societies and charted interactions they witnessed while conducting ethnographies (Wasserman & Faust, 1994). Social psychologists in the 1940's and 1950's also applied network theory to group processes (Wasserman & Faust, 1994). Other sociology studies have utilized network theory to understand different friendship networks (Johnson et al., 2012; Wimmer & Lewis, 2010). Other applications have varied, including the study of international relations and politics (Cranmer, Desmarais, & Menninga, 2012; Ward & Hoff, 2007), brain network structure (Simpson et al., 2012) and in business and organizational interactions (Gallermore et al., 2015; Lomi & Fonti, 2012).

Leadership Networks

Network theory has been particularly useful in contemporary research in considering the role that relationships play in leadership emergence and leadership effectiveness (Hiller et al., 2011). Carter, DeChurch, Braun, and Contrator (2015) argue that leadership is based on networks because it is relational, situated in a certain context, patterned, and both formal and informal. Leadership is naturally based on relations because it mutually looks at patterns among leaders and followers (Tee et al., 2013). Each

leadership network will vary depending upon the social and historical situations that are situationally present (Carter et al., 2015). These networks are patterned because each member in a leadership network will encounter a different experience of the relationship between different nodes because of their title or characteristics (Graen & Uhl-Bien, 1995; Lord et al., 2001). Based on the power dynamics, a leader in a network will have a different experience than a follower in a network. Leadership can be both formal and informal because while it is more common for leadership to originate from someone in a formal position of authority, leadership can also emerge from a non-formalized collective group of individuals (Carter et al., 2015). An example of an informal network is the proverbial "old boys club" which is an exclusionary network often discussed in business and management literature (Lovett & Lowry, 1994).

Carter et al. (2015) discussed three domains of leadership in networks. Those domains are leadership in networks, leadership as networks, and leadership in and as networks. Leadership in networks considers the characteristics of an individual's social network which significantly impact their opportunities for promotion (Pastor et al., 2002). Another aspect of the leadership in network domain is that the structure of the network plays a pivotal role in leadership outcomes (Mehra et al., 2006). Structure has proven to be important because the centrality of a leader has a positive correlation towards group and team performance, as well as leadership effectiveness (Balkundi & Harrison, 2006; Mehra et al., 2006).

"Leadership as networks" focuses on ties and relationships formed in a leadership network, defined as someone accepting of someone else's role as a leader in a specific

network (DeRue & Ashford, 2010). Studies focusing on leadership as networks, home in on the effects that a leadership network, where leadership is distributed among team members instead of one significant leader, has on performance outcomes such as an organization's relationship with their clients (Carson et al., 2007). To clarify, research on "leadership in networks" looks at other types of social networks to compare how they are related to measures of leadership, which are more sociological in nature (Carter et al., 2015). Studies in "leadership as networks" seek to answer factors explaining the emergence of a leadership network and how the relationships affect leadership outcomes, tending to be more psychological as they consider the behaviors of leaders (Carter et al., 2015). The third concept, "leadership in and as networks", identifies antecedents for emerging leadership structures, how these leadership structures evolve, and then examine what types of outcomes result from leadership networks (Carter et al., 2015).

A general understanding of the theory behind relational networks in leadership is important for practitioners as well, so that they can maintain an accurate assessment of their organizational structure and understand what social influences could positively or negatively manipulate the environment (Balkundi & Kilduff, 2006). Network theory shares the same theoretical aspects of leadership in that they focus on relationships between individuals, they are embedded which indicates a preference for interaction with members of a local community, network relationships build social capital, and they both consider structure or who interacts with whom to build connectivity (Balkundi & Kilduff, 2006). Nurturing a leadership network is import for practitioners who wish to develop leadership, as well as influence policy bringing social and systemic change (Hoppe &

Reinelt, 2010). This change can come from network principles such as “bridging”, where individuals in a network connect dissimilar locations, specialties, or social silos (Brass & Krachardt, 1999). Social change can be addressed by evaluating the characteristics of the mentors in a network and recommending change that may benefit underrepresented or disadvantaged populations (Hoppe & Reinelt, 2010).

A critical aspect of any organization is their leadership, which network theory has analyzed as well. Members of an organization can be leaders without holding formal leadership positions in an organization or team (DeRue & Ashford, 2010). Even without a formal leadership position, actors in a network who are deemed as leaders tend to have centrality within a network (Fang et al., 2015). Kwok et al. (2018) analyzed how leader role identity might influence the emergence of a leader in a network through the dynamic social processes which take place between organizational members. Their study focused on cadets and found cadets who possessed a strong leader role identity are more likely to emerge as leaders in the network, as reflected by the amount of in-degree centrality they had, indicating their ability to build relationships within one’s group (Kwok et al., 2018).

Diffusion of Innovation

Another theoretical application that utilizes the core concepts of network theory is studies which address the diffusion of innovation (DOI). Past literature has typically associated networks with DOI (Liu & Sudharshan, 2005). DOI is a change model which analyzes the process where people adopt new innovations that can be categorized as ideas, philosophies, practices, or even products (Kaminski, 2011). The model describes five different types of adopters. Those adopters are innovators, early adopters, early

majority, late majority, and laggards (Rogers, 2003). Innovators adopt the quickest to new ideas, early adopters are the next quickest, early majority are considered pragmatists who will make slow and steady change when they deem it is appropriate, the late majority take the next longest as they need to be convinced or pressured into adopting change, and the laggards are suspicious of innovation and seek to maintain the status quo (Kaminski, 2011).

Networks are a critical part of DOI because innovators and early adopters can play an important role as change agents who influence those around them to accept change and innovation (Kaminski, 2011). DOI researchers have sought to understand the structure of relationships which shape communication and the spread of new ideas (Liu, Madhaven, & Sudharshan, 2005). Network analyses use relationship structures to see who talks with whom and who are key influencers in the spread of innovation (Burt, 1987). Social characteristics and unique social positions within an embedded network have been used to measure the extent of diffusion within social systems (Valente, 1996). Networks are helpful for identifying critical mass, which is an important stage in DOI because that is the point when enough people are adapting to the new innovation to sustain the rest of the populations that still needs to adapt (Valente, 1996). Identifying where those prone to pushing the diffusion of innovation in a network are located is critical for helping to push a new line of research or ideas (Valente, 1996).

Knowing the importance of these interpersonal contacts in DOI, researchers use networks to isolate where opinion leaders are located and utilize them as champions for innovation (Valente & Davis, 1999). Centralized networks tend to be more efficient in

the diffusion of ideas (Valente & Davis, 1999). This is particularly useful in research on consumer behavior, as the decisions of consumers are typically correlated to the actions of their neighbors in a network (Alkemade & Castaldi, 2005). In consumer studies, consumer value will increase when the number of consumers adopting the innovation becomes larger, and this is referred to as positive network externalities (Katz & Shapiro, 1985). Contrarily, consumer value may drop while the number of adopters increases, because for that particular consumer there is an over-exposure of the product, and this is known as negative network externalities (Alkemade & Castaldi, 2005). All of this is determined by the structure and embeddedness of the relations in a network of consumers.

Organizational Analysis in Sport

One area of research in sport management which capitalizes on the unique features of network theory, are studies analyzing the structure and relationships between an organization's employees and other key stakeholders. Organizations which have been studied include national sport organizations and intercollegiate athletic departments. Katz et al. (2018) applied network theory to consider the structures and relationships which exist between senior woman administrators and athletic directors. Findings show that the senior woman administrators' network is much less cohesive than the athletic directors' network, with women also being located outside the center of the affiliation networks (Katz et al., 2018). This is another example of network theory serving duo purposes to analyze the structure of an organization, while also addressing a social issue associated with networks related to the organization. Many non-sport and sport studies are being

done to address the notorious “old boys’ network” (Hoffman, 2011; Walker & Bopp, 2011), but more studies could and should be done utilizing network theory to address an issue inherently based on relationships.

Previous studies look at the position of key stakeholders such as fans, athletes, and coaches, and their specific connections between a national sport organization and other stakeholders (Parent et al., 2018). This is similar to previous studies which have looked at the network of major sporting event stakeholders to analyze who provides the most resources and assistance in planning and hosting a major event (Parent & Smith-Swan, 2013; Parent, 2015). These studies consider previous network research on major sporting events which show that the flow of a network matters for the exchange of goods, money, and communication between important stakeholders (Borgatti, 2005). The flow of networks in organizations working on major sporting events is important to study because this flow can affect power structures and the distribution of the flow of information in these critical networks (Borgatti & Lopez-Kidwell, 2011). In a study considering the coordination of international sports events, network theory showed that governments, organizing committees, and members of the host venue are the most centered figures in the network, and have the most power (Naraine et al., 2016). Knowing that the organizing committee is not the only stakeholder in control of a major event network is critical for practitioners in understanding who else plays an important part of managing a major event (Naraine et al., 2016)

The findings from studies focusing on international sporting events can be extended to analyze organizations and events which work with multi-level and multi-

sectoral sports. Parent et al. (2017) utilize network analysis to consider the types of ties and relationships formed, such as collaboration, communication, coordinating bridge, instrumental, legal, regulatory, transactional, as well as internal and external link ties, between all of these stakeholders in planning of the Vancouver 2010 Winter Olympic Games (Parent et al., 2017). Similar to the findings of Naraine et al. (2016), they find that a national and federal government is an important stakeholder in the networking for coordinating these events, thus illustrating the influence they have (Parent et al., 2017). Showing the types of relationships which exist demonstrates the benefits, opportunities, and challenges each stakeholder faces while planning a major sporting event (Borgatti & Foster, 2003).

From an organizational perspective, network analysis is also applied to the trade markets for European football (Bond et al., 2018). The subject of trade previously did not utilize the consideration of networks and relationships, until the theory of the Buyer-Seller network was explored (Kranton & Minehart, 2001). New research utilizes Granovetter's (2017) idea of structural and relational embeddedness which postulates that all economic behavior, including the acquisition of athletic talent is rooted in relationships. The economic actions taken by players, clubs, countries and federations are connected by what type of relationships they have based on their position in the football organization and the structure of their overall network (Bond et al., 2018). Relationships in such a network for sport are focused on position in the network, and how that position will create structural holes (Burt, 1992). An analysis of the football transfer network shows that it has a similar structure to that of a normal trade and international relations

network, where the core of the network is located in European countries, with less-developed countries where soccer is much less developed, being on the periphery of the network (Bond et al., 2018).

Combining the application of network theory to leadership with the application of networks to analysis of a sport organization, Fransen et al. (2015) investigated shared leadership within sports teams. Athlete leaders usually occupy a central position on the field and in the network among their teammates, which garners them longer playing time while they also demonstrate high task competence, longer team tenure, and stronger social connectedness with their teammates (Fransen et al., 2015). In an analysis of 35 sports team which include the sports of volleyball, soccer, basketball and handball, they found shared leadership amongst the teams, and no significant differences were found between the leadership qualities of coaches and team leaders (Fransen et al., 2015). The network was created by having members of each team fill out a survey ranking the leadership qualities of each player, as well as a survey which assigned role-specific leadership tasks (Fransen et al., 2015). The tasks were organized into a task leadership network, a motivational leadership network, a social leadership network, and an external leadership network (Fransen et al., 2015). The authors found that athlete leaders were ranked as better motivational and social leaders than their coaches, and the team captain and informal athlete leaders took charge on leadership tasks (Fransen et al., 2015). This shows that there is not simply one sole leader on each team, and that the network of a team is a complex social system where other members of the team must step forward as leaders (Fransen et al., 2015).

An analysis of the connections formed within an organization can also show biases which exist as a result of those specific relationships. Sanders (2011) found that conference ties, conference tiers, and design all had a clear influence on the results of the Bowl Championship Series (BCS) polls and bowl game selection. These structural aspects of college football help shape ranking patterns in the coaches' poll and the BCS rankings (Sanders, 2011). This study considered conference type, conference size, and the results of the coaches' polls to construct affinity matrixes to show the levels of interconference support for both specific conferences, and conferences which are either automatic or non-automatic qualifiers (Sanders, 2011). This is significant because of the money that is at stake for conferences and teams who qualify for bowl games, and it also reiterates the issues of inequalities which have previously been shown in college football (Eckard, 1998).

Network Theory and Coaching

In a few instances, network theory in sport management has been utilized to evaluate coaching lineage. These studies consider the influence that a mentor/mentee relationship has on the success of a coach coming from a particular "coaching tree". Network theory is applied to coaching lineage to evaluate coaching trees which shows the ancestry of all the different coaches who have worked for a particular coach (Fast & Jensen, 2006). The coaching network for the National Football League (NFL) is a very complex network of relationships containing many different connections amongst coaches and teams (Fast & Jensen, 2006). The NFL coaching network shows that considering the mentors a coach has worked under are important for understanding the

performance of that coach when they earn a head coaching position (Fast & Jensen, 2006).

McCullick et al. (2016) reinforce this point in their analysis of the NFL head coaching network. Via the network analysis they performed, they concluded that NFL coaches must have few but strong coaching roots, established roots with the same coaches grow and prosper, and that mentors who had an abundant amount of protégés did not necessarily have successful protégés (McCullick et al., 2016). They also found that assistant coaches should look to work under successful head coaches, as those relationships tend to produce more successful head coaches (McCullick et al., 2016). Understanding relationships and the networks in coaching is important for practitioners, because other studies have indicated that expert coaches viewed their own development as being reliant on the relationships they built and the networking they have done with other coaches who share their philosophy (Nash & Sproule, 2009). Thus, a coach's location in the network and who they have ties with can be advantageous for their own professional development.

Present Study

Reviewing the role that human capital, social capital, and relational networks (network theory) play in human resources management, organizational behavior in sport, leadership, and coaching, helps us understand why the relationships and network connections that exist in the FBS need to be examined further. Researching the structures of the FBS coaches' network will provide further understanding into the complexities of the network for researchers and practitioners, which could aid in hiring decisions. This

will include an exploration into how the structures of the network explain hiring decisions in the FBS, and the effectiveness of those hiring decisions (where do successful coaches come from). With this information, researchers will be able to understand who are key players in the network, how information and capital might be diffused between coaches and FBS institutions (organizations), who are key players (brokers) in a network, and what effect does these structure have on coaching outcomes, such as on-field win percentage. Chapter three will discuss the methodological approach used in this exploratory study.

