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Assembling the Ideal Doctoral Dissertation Committee in Engineering Education

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Assembling the Ideal Doctoral Dissertation Committee in Engineering Education

Introduction

The engineering education PhD has been rapidly growing over the past couple of years. As of right now there are 20 institutions that offer some type of doctoral degree in engineering education. These degrees include engineering PhD's with a concentration in engineering education, PhD in STEM education, or Engineering Education degrees similar to those offered at Virginia Tech, Purdue, and Utah State University[1-4]. Several other traditional engineering doctoral programs such as aerospace, electrical, and mechanical engineering programs offer doctoral students the opportunity to pursue engineering education research dissertations that are directly related to their discipline.

The field of engineering education offers a new context that requires an interdisciplinary approach involving knowledge of engineering curriculum, pedagogy, students, and educational knowledge pertaining to learning sciences. While it is commonly related to education and engineering perspectives, recent studies have required collaboration between the fields of computer science, business, management, and information science among others [5]. The interdisciplinary nature of this new field offers a challenge to doctoral students seeking to achieve a degree in the field. One of these challenges becomes apparent when forming doctoral committees that include members capable of directing and supporting students to the successful completion of their interdisciplinary degree. To aid students in addressing these challenges, this paper addresses the research question: *What are important characteristics of doctoral committee members for a student pursuing an engineering education PhD?*

Literature Review

Faculty members are an important support system for graduate students, especially a faculty advisor and the members of a student's committee [6, 7]. These faculty members not only provide the necessary disciplinary content knowledge, but can also provide personal, career or emotional support[7]. While earning an interdisciplinary degree, as that in engineering education, the role of the advisor can become more complex[8]. Co-advisors may be needed to provide the additional content expertise or the creation of an interdisciplinary committee. For a review of the work on interdisciplinary graduate supervision, see [9].

Where a number of studies have investigated the role of the graduate advisor for interdisciplinary students [9-11], few investigate the role of the graduate student's committee. A graduate student's committee generally comprises of 4-5 members who "work with them on developing a program plan, preparing and taking comprehensive exams, planning and executing a study, and completing the dissertation" [12]. For a graduate student earning an interdisciplinary degree, the role of the committee may vary from a traditional committee. Committee members may be used to supplement expertise from disciplines that the advisor is not familiar with to aid the student's interdisciplinary understanding. Limited research has been done investigating interdisciplinary PhD committees.

In general, a PhD committee is formed with a number of faculty members in the same department as the defending student. The norms and expectations of the department are known to the committee members before the student forms them into a committee. With an interdisciplinary committee, department expectations and processes may be inconsistent across members [8, 9]. Also, disciplinary egocentrism [13] can play a role with some members of the committee placing less value on the input from the committee members from other departments. These challenges, common on interdisciplinary teams, are uncommon within traditional doctoral committees, potentially causing more challenges for the student.

Methods

This study utilized a 4 round Delphi method as a means to achieve consensus about the key *technical*, *personal*, and *professional* characteristics of a doctoral advisor and the overall committee for Engineering Education.

Delphi Method Overview

The Delphi method was first utilized by the RAND Corporation in the 1950's as a means to obtain reliable consensus among experts [14, 15]. The method is typically applied in situations where judgmental information is needed to set goals, develop policy, and predict the events of future events [14, 16, 17]. The key advantage of the approach is to avoid direct confrontation among the experts, limit the distortion of data from that results from individual interests, bias, and communication unrelated to the study[14, 16].

The primary type of Delphi method is the "ranking-type" that is used to develop group consensus about the relative importance of issues [14]. The approach requires three general phases: 1) brainstorming for important factors, 2) narrowing down the original list to the most important ones, and 3) ranking the list of important factors [14] as detailed in Figure 1.