Chapter 3. Methods

Overview

This study sought to provide an innovative approach to understanding the network structures and patterns which exist in the community of college football coaches via an exploratory study which analyzes the networks of Power-5 coaches. Specifically, the present study sought to gain a better understanding of what network structures exist, and how these structures and relationships may influence the on-field success for Power-5 coaches. This exploratory study will help researchers and practitioners understand the role that relationships (e.g. mentor/mentee relationships) play in influencing on-field success, which may help answer future network-focused research questions and assist practitioners in making the best hiring decisions based on a candidates coaching lineage.

The purpose of the present study was to perform an exploratory analysis into the networks of National Collegiate Athletic Association (NCAA), Division I Football Bowl Subdivision (FBS), Power-5 coaches. This chapter of the dissertation will provide a comprehensive review of the methodology which will be used in the present study. This will include an explanation of the data collection process, data organization and entry, a review of the network structures as applied to the current study, and an explanation of the data analysis as conducted through UCINET 6 (Borgatti, Everett, & Freeman, 2002) and SPSS Statistics. The data collection and these programs will be utilized to construct a

one-mode, relational network, where each vertex can be related to every other vertex, because there are only one set of actors involved in the network (e.g. Power-5 coaches) (de Nooy et al., 2018). When exploring the structures of a network, two common groups of metrics used focus on the degree centrality (Zhao et al., 2017) and the structural holes of the network (Burt, 2015). The remainder of this chapter will explain the data collection process, the visualization of the network, and the variables and analysis used for exploring the network.

Data Collection

This study, exploratory in nature, utilized quantitative data consisting of both quantitative network-level metrics as well as metrics for a coach's on-field success. The data collected for the present study will consist of the 219 (N = 219) most recent college football assistant and head coaches from the Power-5. This covers a time period ranging over the past 20 years beginning with the 2000 college football season and running through the 2019 college football season. Data was collected from the *Sport-Reference* (College Football), *247 Sports*, as well as from coaching biographies from the official athletic department websites affiliated with each Power-5 program.

Population sampling was utilized for data collection. With population sampling, every member of a given population is included in the study (Andrew et al., 2011). This method is most appropriate for this study because a census of the entire Power-5 head coaching population over the recent specified time period will give the best representation of this population and what type of structures are formed in their network. Utilizing such a wide array of coaches over an extended period will also acknowledge

any industry trends, such as the use of a popular scheme or strategy, which may have occurred in the sport over the course of that time period. Research shows that hiring trends, such as the present trend of hiring offensive-minded coaches, exist in the context of the Power-5 (Barnett, 2015; Dodd, 2015; Forde, 2015).

Specific data collected for each coach will include a performance attribute as measured through their on-field win percentage, and data collected for the mentor/mentee relationships formed between coaches in the network. On-field win percentage is a common variable used to measure success and past performance, particularly in studies considering the performance of Power-5 coaches (Inoue et al., 2012; Maxcy, 2013; Soebbing et al., 2015). This variable will be utilized in a regression analysis which considers the quantitative measurement of particular network structures in order to determine whether particular network structures (e.g. centrality, brokerage) are likely to help in a coach's professional development through their mentor/mentee relationships, thus leading to future success for that coach.

Relationships were classified through mentor/mentee relationships. McCullick, et al. (2016) utilized a similar approach to analyzing the relational nature of coaching, and utilized the assumption that mentoring takes place when one particular coach works as an assistant coach underneath the tutelage of a head coach, making that assistant coach a "protégé" or a "mentee" in a mentor/mentee relationship. Furthermore, the researcher created an edge list utilizing the coach's biographies which lists all of the mentor/mentee relationships that existed through the coach's experience as an assistant coach, prior to their obtaining a head coaching position. This considered any role or position that coach

played as a full-time assistant coach. That may include positional coaching roles, such as quarterback, running back, wide receiver, tight end, offensive line, defensive line, linebacker, or defensive back coach as well as any other full-time assistant coaching role. A coach's experience as an intern or a graduate assistant were not considered for this particular study, as it is unclear how involved a part-time coach may have been with the day-to-day operations of the team and gaining experience towards becoming a head coach.

An edge list was created utilizing the data collected on a coach's relationship with a particular coach. An edge list is simply a list containing all of the pairings which exist between two actors (vertices) in a one-mode network. Furthermore, the network for this particular project is a directed graph, where the first vertex listed in the edge list is the sender of the relationship and the second vertex listed is the receiver. In a mentor/mentee relationship, the mentee will be first vertex listed in the edge list as they are providing their services to the mentor who is inherently providing them leadership and human capital in return. Additionally, coach's development is dependent on the informal connections they form with coaches who are like minded (Nash & Sproule, 2009), which is accomplished through service to a mentor coach (McCullick et al., 2016). Therefore, mentoring occurs when an assistant coach provides their services to a mentor coach or the head coach (Cushion et al., 2003).

Data Visualization

Whole Network Visualization

The edge list containing all of the mentor/mentee coaching relationships which exist in the FBS network was entered into UCINET 6 (Borgatti, Everett, & Freeman, 2002) for both visualization and analysis. NetDraw (Borgatti, 2002), a component of UCINET 6 (Borgatti, Everett, & Freeman, 2002) was utilized for visual examination of the network. NetDraw (Borgatti, 2002) will be utilized for the purpose of visualizing the entire network of the Power-5 coaches and identifying patterns. Network visualizations are important for helping to trace and present different patterns which exist among the ties in the network (de Nooy et al., 2018). These visualizations help illustrate useful concepts and proofs which exist in the network (de Nooy et al., 2018). Analysis of social networks focuses on relationships; therefore, a drawing should be organized in a logical manner where the vertices that are connected are placed in a position closer to each other (de Nooy et al., 2018). NetDraw (Borgatti, 2002) helps accomplish this.

Ego-Network Visualization

Visualizations will also be created for individual coaches based on their ego-network. While visualizations of the whole network are considered a sociocentered approach, considering the interaction of relationships among the entire network, an ego-network approach focuses on the position of one person in the network (de Nooy et al. , 2018). The visualization of an ego and their network considers the ego (individual of interest or a "focal person"), and the alter(s), also known as the people they form relationships with (either out-degree or in-degree in a directed network) (de Nooy et al., 2018). An ego-network is a network where focus is placed on one particular actor in the network, and their corresponding relationships or ties. Simply defined, an ego-network

focuses on the structures which exist in a focal node's network (Kumar & Zaheer, 2019). Therefore, breaking down the picture of a large network (such as the Power-5 coaches' network in the present study) into visualizations of one particular coach's network or a smaller group of specific coaches' through the ego-network visualization, will help to understand the features of a network. A focus on the ego-network can help explain phenomenon that are going on at both a macro and micro level, such as theorizing the spread of human and social capital (Kumar & Zaheer, 2019). In the present study, the ego networks of the top 25% and the bottom 25% of coaches will be extracted and synthesized into two different plots (one plot combining the ego networks of the top 25% of coaches and a second plot visualizing the bottom 25% of coaches) in order to visually compare how the networks of the best coaches differ from the networks of some of the least successful coaches in the Power-5. By extracting the ego-networks of the top coaches in the network (the most successful coaches), comparisons can be made to ego-networks of coaches from the bottom tiers of success to deduct whether network structures or tendencies affect the on-field success of a particular coach.

Data Analysis

Utilizing UCINET 6 (Borgatti et al., 2002), different metrics will be calculated to empirically characterize the structure of the network and help understand how the role of mentorship and the network can affect a coach's on-field success through their win/loss percentage. Specific metrics which encompass the two most important concepts indicating the influence of nodes will be measured and variables which will be specifically considered in this study include degree centrality, the number of in-degree

relationships, the number of out-degree relationships, density, the effect size of structural holes, and betweenness.

Degree Centrality

In large networks containing many actors, important nodes can have a tremendous influence on the structure and function of the entire network (Zhao et al., 2017). One key metric used to assess influence on the network is degree centrality, which considers the location of each individual node and its effect on other nodes. Centrality is perhaps the most commonly used structural concept in network theory and suggests a node's ability to influence, diffuse, or contribute to a network is largely dependent upon how central an actor is within the network (Borgatti, 2005). Higher levels of centrality may suggest that this individual is a trusted source, who may provide much information and opportunity to acquire both human and social capital. In the context of the Power-5 coaches' network, highly centralized individuals are likely going to be mentor coaches who have developed many relationships with mentee coaches, because they have sustained success in the coaching profession. That is, that mentor coach who is a central figure has a good win percentage and has been maintained by a Power-5 program, while also providing leadership and mentorship for many mentees who later successfully obtain a head coaching position themselves.

Degree centrality is calculated in UCINET 6 (Borgatti, Everett, & Freeman, 2002) by utilizing the Multiple Centrality Measures function as well as the Bonacich Beta Centrality Measure. The Multiple Centrality Measures function provides data for a wide range of centrality measures, but this study will focus on a few specific measurements

including Betweenness, Out-Degree, and In-Degree. Density may also be considered a centrality score, as individual ego networks which have formed many connections are typically located more centrally in the network (Pauli, Basso, Gobi, & Bilhar, 2019).

Betweenness Centrality (Centrality & Structural Holes)

Betweenness considers whether an individual is central in the network, and therefore has many different actors who go through them or have a connection with them (de Nooy et al., 2018). A general conceptualization of betweenness holds that a person is needed as a link between contacts in a network in order to facilitate the spread of information in the network (de Nooy et al., 2018). Thus, two disconnected actors in an ego's network are considered an opportunity to broker a connection (Burt, 2015). This is also known as a structural hole, which will be discussed later. Therefore, betweenness helps researchers conceptualize both centrality and filling the void of structural holes, as a betweenness score is the count of structural holes an ego has exclusive access to (Burt, 2015).

In the context of the Power-5 coaches' network, this will indicate whether as a coach it is critical to be a central figure in the network who is the source of the spread of innovation and information and is the source of mentorship for other coaches in the network. This is important to consider as a coach who is very central in the network will be viewed by peers as either a successful coach who is able to provide more opportunities for other protégé coaches because of their ability to maintain success and a higher status in the industry, or because they are a coach who is perceived to have great leadership

capabilities and is a source of information and innovation for other protégé coaches in the network.

Out-Degree Centrality

Out-degree is one of two measurements (along with in-degree) which considers the degree of a vertex, or how many relationships the actor is involved with. The degree of an individual vertex in the network considers the number of lines or ties in the network which one particular vertex or actor are involved with (de Nooy et al., 2018). Vertices with a higher degree (out- or in-) are more likely to be found in more dense sections of the network, indicating higher involvement within the network (de Nooy et al., 2018). Out-degree considers the number of arcs (connections) which an actor sends in the network. In essence, an out-degree relationship is described by a node seeking out a relationship with the receiver (Cranmer et al., 2019).

Conceptually, it looks at the expansiveness, outreach, or "sociality" of an actor in the network (Wasserman & Faust, 1994). The value for out-degree is calculated through UCINET 6 (Borgatti, Everett, & Freeman, 2002) and in this study represents the number of mentor coaches a protégé has worked for. In the context of the Power-5 coaches' network, coaches with a higher out-degree value had more outgoing relationships to different mentor coaches. This would represent that they have worked with more mentors and potentially have had a variety of sources for increased human and social capital. This represents the coaches being social actors in the network.

In-Degree Centrality

In-degree is the second measurement which considers the degree of a vertex. Similar to how out-degree considered the "sociality" of an actor in the network, in-degree considers the "popularity" of an actor in the network. In-degree centrality is an actor-level attribute which structurally measures the popularity of a node and how many in-coming connections they have (Wasserman & Faust, 1994). A higher in-degree measurement considers higher popularity and that this individual is more of a central (popular) actor in the network. Lower values for both in-degree and out-degree measurements indicate more egalitarian networks (Hepworth et al., 2019).

In the context of the Power-5 coaches' network, a coach with a higher in-degree metric indicates that they have a lot of protégé coaches coming in to work for them who go on to obtain Power-5 head-coaching jobs. This may indicate a variety of factors, primarily that they could be perceived as a trustworthy source of knowledge and information which may help a protégé coach grow, and also lead to a higher likelihood of a protégé coach obtaining a head coaching position themselves because of the leverage and success of that mentor coach with the high in-degree metric. It could also simply indicate that the mentor coach with the high in-degree has longer on-field success and they may have a longer tenure in the industry because of their success, thus a greater likelihood of having protégé coaches who obtain head coaching positions.

Beta Centrality

Beta centrality considers how powerful a connection is. In the context of networks, power indicates an individual can have a dominant presence over other actors

in the network who are connected to them (Hanneman & Riddle, 2005). Furthermore, power in a network can occur at both the micro level or through the relationships between actors, and the macro level through an individual potentially dominating the entire population (Hanneman & Riddle, 2005). Practically speaking, having great power or position in the network means an individual may have greater leverage in bargaining with other actors or greater influence over actors because their connections are very meaningful (Hanneman & Riddle, 2005).

In the context of the Power-5 coaches' network, greater power would be conceptualized by a mentor coach having many out-going ties to other coaches in the network, particularly well-connected coaches, but the in-coming ties they have from mentee coaches are not well-connected to other coaches in the network. Thus, the mentor coach will have greater power over those mentee coaches, because they have more access to other members of the network than the mentee coaches. This follows the notion that an individual is better off being connected to another individual who is very well connected (e.g. a protégé coach who is not well connected being connected to a mentor coach who is very well connected). Thus, the measurement of power belongs to the mentor coach, who is well connected in the network.

Density (Centrality & Structural Holes)

Density considers how interconnected a network is. It is one of the most useful measurements and is understood as the proportion of existing and possible links between individuals in a network (Hanneman & Riddle, 2011). Density represents the strength of the network (Hanneman & Riddle, 2005). Previous scholarship has associated high

density with positive effects, such as efficient communication and transfer of knowledge (Lechner, Frankerberguer, & Floyd, 2010). Scholarship has also associated it with negative effects, such as limiting creativity, increased pressure and stress on individual performance, and decreased productivity and responsibility (Hardy et al., 2005). The measurement for density is calculated as a percentage and is calculated by the number of total connections in a network divided by the number of possible connections in the network (Burt, 2015; Pauli et al., 2019). Density can be measured for the whole network, as well as for the individual ego's, and provides researchers with an idea of how many relationships are formed in a population. In the context of the Power-5 coaches' network, density will illustrate how social and popular coaches are across the whole-network, and across their own ego-network. For the whole-network, the amount of density will demonstrate cohesion and how frequently coaches create relationships with a variety of coaches. In the ego-network, it will simply focus on how many ties are formed between a particular coach with other mentor or mentee coaches, as well as how connected that particular coach is with the connections of their mentors and mentees.

Structural Holes

Utilizing the Structural Holes function in UCINET 6 (Borgatti, Everett, & Freeman, 2002), metrics for Structural Holes will be produced which considers density, the effective size, and again betweenness of actors in the network. A structural hole is a non-redundant source of information that is filled by an actor, in this instance also known as a broker. These brokers are actors who connect to separate and different groups of actors. People who connect these groups together are exposed to a diversity of

surrounding opinion and behavior (Burt, 2015). Previous research has shown that individuals who are brokers of information in the network are paid more than peers, receive better recognition and performance evaluations, and are promoted quicker than other members of a network (Burt, 2005; Burt et al., 2013).

Effective Size for Brokerage

The effective size for brokerage, not to be confused with effect size in conventional statistics, is a count of the number of ego's contacts discounted for clustering and is the count of the clusters (groups) to which an ego is connected (Burt, 1992). It can be operationalized as the number of nonredundant contacts in an actor's network (Burt, 1992). Effective size will be higher if there are nonredundant contacts in a particular ego network for an actor, thus if effective size is higher than that particular actor is connected to different groups or cliques and can serve as a broker for those groups. However, if an actor's effective size is lower, then they are a part of a closely connected group (clique) and there are many redundant ties, thus redundant information. Contextually for the Power-5 coaches' network, a higher effective size means that a coach will have a history working for a variety of head coaches who are not interconnected with each other. Thus, they have been part of many coaching trees.

Structural Hole Betweenness

In the context of structural holes, betweenness is a count of the structural holes which an actor has exclusive access to (Burt, 2015). Thus, betweenness considers both brokerage and small-group centrality because it considers one actor's control over the connections formed in a group of actors (Freeman, 1977). If an actor is a broker, their

betweenness score will be higher because that score will statistically represent the number of connections which don't exist, that they can create in the network because they then will have that ability to serve in the role of a broker. In larger networks, such as the Power-5 coaches' network, betweenness scores are typically higher as an increase in the number of contacts typically leads to an increase in the number of structural holes (Burt, 2015). Again, in the context of the FBS coaches' network, a higher betweenness metric for a coach will indicate that they are well connected and have the opportunity to bridge the gap between groups of coaches, which previously did not exist. Again, being a broker is good because of the potential access to diverse sources of information and ideas. In the context of Power-5 coaches', this could be access to information or relationships about obtaining a particular head coaching opportunity, or access to a wide array of coaching philosophies or strategies which a coach could use to help improve their teams and win.

Summary

This exploratory study looked to learn about the key structural phenomena of the Power-5 coaches' network and understand how these structures may affect a coaches' on-field success. This study utilized data from all of the Power-5 coaches over the past 20 years of Power-5 college football, in order to best represent and study the contemporary Power-5 coaching community. The data collected for each coach consisted of data representing the mentor/mentee relationships they have formed with coaches, as well as their on-field win percentage. The data for the relationships were organized into an edge

list, which was utilized for input in the network analysis statistics program UCINET 6 (Borgatti, Everett, & Freeman, 2002).

Then, utilizing UCINET, the author ran an analysis for metrics of Degree Centrality and Structural Holes, two popular categorizations of analysis used for analyzing network structure. These metrics will be described and visualized through network plots. Then, the author ran a regression analysis using SPSS to analyze whether any of these structural metrics have any correlation to a coaches' on-field success as measured through winning percentage. This helped in providing useful background information about the structural tendencies of coaches' networks and the important role that consideration of networks can play into understanding the coaching profession. It also explains what role networks and relationships play in the coaching profession, and how these relationships effect on-field success. Chapter four discussed the findings and provides analysis and evaluation of the data.

Table 1. Key Terms

Network Term	Conceptualization	Operationalization
Degree Centrality	The influence of nodes as measured by the number of neighboring nodes.	More central coaches will have many nodes connected to them.
Betweenness	The number of structural holes to which an ego has exclusive access to.	An actor serves as the shortest path between connecting two particular individuals.
Out-Degree Centrality	The number of arcs (connections) which an actor sends in the network. A node seeks out a relationship.	A mentee/protégé coach will form an out-degree connection towards a mentor coach. Higher out-degree represents "sociality".
In-Degree Centrality	The number of in-coming connections an actor has. Considers the popularity of an actor in the network.	A mentor coach will have in-degree connections and will have a higher in-degree with the more coaches they mentor.
Beta Centrality	Considers how powerful a connection is, as an individual can have a dominant presence over other actors in the network who are connected to them, via strong relationships.	A coach who possesses greater power in the network will have greater leverage in bargaining with other actors or greater influence over other actors.
Density	The index of the degree of dyadic connection in a population. It is the ratio of the number of connections in the network to the number of possible connections present.	Density will represent how well-connected coaches are in the Power-5 network. It will consider how many ties are formed between all of the coaches.
Structural Holes	A non-redundant source of information that is filled by an actor, also known as a broker.	A coach who bridges a connection between two other coaches in the network who had no previous connection or tie.
Effective Size for Brokerage	The count of the number of ego's contacts discounted for clustering and is the count of the clusters (groups) to which an ego is connected.	A coach with a higher effective size indicates that they are connected (in-degree and out-degree) to many non-redundant clusters.

Chapter 4. Findings

This chapter highlights the key findings from the UCINET analysis as well as the regression analysis in SPSS to best answer the research questions posed in this study. Explanations of the results as well as tables and visuals of the whole network and the ego network (ego network refers to the metrics for the individual coaches) are included and discussed. When conducting analysis of a network and its accompanying structures, it is important to include a visual analysis in accompaniment with a statistical analysis to help provide a better picture and a practical context explaining the interactions occurring in the network. Network visualizations (also referred to as layouts) can be optimized to help examine node and edge perspectives (Zou & Brooks, 2019). This allows for researchers to analyze community relationships in social networks and the interactions as generated through node matrices or edge lists (Henry et al., 2007), such as the edge list used in the present study.

Data Analysis

RQ 1. What type of patterns for centrality and structural holes exist in the whole-network?

For the one-mode relational network of the Power-5 coaches, structural analysis and visuals were created utilizing UCINET 6. Visuals were created for the whole network (Figure 1), as well as the top 10% of the winningest coaches (Figure 2) and for the

bottom 10% of the least successful coaches (Figure 3). The visuals were created for the top 10% of coaches and for the bottom 10% of coaches to consider how the overall structure for each group of coaches may vary. UCINET 6 produces statistical metrics for both individual coaches' and for the whole network. The metrics for the whole network will also be reported in this section in association with the first research question (Table 1).

Figure 1 illustrates the entire FBS coaches' network. Despite data being collected for 219 coaches (N = 219), only 210 coaches (nodes) appear in the network. The output from UCINET does not show the coaches who are isolates. A coach who is an isolate does not have any connections to any other coaches in the network. The nine coaches who are isolates include hc10 (Bronco Mendenhall), hc68 (Jim Mora), hc75(Jim Grobe), hc144 (Sylvester Croom), hc172 (Mike Shula), hc187 (John Mackovic), hc194 (Tom Holmoe), hc196 (Jim Caldwell), and hc214 (Chris Klieman). A quick visual inspection of the network shows that the network is not cohesive and that there are many different central figures in the network. That is, based on how many individuals appear in the middle of the whole network, without numerous in-degree ties to a select few coaches, it appears that there are many different coaches who played the role of mentor to a group of protégé or mentee coaches. This represents that there are not any particular "go-to" mentor coaches who are very popular individuals in the network. Rather there were a variety of coaches who played the role as a mentor coach for other mentee assistant coaches in the network. Coaches without any in-degree ties, who are strictly the mentees or protégés in this instance, tend to be more towards the periphery of the network. Mentor

coaches with fewer connections may be located more towards the periphery as well, but coaches who have been mentors to multiple mentee coaches will be pushed to the middle of the network. The coaches located in the middle of the network are likely to have a relatively high amount of both in-degree and out-degree connections.

Figure 1. FBS Coaches Network

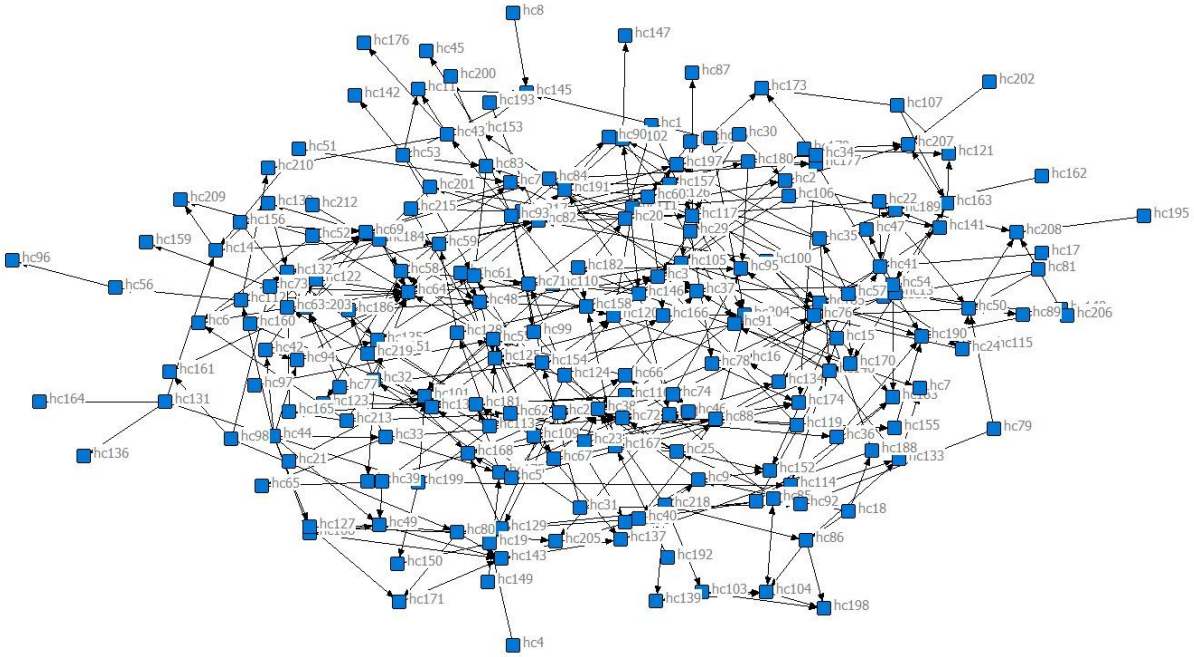


Table 2. Whole network measures

Measure	FBS Network
# of Nodes	210
# of Ties	430
Degree Centralization	0.063
Out-Centralization	0.029
In-Centralization	0.067
Density	0.01
Connectedness	0.056

The results in Table 1 reinforce the findings from the visual inspection of Figure 1 that this particular network is not too cohesive. Degree centralization is very low at 0.063, which indicates that there can be many central coaches serving as central figures and as mentors for different mentee coaches. Degree centralization is measured on a scale of 0 to 1. The closer that number gets to one, this indicates that the network is in the shape of a "star", where there is one central coach who forms connections with all of the nodes (Golbeck, 2015).

We can see in Figure 1 where there are many different mentor coaches clustered together in the middle of the visual, and there is not one coach in the network who dominates the network in regard to in-degree connections, thus the lower in-degree centralization score. Out-degree centralization for the whole network considers how frequently coaches in the network create out-going connections, relatively speaking to the size of the network. The results indicate that out-degree centralization does not occur as frequently as in-degree centralization does, although in-degree centralization also occurs at a relatively low rate. In the context of the Power-5 coaches' network, this means that coaches are not that social or popular.

The overall measurement for network density is again rather low at 0.01. This can be seen via visual inspection of the network in Figure 1, as there are very few triangles that can be seen both on the periphery of the network, and in the middle of the network. If there were more density within this particular network, there would be a much denser appearance of lines forming connections between each of the nodes, and visually one would be able to notice much more triadic closure on the periphery of the network as

well. This network does not contain as many lines and connections as other, smaller networks do. Typically, as the number of individuals in a network increases, the density of social connections within a society declines (McPherson & Ranger-Moore, 1991). Networks which are sufficiently small, naturally lead to greater interaction between every actor in the network (McPherson & Ranger-Moore, 1991). Therefore, as a network continues to grow in size, the density of connections experiences a drop-off as it naturally becomes much more difficult for an individual to maintain ties in any social situation with a large population (Pool & Kochen, 1978). Similarly, the connectedness of the network is 0.056. This aligns with the previous metrics showing low out-centralization and in-centralization which shows that the Power-5 coaches simply do not form that many connections to different mentor coaches in the Power-5 coaching network.

When looking at larger networks, such as the network in the present study, it is easier to visualize centrality than it is structural holes, simply because centrality is easily seen through which coaches are located more towards the center of the visualization, and have more in-degree and out-degree connections. Degree centrality is typically more suitable for large, whole-networks because it is easier to visualize centrality (Zhao, Guo, & Wang, 2017). However, because we know that connectivity and density is low (from the visualization and the data), we can deduce that there will be several opportunities for actors in a network to fill a structural hole, considering that connectedness calculates looks at the many different pathways which can be taken for two actors to connect (Hanneman & Riddle, 2011). Therefore, this will inherently increase the number of opportunities for actors to serve as brokers between unconnected networks.

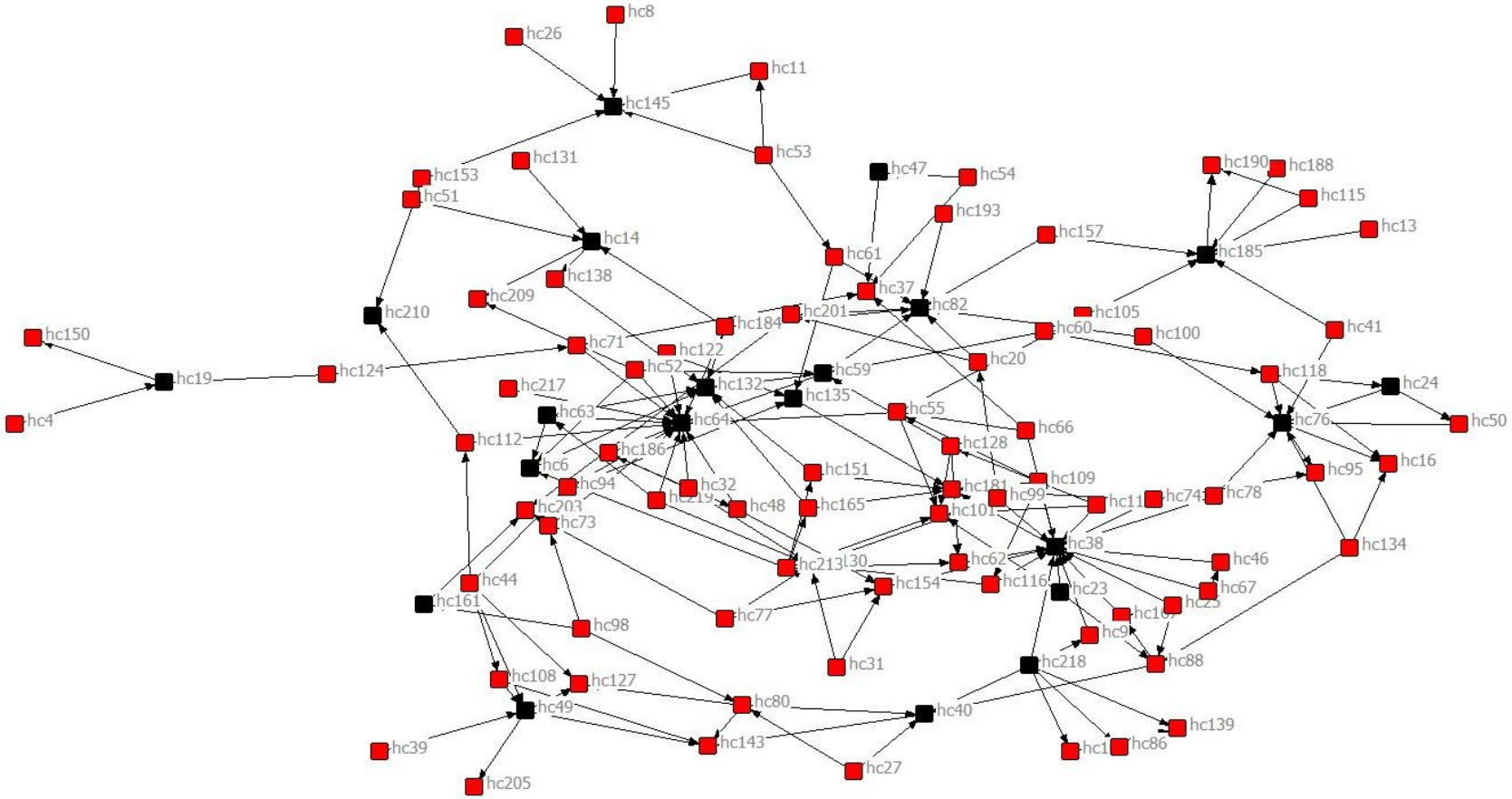
Visualizing successful Coaches

Examination of Figure 2 depicting a visual representation of the network of the top 10% of coaches shows more centrality in terms of their in-degree centrality (incoming ties) to the more successful coaches in the network. Bearing in mind that coaches in this network can be both a mentor and a mentee, the visualizations show what sort of in-degree and out-degree connections a particular coach may have. Research about mentor and mentee relationships, typically refers to this dynamic of mentor/mentee relationships through the vernacular of "coaching trees" (Fast & Jensen, 2006). The top 10% of coaches are represented by the black squares in Figure 2, and their alters (the term alters in ego-network analysis refers to connections) are represented by the red squares. We can see that hc64 (Nick Saban), hc38 (Urban Meyer), hc132 (Bobby Bowden), hc76 (Bob Stoops), hc82 (Les Miles), and hc185 (R.C. Slocum) all have a higher amount of in-degree connections from other protégé coaches in the network, representing that they are mentors to a variety of different mentee coaches in the network.

Also, in the network plot for the most successful coaches is that some of the coaches who are in the top 10% either share a direct connection with one another or share connections with other alters in the network. An example of coaches who share a direct connection with one another are hc38 (Urban Meyer) and hc218 (Ryan Day), hc64 (Nick Saban) and hc63 (Kirby Smart), and hc76 (Bob Stoops) and hc24 (Lincoln Riley). Overall, we can see in the network of the successful coaches that the Effective Size for the structural holes of the coaches appears to be rather high. The figure shows that hc64, hc82, hc38, hc218, hc76, and hc185 have many different nodes they are connected to, via

both in-degree and out-degree connections. Therefore, they are members of different clusters based on the relationships they have formed with mentor and mentee coaches and the relationships, and the extended relationships formed by those mentor and mentee coaches. For example, Urban Meyer (hc38) has a higher effective size for structural holes as he is a part of many different clusters via both in-degree and out-degree. For Meyer and Saban, consideration can also be given to the fact that Meyer and Saban have had a few different head coaching positions in the FBS, not specifically within the Power-5, however.

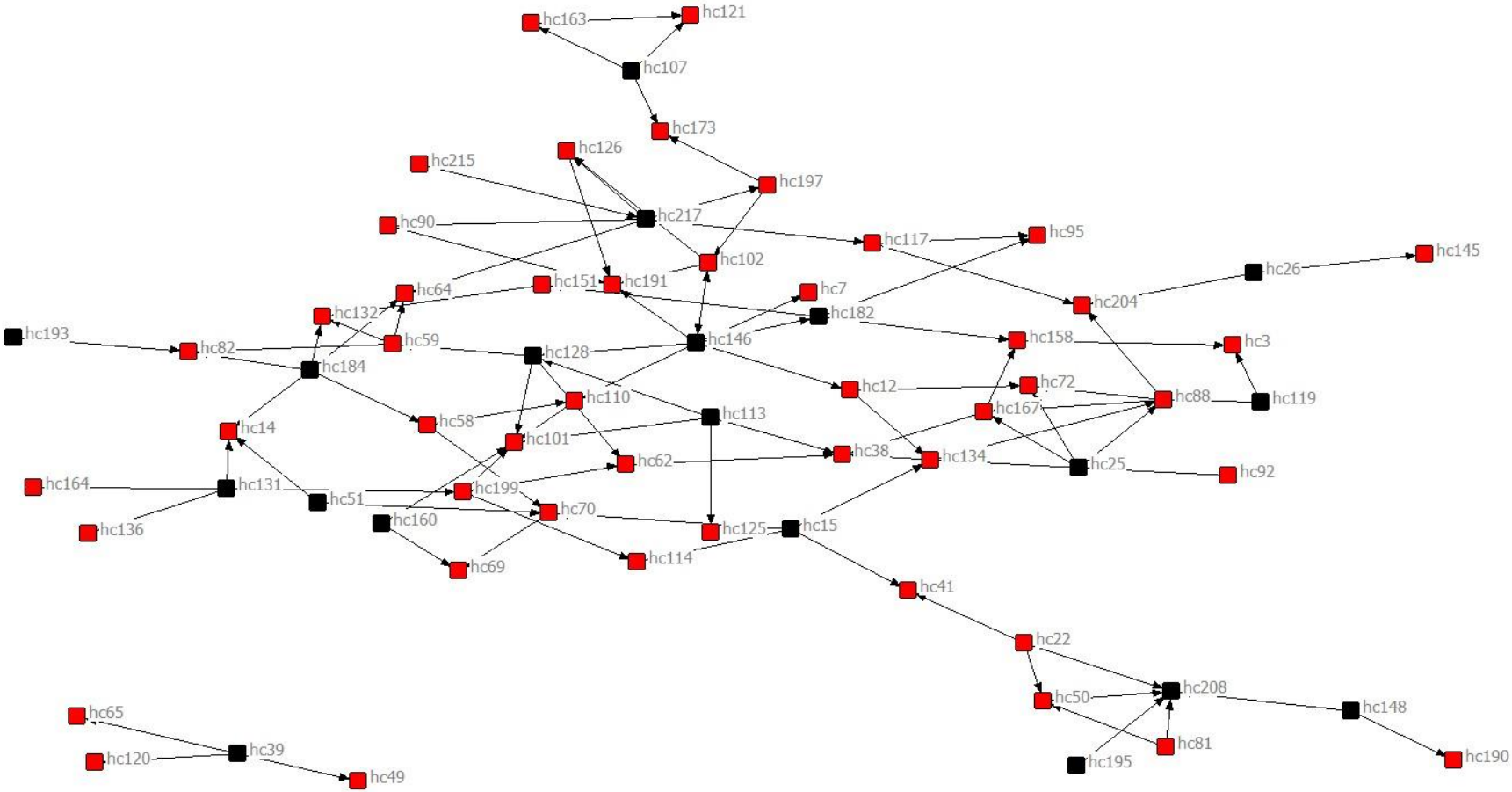
Figure 2. Top 10% most successful coaches (n = 22)



Visualizing Less-successful Coaches

Examination of Figure 3, the visual representation of the network of the bottom 10% of coaches, appears to be more representative of what we see in the entire network in Figure 1. Specifically, there is less centrality and fewer coaches who have higher in-degree centrality like the coaches in Figure 2 demonstrate. In Figure 2, we saw Nick Saban, Urban Meyer, Bobby Bowden, Bob Stoops, Les Miles, and R.C. Slocum have many incoming ties. However, that is not the case in Figure 3, as the only coach with many in-degree connections is hc208 (Hal Mumme). Mumme also has two in-degree connections from, and was a mentor for, two of the other least successful coaches in the network, hc195 (Woody Widenhofer) and hc148 (Guy Morriss). Another coach, hc146 (Ted Roof) is a central figure in the network with a high out-degree centrality, as he has many outgoing connections within the network. Roof also has a high betweenness score, indicating he plays the role of a broker filling many structural holes, as indicative of the ties you can see not only through the high amount of out-degree ties and connections he forms, but because of the connections he can also bridge via the many independent connections of the ties he is connected too. An example is the connection he has to hc12 which can lead him to hc134 and hc72 and the many connections they have. Two of those out-degree connections are to two other coaches who are among the lowest 10%, hc128 (Tim Brewster) and hc182 (Carl Franks). Three of the low performing coaches are not pictured in Figure 3, as they were complete isolates from the network; hc172 (Mike Shula), hc196 (Jim Caldwell), and hc194 (Tom Holmoe).

Figure 3. Bottom 10% least successful coaches (*n* = 22)



RQ 2. How do patterns for centrality and structural holes correlate with on-field success of a Power-5 coach?

After building the network through UCINET and gathering the different network metrics utilized in the above analysis, the specific network metrics for centrality and structural holes were entered into SPSS in order to conduct a Simple Linear Regression Analysis. The purpose of this analysis was to analyze whether these network related metrics explained any of the variance in on-field success for the Power-5 head coaches. That is, the researcher is interested in exploring whether any of the network related variables have a statistically significant meaning in the variance of success for the head coaches. These results will help researchers and practitioners in determining what role network structures play in the professional development and success of the coach, and which particular structures will need further research because they play a significant role in the success of the coach.

Data were organized into a spreadsheet which included metrics for the independent variables of Out-Degree, In-Degree, Betweenness, Bonacich Centrality, Effective Size of Structural Holes, and Density. These variables now consider each coach at the micro-level in isolation, and who they are connected to (in- and out- degree relationships) and what structures they are a part of for these relationships, while the whole-network measurements which were discussed in association with RQ1 were macro-level calculations. In essence, it is a consideration of each coach's ego network. The dependent variable in the study was the on-field success of the coach as measured through their win-loss percentage as a head coach. This data spreadsheet was imported

into SPSS version 26. A preliminary simple linear regression analysis ran which considered every independent variable. Included in the analysis was consideration of collinearity diagnostics and the normality of the distribution. The P-P plot observed the cumulative distribution function (CDF) of the standardized residuals for this study compared to the expected (CDF). All of the residual values clustered around the horizontal line, indicating multivariate normality.

After performing the simple linear regression analysis to model the relations between a coaches' network structures (centrality and structural holes) and coaches' win percentage, the results showed that the network-level metrics uniquely explained 22.7% of the variability in the coaches' win percentage (F (6, 212) = 10.024, p = .000). However, tests to see if the data met the assumption of collinearity indicated that multicollinearity was a concern for Out-Degree Centrality, In-Degree Centrality, as well as Effective Size (Out-Degree, Tolerance = 0.063, VIF = 15.847; In-Degree, Tolerance = 0.031, VIF = 32.254; Effective Size, Tolerance = 0.031, VIF = 32.371) as demonstrated in Table 2.

Table 3. Coefficients

Independent Variable	Unstandardized Coefficeints		Standardized Coefficients			95.0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
Out Degree	-3.652	2.195	-0.402	-1.664	0.098	-7.978	0.675	0.063	15.847
In Degree	-0.432	2.244	-0.066	-0.193	0.847	-4.856	3.992	0.031	32.254
Betweenness	-0.022	0.012	-0.127	-1.918	0.056	-0.045	0.001	0.84	1.191
Bonacich	-0.657	1.017	-0.042	-0.646	0.519	-2.663	1.348	0.863	1.159
Effective Size	3.424	2.31	0.511	1.482	0.14	-1.13	7.979	0.031	32.371
Density	26.965	12.316	0.169	2.189	0.03*	2.687	51.242	0.616	1.624

*$p < .05$

Furthermore, the measurement for In-Degree centrality was removed from the analysis in order to improve the issue of multicollinearity. In-Degree Centrality was removed as opposed to Out-Degree Centrality and Effective Size, because In-Degree and Effective Size both had the highest VIF values, and Effective Size was deemed as a more important variable to maintain in the study because it represents a more holistic measurement for the network, as it considers the different clusters which an ego (coach) is connected to and the number of nonredundant ties in the ego's network. Also, it is less likely that every coach will have an in-degree tie or measurement, but more likely and applicable that a coach has an effective size measurement as this considers both in-degree and out-degree connection. Effective Size and Out-Degree were also closer to approaching significance than In-Degree.

After removing In-Degree centrality and experience, a new simple linear regression model was performed to again analyze the relation between a coaches' network structures (centrality and structural holes) and coaches' win percentage. The results showed that the overall, network-level metrics explained 22.1% of the variance (see Table 3). The only variable which was not statistically significant was the Bonacich measure for centrality, t = -0.693, SE = 0.999, p = .489, BCa 95% CI [-2.661, 1.277]. The remaining measures did show statistical significance once collinearity was fixed through the removal of the In-Degree connections metric and experience. Important to note is that network observations violate the independent observations assumption of OLS, so robust standard errors are used.

Table 4. Adjusted Coefficients

	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence		Collinearity Statistics	
Independent Variable	B	Robust Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
Out Degree	-3.246	0.613	-0.357	-5.293	<.001**	-4.455	-2.037	0.805	1.243
Betweenness	-0.023	0.011	-0.129	-1.993	0.048*	-0.045	0	0.87	1.15
Bonacich	-0.692	0.999	-0.044	-0.693	0.489	-2.661	1.277	0.891	1.122
Effective Size	2.989	0.47	0.446	6.355	<.001**	2.062	3.916	0.742	1.347
Density	25.524	9.76	0.16	2.615	0.01**	6.285	44.762	0.976	1.025

*$p < .05$ **$p < .01$

Table 5. Experience and Success

	Unstandardized Coefficients		Standardized Coefficients		
Independent Variable	B	Std. Error	Beta	t	Sig.
Experience (HC)	0.721	0.13	0.351	5.527	0*

*$p < .05$

Table 6. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Out Degree	219	0	8	1.96	1.653
Betweenness	219	0	632.500	31.9772	85.590527
Effective Size	219	0	16.294	3.57248	2.244408
Density	219	0	0.500	0.05166	0.094315

Out-Degree

The results show that for every increase in 1 Out-Degree connection by a coach, their win percentage will decrease by 3.25%, t = -5.293, SE = 0.613 , p = .000, BCa 95% CI [-4.455, -2.037]. This result is statistically significant and shows that as a coach's total number of Out-Degree connections increases, their total win-percentage will begin to decrease. In the context of the present Power-5 coaches' network, this indicates that the more a coach worked as a protégé, thus forming more out-degree connections to other mentor coaches, their win percentage gradually decreased. The standardized coefficient for out-degree is β = -0.357, therefore the strength of the effect for out-degree is for every 1 standard deviation increase in the number of Out-Degree connections for a coach, their win percentage decreases by a standard deviation of β = -0.357 of win percentage.

Betweenness

Results for betweenness indicate that for every increase in 1 unit of the betweenness metric, win percentage will decrease by -.023%, t = -1.993, SE = .011, p = .048, BCa 95% CI [-.045, .000]. This statistically significant result tells us that as the number of structural holes which an individual coach has exclusive access to increases, then their winning percentage as a head coach will gradually begin to decrease. Furthermore, the more small-group centrality a coach has, or the more control over communication within a group of non-redundant ties, may gradually become harmful to the coach. The standardized coefficient beta for betweenness is β = -0.129, representing that for every 1 standard deviation increase in betweenness, the strength of the effect on the win percentage for a coach will decrease by β = -0.129 of a standard deviation.

Effective Size of Structural Holes

For effective size of structural holes, the results show that for every 1 unit increase in effective size, their win percentage will increase by 2.99%, $t = 6.355$, $SE = 0.470$, $p = .000$, BCa 95% CI [2.062, 3.916]. This result is statistically significant and shows that as a coach's effective size increases, so does their on-field success. Conceptually, this alludes to the fact that if a coach has connections to a higher number of different clusters of coaches, and has a higher number of nonredundant contacts in their ego network, they will be better off having built those connections with different cliques and having served as a broker of information between those different groups or cliques. Therefore, a coach has roots to a wider variety of "coaching trees" as compared to other coaches. The strength of the effect for effective size is larger than it is for any other measure, as represented by the standardized coefficient beta of $\beta = 0.446$. This indicates that for every one-unit increase in the standard deviation for effective size, the standard deviation for win percentage will increase by $\beta = 0.446$ of a deviation.

Density

The results for density show that for every 1 unit increase in the density of the network, the coach's win percentage will increase by 25.52%, $t = 2.615$, $SE = 9.760$, $p = .010$, BCa 95% CI [6.285, 44.762]. This result is statistically significant and indicates that for coaches in the Power-5 network, as the density of their network increases, this helps them slightly improve their win percentage once in their own head coaching position. This indicates that the more coaches engage in "clique networks" or groups where they form tight connections with the coaches around them, and this may help them with future

success. Density is zero in networks where no contact is connected with the other actors in the network but is 1 for networks where everyone is connected to each other. In larger networks, it is nearly impossible to have perfect density, thus in larger networks the density scores are relatively lower. The strength of the effect for density is $\beta = 0.160$, as with every one-unit increase in the standard deviation for density will result in a $\beta = 0.160$ standard deviation increase in win percentage

A Note on Experience

Experience was originally left out of the analysis, because of the emphasis placed on network structures. This study looked to explore what role network structures explicitly might play in the development of a coach via their human and social capital, and what role that plays in their on-field success. However, it is important to note that the covariate, years of experience as a head coach can also play an important role. Table 4 indicates the significant results which years of experience has on the success of the coach. For every unit increase in a coach's experience as a head coach, the coach's win percentage will increase by .721%, $t = 5.527$, $SE = 0.13$, $p < .001$, BCa 95% CI [0.464, 0.978]. Thus, it is important to consider that the total years of experience of the coach plays a significant role in increasing their on-field success. This is important to consider for future studies which provide a more in-depth analysis of each of these ego-network covariates. Future research which focuses on each network structure may want to consider experience as a moderating variable which effects the strength of each individual ego-network statistic on win a coach's success.

Discussion

RQ 1. What does the overall structure of the network look like?

Through the visual analysis of the whole-network measures, we can surmise that the Power-5 coach's mentor/mentee network is not dense and does not form a high amount of connections. Generally speaking, coaches do not form too many out-degree relationships with mentor coaches. Thinking about this finding conceptually, this might matter contextually as it indicates that coaches who were mentored by other Power-5 coaches and go on to become Power-5 head coaches themselves, will tend to have fewer mentors in the Power-5 network. Further research will need to consider why this phenomenon exists within the network, but generally speaking we can initially see that the Power-5 network is not dense as the coaches tend to form fewer relationships within the network, and that there is a relative lack of centrality. This matches the previous findings of Fast and Jensen (2006) who found that in the National Football League, coaches who have fewer mentor coaches are more likely to be successful.

The low "in-centralization" and "out-centralization" scores in the network again illustrate that there are not too many relationships formed in the Power-5 network. In-degree centrality is a structural measure for popularity (Wasserman & Faust, 1994) and is measured on a scale from 0 to 1 based on the proportion of actors in the network who have incoming connection (Hepworth, Kropczynski, Walden, & Smith, 2019). Out-degree centrality looks at the outreach of a coach or their sociality (Wasserman & Faust, 1994). Similar to in-degree, it is measured on a scale of 0 to 1. Networks with scores

closer to zero indicate a more egalitarian network (Kropczynski, Walden, & Smith, 2019). Thus, the Power-5 coaches network appears to be more of an egalitarian network.

The coaches' network in general has extremely low popularity or in-degree (n = 0.067) and sociality or out-degree (n = 0.029) amongst the coaches. Again, further research will need to be conducted as to why coaches do not form that many relationships, but overall, the results of the present study show that the network is not too social. This shows a lack of "sociality" as well as a lack of "popularity". In the context of the Power-5 coaches network, there are a variety of reasons which may explain why this exists, however from this network we can simply deduce that coaches are typically not too active in the network, and generally stay close to particular individuals or clusters who are in the Power-5 network.

The low density and connectedness scores show that there is a low amount of cohesiveness in the network. This means that there are not a lot of mentor or mentee relationships that are formed outside of the immediate clusters and mentor/mentee relationships that the coach is already a part of. How connected and cohesive a network is can provide a lot of explanation about the attitudes and behaviors of individuals (Hanneman & Riddle, 2013). As alluded to, in the context of the Power-5 coaches' network, this could indicate that coaches do not move around much and are perhaps loyal to their mentors. Low amounts of density and connectedness are also naturally to be expected in larger networks (Burt, 2015; Hanneman & Riddle, 2013) as it is very difficult to expect that every connection in a large network will connect to one another.

Winning and losing coach networks

The analysis of the networks for the most successful coaches and for the least successful coaches can help us understand more about the Power-5 coaching community, and the development of successful coaches. As indicated in the results, the plot for the more successful coaches indicates that there are more central figures in the network, and that some of these more successful coaches share connections with other more successful connections, such as Ryan Day with Urban Meyer, Lincoln Riley with Bob Stoops, and Kirby Smart with Nick Saban. It is also worth noting that three of the coaches in the network for the winningest coaches come from the same program, the Ohio State Buckeyes; Jim Tressel, Urban Meyer, and Ryan Day. Considering that Bob Stoops and Lincoln Riley are also affiliated with the same institution, the Oklahoma Sooners, this suggests that it might be important to conduct further research which focuses on affiliation networks in future studies which consider not only the role of mentors and mentees, but what role that association with a particular institution may play in affecting Power-5 head coaching attainment and mentorship as well. A study of this nature could help answer the question of whether coaches can be developed in programs who maybe do not have the same rich history or access to resources as top programs like historically and financially successful programs such as Ohio State and Oklahoma (Groza, 2010; Kaempfer & Pacey, 1986).

When looking at the network for the least successful coaches, consideration was given to the fact that there was not as much centrality in the network. The most central coach was hc146 (Ted Roof) who had many out-degree ties. This would match with our

ego-network findings that those who have many out-degree ties have a negative effect on their win percentage. Roof also has a considerably high betweenness score. Both of these notions of high betweenness and out-degree will be reinforced in the regression analysis, which indicates that as those scores increase, win percentage gradually decreases. Thus, it is appropriate that we see a coach like Roof with these higher scores residing in the lower success network. This suggests that coaches who move around frequently in the network might not have great success as a head coach. Further research will need to be conducted on the sociality of coaches in the network.

RQ 2. How do patterns for centrality and structural holes correlate with the on-field success of a Power-5 coach?

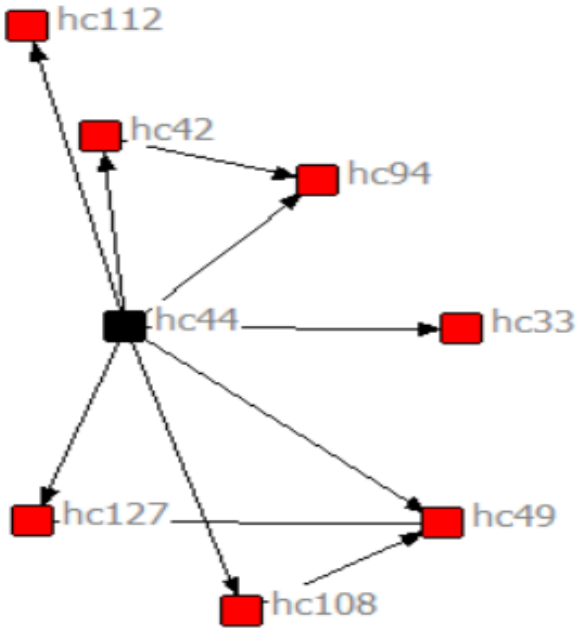
Out-Degree

Results of the regression analysis showed that when considering the localized behaviors of each individual coach, out-degree played a statistically significant role in decreasing the coaches winning percentage (t = -5.293, SE = 0.613 , p = .000, BCa 95% CI [-4.455, -2.037]). The coaches win percentage will decrease by 3.25% for every additional out-going connection a coach has. Similar to the whole network analysis, this analysis of the ego networks shows that being more social can be harmful to individual coaches. It is important to consider in this context that coaches may also be forming more out-degree relationships after a failed head coaching experience of their own, therefore they are returning to the Power-5 network to work with another mentor. More research needs to be conducted to explain this specific behavior, but from these findings we can

deduct that coaches who are not as active in the network and have smaller amounts of and perhaps more loyal connections, tend to be more successful as a Power-5 coach.

Figure 4 provides an example of an individual coach with one of the higher out-degree measurements in the network. This coach is "hc44" Justin Wilcox, the current head coach for the California Golden Bears. He has a higher out-degree number as indicated through the different positions he has held as an assistant coach with these seven coaches in the network. Wilcox is demonstrating network "sociality" by having these different experiences working as a protégé underneath coaches hc112 (Derek Dooley), hc 42 (Clay Helton), hc94 (Steve Sarkisian), hc33 (Paul Chryst), hc49 (Chris Petersen), hc108 (Jeff Tedford), hc127 (Dan Hawkins). While it is important to consider these as opportunities for Wilcox to increase human and social capital, it is also important to consider how these experiences may be detrimental to him (or any other coach with higher out-degree connections). Roach (2016) found with head coaches in the National Football League, human capital may be firm-specific, or in this instance program specific, and therefore coaches might be better off staying in one system and learning from very few different mentors in the setting of only one or two Power-5 programs. Future research which focuses on the out-degree connections should consider variables that may be firm specific for a coach's experience, as this study suggests something similar might be in play for Power-5 coaches.

Figure 4. High Out-Degree



Betweenness

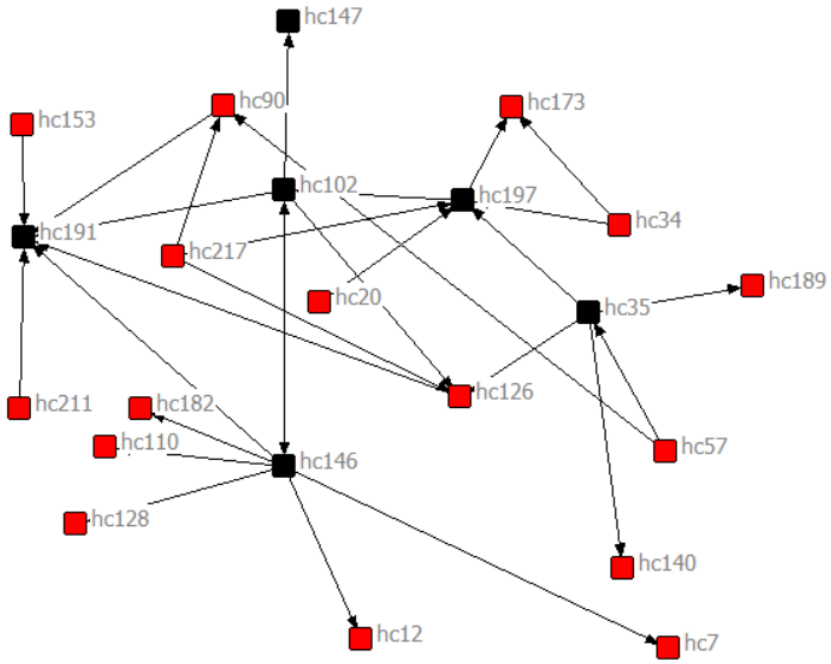
Similar to out-degree connections, increases in the amount of betweenness a coach experiences in the Power-5 mentor/mentee network also results in a slight decrease by 2.3% in coaches' on-field performance (t = -1.993, SE = .011, p = .048, BCa 95% CI [-.045, 000]). Conceptually, this suggests that the more structural holes which a coach has exclusive access to, and the more they serve as a bridge to connecting two actors without a previous relationship, it is going to likely decrease their on-field performance. This indicates that coaches who play the role of brokers in the network, but do not become embedded in the network, may struggle. Coaches with higher betweenness scores have the ability to contact many other coaches via their connections, as they form the shortest paths to a variety of coaches in the network. This indicates that being a weak tie in the Power-5 coaches' network may be detrimental.

This is important as it suggests that a coach will not want to overexpose themselves in the network, similar to how they do with higher out-degree ties. Previous research discusses embeddedness, which is the principle of having common neighbors and being immersed into the network, as being sociologically beneficial to individuals because it becomes easier for actors in a network to trust one another and to have confidence in their interactions with one another because of the trust created by having a mutual friend (Easley & Kleinberg, 2010). This may also be the case with the Power-5 coaching population. Further research will need to investigate why serving as a broker, or over-immersing oneself in the network is truly a detriment. This could be the result of a lack of embeddedness, or it could be related to how information spreads (i.e., the diffusion of innovation in the network).

Figure 5 shows an example of individual coach in the network with one of the highest betweenness scores. This coach is "hc102", Bill O'Brien the former head coach for the Penn State Nittany Lions. In order to better illustrate betweenness, the alters for the nodes which O'Brien is connected to were also included in the figure. In this context, betweenness is demonstrated by the fact that O'Brien has connections (out-going and in-coming) with hc191 (George O'Leary), hc147 (Chan Gailey), hc197 (Ron Vanderlinden), hc126 (Ralph Friedgen), and hc146 (Ted Roof), however he is not embedded within these relationships. But O'Brien's betweenness score is high because each of those coaches in his network have a high number of ties they are connected to as well. Therefore, O'Brien is only "one person away" from being connected to a variety of other figures, but those individuals are not connected to each other. Thus, for an actor in a network, betweenness

considers not only who they know, but who their alters know and the ability for that alter to help the ego contact or make connections with other members of the network. In this context, because of O'Brien's connection to Ted Roof (hc146) he could theoretically leverage that relationship to get access to hc182 (Carl Franks), hc110 (Gene Chizik), hc128 (Tim Brewster), hc12 (Dave Doeren), and hc7 (Paul Johnson) for any purpose. However, because win percentage begins to gradually decrease as betweenness increases, this suggests it may be more beneficial to be embedded in a network, rather than simply having access to a variety of actors and other resources.

Figure 5. High Betweenness



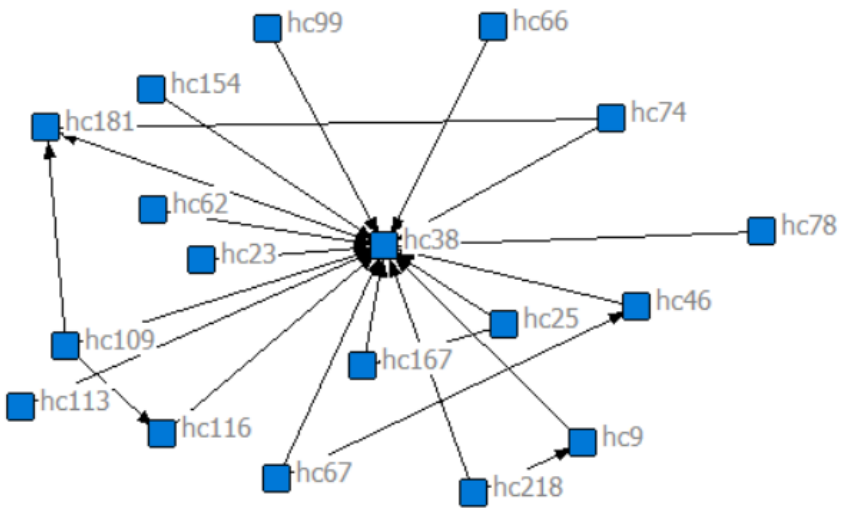
Effective Size of Structural Holes

The results of the study demonstrated that effective size is statistically significant and has a positive effect on the coaches on-field success. For every 1 unit of increase in effective size, a coaches win percentage increases by 2.99% (t = 6.355, SE = 0.470, p = .000, BCa 95% CI [2.062, 3.916]). This indicates that as the number of non-redundant contacts in the coach's network increase, their win percentage is also likely to increase. This suggests that being attached to nonredundant actors helps a coach with their on-field success. What is interesting to consider in the context of effective size, is it is different from a coach having many out-degree ties, which we found has a negative effect on on-field performance, because effective size can be considered through both in-degree connections and out-degree connections. Thus, it considers not only who does a coach work for as a mentee, but who does a coach mentor. Furthermore, the difference between simply considering out-degree ties and effective size, is that the mentorship of the coach may be just as important to consider as who are the protégés they work with and what sorts of skills and ideas can they share with each other.

Figure 6 illustrates an example of a coach with a higher effective size. This is hc38, Urban Meyer who was most recently a head coach for the Ohio State Buckeyes. As the figure shows, there is a lot of non-redundancy among Meyer's contacts in the network, and he is a member of a higher number of clusters compared to other coaches in the network. In this instance, most of the contacts are disconnected from others and are nonredundant connections made. Effective size simply considers the number of non-redundant nodes an actor is connected to, and through visual inspection of the network of

Urban Meyer we see that he has many non-redundant ties to coaches in his network, such as hc154 (Greg Schiano), hc99 (Tim Beckman), hc66 (DJ Durkin), hc78 (Kevin Wilson), and hc113 (Everett Withers). Consider in this instance that not only has Meyer mentored all of these individuals, but he was mentored by hc181, Lou Holtz, a more successful coach. Therefore, when we operationalize effective size in the coaches' network, we may want to consider that in the mentor/mentee relationship, it could be equally important for a mentor to have good mentee coaches work for them as a mentee having a good mentor coach. Further research will need to focus on effective size, and why it is linked to the success of a head coach, especially considering the significance of this phenomena in the present network.

Figure 6. High Effective Size



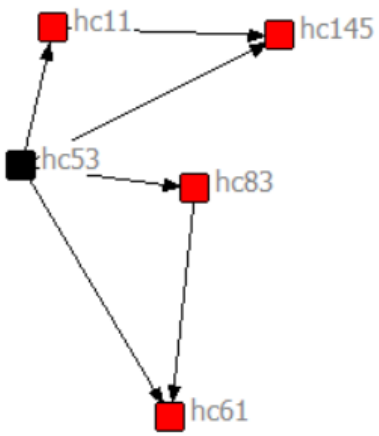
Density

Finally, density was also found to be statistically significant in this study (t = 2.615, SE = 9.760, p = .010, BCa 95% CI [6.285, 44.762]), indicating that for every 1 unit increase in density, win percentage will increase by 25.52%. In this instance, it is better to refer to the standardized coefficients beta β = .160 which indicates the strength of the effect. The strength of the effect is not as high compared to the strength of the effect for Effective Size (β = .446) and Out Degree (β = -.357). In Figure 7, hc53 is the most recent Ole Miss head coach Matt Luke who has a relatively larger density for the FBS Coaches Network, considering that most other coaches in the network who have a high density only have a couple of nodes they are connected to locally in their ego-network. As Figure 7 illustrates, coach Luke's network is rather dense and can be considered a network with shared connections as the coaches in the network have familiarity with one another. For example, Luke shares connections with hc83 (Hugh Freeze) and hc61 (Ed Orgeron) who also know each other. Luke also shares connections in a similar manner to hc11 (David Cutcliffe) and hc145 (Phillip Fulmer).

Density alludes to the fact that there are few connections in the network who are isolates and represents cohesiveness. Furthermore, it shows the strength of the network or the ability to build relationships (Hanneman & Riddle, 2013). Density can be either good or bad. Studies showing that density is beneficial have focused on the fact that it demonstrates cohesion, interpersonal attraction, group pride, and overall commitment (Beal, Cohen, Burke, & McLendon, 2003; Mullen & Copper, 1994). Studies which

propose that high density is detrimental have indicated that it can lead to dangerous levels of deindividuation and groupthink (Buys, 1978) as well as psychological costs associated with either relying on other group members or by self-handicapping oneself in order to protect self-esteem (Carron, Prpavessis, & Grove, 1994; Paskevich et al., 2001; Prapavessis & Carron, 1996). In the context of Power-5 coaches, density appears to be somewhat helpful as it relates to on-field success for the head coaches. Thus, having stronger relationships within a group, or at least being connected to a cohesive group may prove beneficial for the coach. This might be important to consider in future research when discussing the flow and spread of information, ideas, strategies, etc. among the coaches. The total measurement for density in a network provides an index of the degree of dyadic connections which exist in a population through a ratio of the number of connections present divided by the number of paired connections that are in the network (Hanneman & Riddle, 2013).

Figure 7. High Density



Summary

From the whole network analysis, it can be postulated that there is very little centrality in the network, and that there are many different coaches who can serve in the role as a mentor coach. There are not a select few coaches who are considered the "go-to" coaches for forming a mentor/mentee relationship. However, when breaking down the network of the winningest coaches, we see that there are more central figures in that specific network, and that there are shared connections among those coaches. This indicates that there are connections between protégé coaches who are in the more successful network with mentor coaches who are also in the more successful network. Analysis of the network for the least successful coaches shows that coaches who do not form cohesive networks with different clusters, or who are total isolates from the Power-5 coaches' network, may struggle.

After conducting this exploratory study, we found that when considering a coach's ego-network, their total number of Out-Degree connections as well as their Effective Size are significant and the most impactful at predicting their on-field win percentage. Out-Degree has an adverse effect on the on-field success, while an increase in Effective Size is beneficial for the coach. This high effective size suggests that it is important to look for coaches who might be a part of different clusters, regardless if they are clusters from In-Degree ties (the coaches they mentor) or they are clusters from Out-Degree ties (coaches who they've been mentored by). Further research will need to be conducted about why each of these individual variables has their own respective effect on

the coaches' success, but it is significant to know that these particular variables do play a role in coaching outcomes.

These results provide mixed conclusions about the role of different social behaviors in the coaches' network. They show that being social in a coach's network may not be beneficial for a coach as indicated by the higher out-degree and betweenness scores resulting in decreased win percentage. Higher effective size though correlates with head coaching success in the Power-5 network. Considering that this considers in-degree and out-degree connections, who a coach's mentor is may be just as important as who are the mentees they hire and work with for the sake of learning from one another. This study shows that network characteristics are important to consider, and who a coach has worked with via a mentor and mentee relationship may help explain the success of each of these coaches. Future research will need to focus on each of these specific network-level measurements in further detail.

Chapter 5 provides an overall summary of the present study, as well as provide a further discussion about the findings from Chapter 4. The following chapter will also discuss some limitations to the study, as well as discuss future recommendations for research projects utilizing network theory. Because this was an exploratory study in nature, the author will provide recommendations for future research questions and for future studies into the Power-5 network which focus on the preliminary findings from this study. A summary of why this is important for future research as well as how this information can be beneficial to practitioners will also be included.

Table 7. Terms & Results

Network Term	Results	Operationalization (Power-5 Coaches)
Out-Degree	β = -.357, *t* = -5.293, *SE* = 0.613, *p* = .000, Bca 95% CI [-4.455, -2.037]	As a coach's total number of Out-Degree connections increase (the number of mentors they work for), their total win-percentage will decrease.
Betweenness	β = -.129, *t* = -1.993, *SE* = .011, *p* = .048, Bca 95% CI [-.045, .000]	As the number of structural holes which an individual coach has exclusive access to increases, their winning percentage gradually will decrease.
Effective Size of Structural Holes	β = 0.446, *t* = 6.355, *SE* = 0.470, *p* = .000, Bca 95% CI [2.062, 3.916]	As a coach's effective size increases (connections to nonredundant ties increases), their on-field success also increases.
Density	β = .160, *t* = 2.615, *SE* = 9.760, *p* = .010, Bca 95% CI [6.285, 44.762]	As the density of an individual coach's network increases (clique network), their win percentage slightly increases.

Chapter 5. Summary, Conclusions, & Recommendations

This chapter provided a summary of the entire study. Included are an overview of the background, purpose, and research questions. A brief summary of the findings is provided as well. Then, a discussion about the appropriate conclusions which may be drawn from the results of the study. Those conclusions will address the application of Network Theory to the Power-5 coaching community, as well as discuss how these results may be used by practitioners to enhance the Power-5 coaching industry. This will be accomplished via an explanation of how the network of mentor/mentee coaches, and the structures which create their network, can explain the acquisition of the skills and capital which are needed to be a successful coach at a Power-5 institution. Finally, this chapter will discuss limitations of the present study and provide recommendations for future studies.

Summary

Importance for Power-5 Coaches

This study sought to explore the application of Network Theory to understanding sport coaching networks, in this instance specifically focusing on the Power-5 coaches' network. The focus of this study was on Power-5 coaches because of the considerable impact they have on their programs as well as their institutions. Power-5 coaches are critical to these stakeholders because of their abilities to both succeed on the field while

also marketing and representing their program. They are a critical component to universities' business via their financial benefits, recruiting abilities, and the prestige they might bring to a program (Tracy et al., 2018). Coaches are compensated well because of their on-field success, their ability to build relationships with donors and boosters, and their marketable personalities (Humphrey & Mondello, 2007; Inoue, Plehn-Dujowich, Kent, & Swanson, 2012). Hiring the right coaches are vital for an institution for these reasons and hiring the right coach can also have a significant positive impact on the academic performance of their student-athletes (Johnson et al., 2013). It is also important for Power-5 programs to avoid vicious cycles of poor performance on the field and in the program through ritual scapegoating (Dohrn, Lopez, & Reinhardt, 2015). Thus, it is critical for institutions to hire the right coach for their program, who can provide them with these skills. Understanding a coach's past, their lineage, and how they acquire human and social capital will help administrators in the decision-making process.

Human and Social Capital

The skills and abilities a coach has are most likely to be obtained through their human and social capital. Human capital is the knowledge an individual obtains related to their profession, as acquired through education and on-the-job training (Becker, 1962). In the context of coaching, someone who has many years of experience coaching and working in a diverse number of positions as an assistant coach will acquire more knowledge and experience which they can apply to a head coaching position (Wicker, Orlowski, & Breuer, 2016). The age and the number of years a coach spends working for a particular organization will also increase their human capital (Fogarty, Soebbing, &

Agyemang, 2015). Acquiring human capital is significant for a Power-5 coach as studies have shown that a coach's career attainments is best predicted by their coaching experience rather than affiliation or playing experience (Tracy et al., 2018). However, previous research has shown that the challenges, tasks, and training that a mentor coach may provide a mentee coach are important for the professional development of a coach (Ready, Hill, & Conger, 2008).

Social capital is also central to this study and to understanding the development of Power-5 coaches. Barros and De Barros (2005) showed that human capital and social capital go hand-in-hand with each other, as social capital is naturally acquired through the same processes which human capital are acquired. Social capital is operationalized through the dense interaction of members within relational networks who spread knowledge and information between a group of individuals (Bourdieu, 1986; Boudieu & Wacquant, 1992). Scholarship focusing on social capital in sport management have demonstrated that is has a significant impact on strengthening team environments (Collins, 2004; Seppel, 2006) as well as assisting in job attainment and career development for coaches (Cunningham & Sagas, 2004).

Application of Network Theory

Therefore, to best analyze and understand who are the coaches that are most likely to leverage their human capital and social capital to help them produce on-field success, it is necessary to understand the lineage of these coaches as best demonstrated through the Power-5 mentor/mentee network. Network theory is an innovative approach for exploring and describing expansive networks (Quatman & Chelladurai, 2008) and is

therefore most likely to assist researchers and practitioners with understanding the capital and skills a coach will possess. Network theory is useful for helping to assess the formal social structures and tendencies which exist, describing the properties of a network and its influence on society (Wasserman & Faust, 1994). It will be useful in helping researchers and practitioners understand the nature of the network of Power-5 coaches for the purpose of understanding how social and human capital are acquired via mentorship experiences.

Studies utilizing network theory typically consider the structures of relationships that exist in the networks (Latora et al., 2013; Pauli et al., 2019; Zhao et al., 2017). Furthermore, they focus on such fundamental concepts as brokerage of information and centrality. Brokerage conceptualizes who in a network is valuable in regard to receiving and sharing information from a variety of sources (Balkundi et al., 2019). Centrality shows how popular a node is, by centralizing in a network visual the individuals who create many different connections and have many different relationships with different figures in the network (Cranmer et al., 2019). A fundamental understanding of the role networks play in different communities of sport is important for addressing persistent social issues, such as the underrepresentation of minority populations in head coaching positions, and coaching burnout (Nixon, 1993; Quatman & Chelladurai, 2008). A fundamental understanding of networks is particularly useful in the Power-5 mentor/mentee network for understanding what are the structures and relationships which are typically formed for the more successful coaches.

Purpose and Research Questions

A better understanding of the relationships which coaches form, and how those structures affect a coaches' human and social capital, and inherently their success, is important. Therefore, the purpose of the present study was to perform an exploratory analysis into the networks of Power-5 coaches. Two primary aims of this study were to gather data and construct the network for some of the most recent Power-5 head coaches and identify the structures which exist within that network. The second aim was to discern what roles these structures have on predicting the success of a head coach in the Power-5, as measured through their win percentage. This leads to two specific research questions:

RQ1: What type of patterns for centrality and structural holes exist in the whole-network?

RQ2: How do patterns for centrality and structural holes correlate with the on-field success of a Power-5 coach?

This exploratory study provides coaches and practitioners with an understanding of which type of relationships form in the network and how these relationships benefit an individual coach and a Power-5 institution. Completing this study will assist in the creation of future studies which utilize the present study's findings to assist in answering more specific research questions related to the structures of the Power-5 coaches' network, and how the network affects the professional development of a Power-5 coach.

Data Collection and Analysis

This study collected data for the 219 most recent college football head coaches (*N* = 219) from the Power-5 conferences. Specific data collected for each coach include a performance attribute as measured through their on-field win percentage and data collected for the mentor/mentee relationships formed between coaches in the network. These relationships were measured via consideration of a coach serving in any assistant coaching role with another head coach in the network. All assistant coaching positions, except for intern and Graduate Assistant, were considered. Thus, when an assistant coach works underneath the tutelage of a head coach, that assistant coach serves in the role as a protégé or mentee in the mentor/mentee relationship.

Network Visualization

After creating an edge list utilizing the data collected for a coach's relationship with a particular coach, the data was entered into the program for the network analysis and visualization software, UCINET 6 (Borgatti, Everett, & Freeman, 2002). This assisted with all network analysis', particularly for the whole network analysis as well as the ego-network analysis' (analysis for one particular coach) and for calculation of the network structures which existed within the whole-network and ego-network analysis. Network visualizations are important for assisting with tracing and presenting different patterns which exist among the ties in the network (de Nooy, Mrvar, & Batagelj, 2018). Visualizations for the present study were broken up into three distinct visualizations. The first visualization was for the entire network of coaches. The second visualization focused on the top 10% of the most successful coaches in the network, in order to isolate

them from the rest of the network and consider what their structures looked like. The third visualization similarly isolated the bottom 10% of coaches based on their win-percentage to again consider how network structure may have hindered their professional development and acquisition of capital.

Network Analysis

Metrics for whole-network structure included the total number of nodes and ties in the network, degree centralization, out-centralization, in-centralization, density, and connectedness. Coefficients for the individual coaches and their network structure considered their out-degree measurement, in-degree measurement, betweenness, Bonacich centrality, effective size of structural holes, density, and experience. After producing these measurements through UCINET, data was transferred over to SPSS version 26. A simple linear regression analysis was performed which considered each of these coefficients in relation to the outcome variable of on-field success for the head coaches as measured through winning percentage.

After the preliminary analysis, the data was adjusted to fix for multi-collinearity. Specifically, In-Degree centrality was removed from the analysis to address the issue of multi-collinearity. After removing In-Degree centrality, a new simple linear regression model was performed to again analyze the relation between a coaches' network structures (centrality and structural holes) and coaches' win percentage. The results showed that the network-level metrics for each coach explained 22.1% of the variance. Only one coefficient was found to be not statistically significant, and that was the Bonacich measure for centrality (t = -0.693, SE = 0.999, p = .489, BCa 95% CI [-2.661, 1.277]). All

other network metrics proved statistically significant; including out-degree centrality (t = -5.293, SE = 0.613, p = .000, BCa 95% CI [-4.455, -2.037]), betweenness (t = -1.993, SE = -011, p = .048, BCa 95% CI [-.045, .000]), effective size (t = 6.355, SE = 6.355, p = .000, BCa 95% CI [2.062, 3.916]), and density (t = 2.615, SE = 9.760, p = .010, BCa 95% CI [6.285, 44.762].

Conclusions

Based upon the results of the whole-network visualization, whole-network statistics, the ego-network visualization for the top 10% of coaches, the ego-network visualization for the bottom 10% of coaches, and the regression analysis, there are a few conclusions that can be made about the role of network theory in analyzing Power-5 coaches' and the specific structures of their network and how it might affect their acquisition of human and social capital. These conclusions are based on the analysis of this exploratory study of the one-mode relational network considering the mentor/mentee relationships of the Power-5 coaches' network and the research questions associated with this study.

The importance of low out-degree and low betweenness

Analysis of the network visualizations show that overall there are low amounts of degree centrality across the entire network. There are not any dominating central figures who have many in-degree and out-degree connections, which would force them to the center of the network visualization. Networks with very central figures tend to take on a "star shape" which is characterized by one individual (or a few individuals in larger networks) being located in the center of the whole-network visualization and having

many actors go through them (Burt, 2015). This indicates that generally speaking, coaches are not too social regarding the people they form working relationships with, and it suggests they do not form relationships with higher amounts of mentors. Networks with high degree centrality are characterized by nodes having many neighbors, as degree centrality indicates the influence of neighboring nodes through the relationships they form (Zhao et al., 2017).

Fast and Jensen (2006) experienced similar findings when looking at the mentor/mentee networks of NFL coaches. They found that coaches who worked as assistant coaches for many seasons, and with different teams, were not as successful as the coaches who tended to stay with a single mentor until they were promoted to a head coaching position (Fast and Jensen, 2006). This resembles what was found in the present study, where coaches who have higher out-degree and create more relationships with mentors, begin to drop off in success. McCullick, Elliot, & Schempp (2016), drew similar conclusions in a study analyzing NFL coaching trees, and established that roots are necessary, but fewer are better and that established roots prosper and flourish for coaches. Again, this is similar to the present study in regard to both the lower amount of out-degree relationships as well as the fact that three of the nine coaches who were isolates in the network (did not have established roots) were in the network of the bottom 10% of performing coaches. The present study leads to a similar conclusion, except in the context of the Power-5.

From the network for the top 10% of coaches, we see that there is slightly more centrality within that network of the more successful coaches. This meant that these

coaches had a greater combination of both in-degree connections and out-degree connections. Note, that this is not explicitly out-degree connections or in-degree connections, but consideration of both metrics. This both reinforces the idea that coaches are not too social, but it also considers the idea that more successful coaches may come from more central figures. This was observed through the fact that Urban Meyer and Ryan Day shared a connection (members of the top 10% network) as well as Lincoln Riley and Bob Stoops, and Kirby Smart and Nick Saban (also members of the top 10% network). Both Meyer and Saban also had higher amounts of relationships with protégés who would obtain head coaching positions. This behavior, although further research needs to consider the specific aspects of this behavior in the Power-5 network, also aligns with what Fast and Jensen (2006) found that instead of coaches being "social" and "paying their dues" moving around the coaching network, the most talented assistant coaches usually will stay with a single mentor until promoted to a head coaching position.

Another indication that low out-degree and betweenness are important to consider in the Power-5 coaches' network, is the fact that in the network of the bottom 10% of coaches, some of the more central figures in the network had higher scores for those two variables. Furthermore, the most central coach in the network was Ted Roof, who also had many out-degree ties. Roof also had a very high betweenness score, suggesting that he was a broker and filler of many structural holes. It is important to investigate this further as this also alludes to McCullick, Elliott, & Schempp's (2016) findings that fewer roots are stronger, while established roots are also more important. While research in

other industries and domains suggest the benefits of brokerage (Kellogg, 2014; Soda, Tortoriello, & Iorio, 2018), this study indicated that serving in the role of an information broker between many different cliques or coaching trees is potentially harmful for coaches. This conclusion can also be drawn from the regression analysis that higher betweenness scores have a statistically significant impact on lowering a coaches' on-field success and performance. Similar to the winning coaches' network, the losing coaches' network indicated that there were a few shared connections between coaches in the low-performing network.

Effective Size and Density Helps

Another conclusion from this study is that a coach who has a higher amount of effective size for structural holes as well as more density in the network may help coaches. The results of the regression analysis indicate that the effect of higher effective size for structural holes may have a more significant impact ($\beta = 0.511$). Further research will need to be conducted to fully understand why higher effective size for structural holes impacts coaching performance, however from this study we can conclude that this structural phenomenon in the network exists and is to the benefit of the coaches. A lower effective size score is indicative of a clique network (Burt, 2015). A higher effective size score is indicative of a broker network, as there are many nonredundant ties (Burt, 2015). Considering that this is a measurement of all connections, both in-degree and out-degree, it is important when evaluating this conclusion to consider that coaches with higher effective size for structural holes will have both in-degree and out-degree connections accounted for. This important for understanding this result, because even though it is

suggesting more ties, particular non-redundant ties help, it is not focusing solely on the higher out-degree ties which we know has a negative effect on Power-5 coaches' in the network. This is an important conclusion to draw for performing future studies of the Power-5 coaches' network which further analyze each of these individual findings, to understand what effect these structures have on Power-5 coaching outcomes.

Density also appears to help the coaches' but only slightly ($\beta = 0.169$). Studies which inspect network density in other disciplines have found that strong ties create positive effects such as better communication and transferring of tactical knowledge (Lechner et al., 2010). Density is indicative of strong ties and network cohesion and strength (Pauli et al., 2019). Pauli et al. (2019) found that increasing amounts of density can have a curvilinear effect on performance. Considering the results this study is producing, which show a positive effect for effective size of structural holes (which indicates brokerage and non-redundant contacts) as well as the effect of density, further research will need to be conducted which considers a similar phenomenon, where in certain circumstances coaches with higher density and cohesion experience success, while coaches with less cohesion and more fluidity in the network also experience success. Understanding this is critical to understanding the diffusion of innovation in a network and the transfer of information in network, which density can help operationalize (Pauli et a., 2019).

Usefulness of Network Theory

One final conclusion which can be drawn from this exploratory study is that networks, and an understanding of a Power -5 coach's network is relevant and beneficial

for understanding the network structures which tend to exist for more effective coaches. Therefore, applying network theory to the understanding of the Power-5 coaches' network is beneficial and should be looked into in further detail by both researchers and practitioners. The results of both the network visualization and the regression analysis for the structures of coaches suggests that network structures do play a role in determining an individual coach's on-field success. This is evident in the statistical significance of most of the network structure metrics, whether they have a positive or negative impact on the on-field performance of a coach. The network for the top 10% of the most successful Power-5 coaches is also different from the network for the bottom 10% of performing coaches, with different structures existing.

This and the conclusions drawn from the present study shows that network theory can be a useful analytic tool for evaluating the development and spread of information in the FBS coaches' network. Understanding how a coach acquires human and social capital via these network structures and what effect it has on their development and success will prove to be very beneficial to researchers and practitioners. The results from both the regression analysis and the ego-networks of the top 10% of coaches and the bottom 10% of coaches indicate that differences in structures, and the specific structures of the regression analysis, do have an impact on coaching outcomes. Understanding why these specific behaviors affect coaches, and how these structures are operationalized in the coaching community, will require further research.

Recommendations

Based on the conclusions of this study, this sections presents recommendations for future studies related specifically to the application of network theory to the Power-5 coaching community, other coaching communities, as well as recommendations for how this information may be presented to practitioners and stakeholders responsible for making these decisions for hiring a head coach.

Future Studies

Future studies focusing on the application of Network theory to the Power-5 coaching community specifically should consider utilizing an affiliation network which considers the institutions a coach works for as well as the coaches a coach works with. An affiliation network allows researchers to consider two-modes within the network. That is, in addition to analyzing the other coaches a coach is linked to or has worked with, the network would also incorporate the institutions which a coach has been affiliated with, and calculates patterns and structures in relation to both their relational information with other coaches and their affiliation patterns with an institution. The author suggests this study because it will consider what role other resources may play in affecting a coach's success. For example, in the network for the present study, we saw that the network for the top 10% of the most successful coaches indicated shared connections by coaches at some of the more historically and financially successful Power-5 programs, such as Ohio State and Oklahoma. Therefore, it is interesting to consider whether access to such successful institutions and the resources they have available plays a vital role in assisting a coach with their success and or building their

network structures. It would also indicate how important it is for a coach is to be brought up through a coaching tree which has affiliations or experience with these higher performing, more historically successful programs.

Future studies should also be done which isolate the various measurements for network structure which were used, in order to provide more detail and clarity as to why these patterns play a significant role in explaining the success, or lack thereof, for a coach. For example, future studies should investigate, either qualitatively or quantitatively, why specifically having a higher betweenness score, or being a broker in the Power-5 network, is harmful for the coach's overall outcome of win percentage. The author suggested how each of the coefficients in this study could be operationalized, but more in-depth studies which focus on each of these coefficients separately could provide further explanations, and more information about how networks and relations explain the development and success of Power-5 coaches, or other sports coaches.

Additionally, future studies should consider how all of these network coefficients may be different across different sporting leagues. Furthermore, future studies should consider how the network of Power-5 coaches may be different than the network of coaches in the National Football League (NFL). Comparisons would be helpful considering the economic and bureaucratic differences which exist between the two leagues. Specifically, as alluded to earlier, some Power-5 programs may differ in regard to their access to resources, capital, or even recruiting. However, in the National Football League, there should theoretically be more competitive balance and more evenly distributed access to financial resources and capital considering the nature of the NFL

and its approach to revenue sharing. Thus, this may affect the role of mentorship and the structures of the network for NFL coaches.

Another application of network theory to the Power-5 coaching community, could be utilized to help address the issue of the underrepresentation of minority coaches in head coaching positions. A study of this nature could identify how the networks of minority coaches differ from the networks of White coaches. Previous studies have provided context to the underrepresentation and inequalities which exist for minority coaches, and how they may be placed at a disadvantage via access discrimination (Agyemang & DeLorme, 2010; Cunningham, 2006; Singer et al., 2010). The application of network theory to this issue may indicate how the ego-networks of minority coaches differ from the ego-networks of White coaches, and how these structures may place minority coaches at a disadvantage in the network.

Finally, future studies which utilize Network theory in the context of the Power-5 should consider other coefficients and outcome variables and how different network coefficients play a role in these alternative outcomes. For example, what role might network, and the human and social capital acquired via those networks, play in recruiting? It is interesting to consider whether specific skills are shared in a network among coaches which may affect their on-field success. In this instance recruiting would be considered as one of these coefficients, and certain recruiting abilities may be shared among coaches in the network. This may have a direct result on other outcome variables for those coaches. Other dependent variables which may be considered in future studies include bowl game appearances, bowl game victories, conference championships,

national championships, or players coached who are drafted into the NFL. Another coefficient which can be considered in future studies is the use of a measurement for the duration of a relationship through the number of years coaches worked with each other. This may also explain some of the variance in how relationships and networks affect coaches and their various outcomes.

Application to Practice

The results of this study can be useful for practitioners and key stakeholders in the Power-5, such as coaches and athletic directors. This study suggests that having fewer out-degree connections, lower betweenness scores, and higher effective size for brokerage, and higher density is beneficial for a coach. These findings provide an important steppingstone to research which will help isolate and identify why these particular structures are important for the development of a coach. These initial findings indicate that generally speaking, individual coaches will want to form fewer out-degree relationships and have less mentor coaches. It also shows that coaches who come from a situation where they have higher non-redundant connections, whether as a mentor or mentee, also have a positive correlation with success. Again, future research will need to address specifically how some of the brokerage metrics and other centrality metrics are operationalized in coaching practices and networks, however these results and the adverse effect of a higher out-degree measurement reinforces network trends from previous studies focused on the NFL which highlight the importance of having fewer mentors (Fast & Jensen, 2006; McCullick et al., 2016).

For athletic directors and other stakeholders involved with hiring a head coach, they may want to consider the different structures of coaches they are looking to hire, such as lower out-degree scores and higher effective size scores. Consideration might be given to a coaching candidate who has fewer mentors, as higher out-degree scores refer to having more mentors. They may also want to consider the tree a coach comes from and consider the number of redundant ties which exist in the tree that coach is coming from (both in-degree and out-degree). The findings of this study help us understand that out-degree scores and effective size for structural holes have their own respective effect on the coaching outcomes. Further research will need to investigate the role of the spread of innovation in coaching trees and practice, in order to fully understand the role of the higher effective size for structural holes.

Limitations

There are a few different limitations of this study. First, the study only considers coaches who have become head coaches. While this is appropriate for the context of a study focusing on lineage, and mentor/mentee relationships, future studies should go more in-depth and also consider assistant coaches who have not become head coaches. This could be helpful in advancing the study of networks in the context of the FBS and in discerning the differences in structure between coaches who successfully obtain a head coaching position, and coaches who do not successfully obtain coaching positions. Such a study, which considers who has not yet obtained a head coaching position, could be helpful in specifically identifying candidates who could fill a head coaching position by utilizing a more advanced model of inference. A second limitation is that there is not

enough analysis of ego-networks for individual coaches. A whole-network visualization and measurement is helpful to an extent, but individual considerations of maybe the most successful coaches (separate from the visualization of the top 10% of successful coaches presented in this study) as well as the most focal mentors would be helpful in identifying specific coaching trees which an athletic director should target for filling an open coaching position (i.e., mentee coaches in the Nick Saban coaching tree, the Urban Meyer coaching tree, etc.).

Finally, this study does not utilize a variable which considers the strength of a relationship between two coaches. This may be accomplished through the measurement of how long a relationship between a mentor and mentee coach lasted. This study simply utilizes density as an indicator for strength of relationship but utilizing the years a relationship between two coaches existed will also be helpful for understanding loyalty and strength of ties between mentors and mentees. As discussed in the last chapter, experience was originally left out because of the emphasis placed on network specific structures. However, it is important to consider both the number of years of experience of a head coach, as well as the length of the relationship they have with a particular coach, as this will help explain the strength of a tie an individual has, as well as better quantify the human capital experience they have as a coach. It will also be useful for understanding how years of experience affects the development of these ego-network variables as it will allow researchers to see how they develop over time in the coach's career.

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Appendices

Appendix A. FBS Coaches List

ID	Name
hc1	Larry Fedora
hc2	Bobby Petrino
hc3	Willie Taggart
hc4	Justin Fuente
hc5	Pat Narduzzi
hc6	Mark Richt
hc7	Paul Johnson
hc8	Dave Clawson
hc9	Steve Addazio
hc10	Bronco Mendenhall
hc11	David Cutcliffe
hc12	Dave Doeren
hc13	Dino Babers
hc14	Dabo Swinney
hc15	Davide Beaty
hc16	Bill Snyder
hc17	Kliff Kingsbury
hc18	Matt Rhule
hc19	Gary Patterson
hc20	Mike Gundy
hc21	Matt Campbell
hc22	Dana Holgorsen
hc23	Tom Herman
hc24	Lincoln Riley
hc25	Chris Ash
hc26	Lovie Smith
hc27	Scott Frost
hc28	Matt Canada
hc29	Tom Allen
hc30	Jeff Brohm
hc31	P.J. Fleck
hc32	Mark Dantonio
hc33	Paul Chryst
hc34	Pat Fitzgerald
hc35	James Franklin

hc36	Kirk Ferentz
hc37	Jim Harbaugh
hc38	Urban Meyer
hc39	Jonathan Smith
hc40	Chip Kelly
hc41	Kevin Sumlin
hc42	Clay Helton
hc43	Mike MacIntyre
hc44	Justin Wilcox
hc45	Herman Edwards
hc46	Kyle Whittingham
hc47	David Shaw
hc48	Mario Cristobal
hc49	Chris Petersen
hc50	Mike Leach
hc51	Chad Morris
hc52	Jeremy Pruitt
hc53	Matt Luke
hc54	Derek Mason
hc55	Will Muschamp
hc56	Barry Odom
hc57	Joe Moorhead
hc58	Gus Malzahn
hc59	Jimbo Fisher
hc60	Mark Stoops
hc61	Ed Orgeron
hc62	Dan Mullen
hc63	Kirby Smart
hc64	Nick Saban
hc65	Mike Riley
hc66	DJ Durkin
hc67	Gary Andersen
hc68	Jim Mora
hc69	Rich Rodriguez
hc70	Todd Graham
hc71	Jim McElwain
hc72	Bret Bielema
hc73	Butch Jones
hc74	Charlie Strong

hc75	Jim Grobe
hc76	Bob Stoops
hc77	Darrell Hazell
hc78	Kevin Wilson
hc79	Tracy Claeys
hc80	Mark Helfrich
hc81	Sonny Dykes
hc82	Les Miles
hc83	Hugh Freeze
hc84	Scott Shafer
hc85	Mike London
hc86	Al Golden
hc87	Frank Beamer
hc88	Paul Rhoads
hc89	Art Briles
hc90	Randy Edsall
hc91	Kyle Flood
hc92	Jerry Kill
hc93	Bill Cubit
hc94	Steve Sarkisian
hc95	Steve Spurrier
hc96	Gary Pinkel
hc97	Charlie Weis
hc98	Brady Hoke
hc99	Tim Beckman
hc100	Bo Pelini
hc101	Mack Brown
hc102	Bill O'Brien
hc103	Frank Spaziani
hc104	Tom O'Brien
hc105	Tommy Tuberville
hc106	Danny Hope
hc107	Jon Embree
hc108	Jeff Tedford
hc109	Joker Phillips
hc110	Gene Chizik
hc111	John Smith
hc112	Derek Dooley
hc113	Everett Withers

hc114	Turner Gill
hc115	Mike Sherman
hc116	Luke Fickell
hc117	Ron Zook
hc118	Mike Stoops
hc119	Paul Wulff
hc120	Dennis Erickson
hc121	Rick Neuheisel
hc122	Lane Kiffin
hc123	Houston Nutt
hc124	Randy Shannon
hc125	Butch Davis
hc126	Ralph Friedgen
hc127	Dan Hawkins
hc128	Tim Brewster
hc129	Bill Lynch
hc130	Jim Tressel
hc131	Robbie Caldwell
hc132	Bobby Bowden
hc133	Al Groh
hc134	Mark Mangino
hc135	Pete Carroll
hc136	Bobby Johnson
hc137	Rich Brooks
hc138	Tommy Bowden
hc139	Jeff Jagodzinski
hc140	Ron Prince
hc141	Joe Tiller
hc142	Tyrone Willingham
hc143	Mike Bellotti
hc144	Sylvester Croom
hc145	Phillip Fulmer
hc146	Ted Roof
hc147	Chan Gailey
hc148	Guy Morriss
hc149	Bill Callahan
hc150	Dennis Franchione
hc151	Skip Holtz
hc152	Paul Pasqualoni

hc153	Doug Marrone
hc154	Greg Schiano
hc155	Dave Wannstedt
hc156	Bill Stewart
hc157	Steve Kragthorpe
hc158	Jim Leavitt
hc159	Brian Kelly
hc160	Greg Robinson
hc161	Lloyd Carr
hc162	Bill Doba
hc163	Karl Dorrell
hc164	John Bunting
hc165	Chuck Amato
hc166	Larry Coker
hc167	Dan McCarney
hc168	Terry Hoeppner
hc169	Glen Mason
hc170	Walt Harris
hc171	Dirk Koetter
hc172	Mike Shula
hc173	Gary Barnett
hc174	Randy Walker
hc175	Barry Alvarez
hc176	Bobby Wallace
hc177	Ron Turner
hc178	Gerry DiNardo
hc179	Keith Gilbertson
hc180	Buddy Teevens
hc181	Lou Holtz
hc182	Carl Franks
hc183	Frank Solich
hc184	Kevin Steele
hc185	R.C. Slocum
hc186	Bobby Williams
hc187	John Mackovic
hc188	Bob Toledo
hc189	Mike Price
hc190	Jackie Sherrill
hc191	George O'Leary

hc192	Terry Allen
hc193	Cam Cameron
hc194	Tom Holmoe
hc195	Woody Widenhofer
hc196	Jim Caldwell
hc197	Ron Vanderlinden
hc198	George Welsh
hc199	Carl Torbush
hc200	Larry Smith
hc201	Bob Simmons
hc202	Terry Shea
hc203	Don Nehlen
hc204	John Cooper
hc205	Paul Hackett
hc206	Dick Tomey
hc207	Bruce Snyder
hc208	Hal Mumme
hc209	Mike DuBose
hc210	Jim Donnan
hc211	Geoff Collins
hc212	Scott Satterfield
hc213	Manny Diaz
hc214	Chris Klieman
hc215	Matt Wells
hc216	Neal Brown
hc217	Mike Locksley
hc218	Ryan Day
hc219	Mel Tucker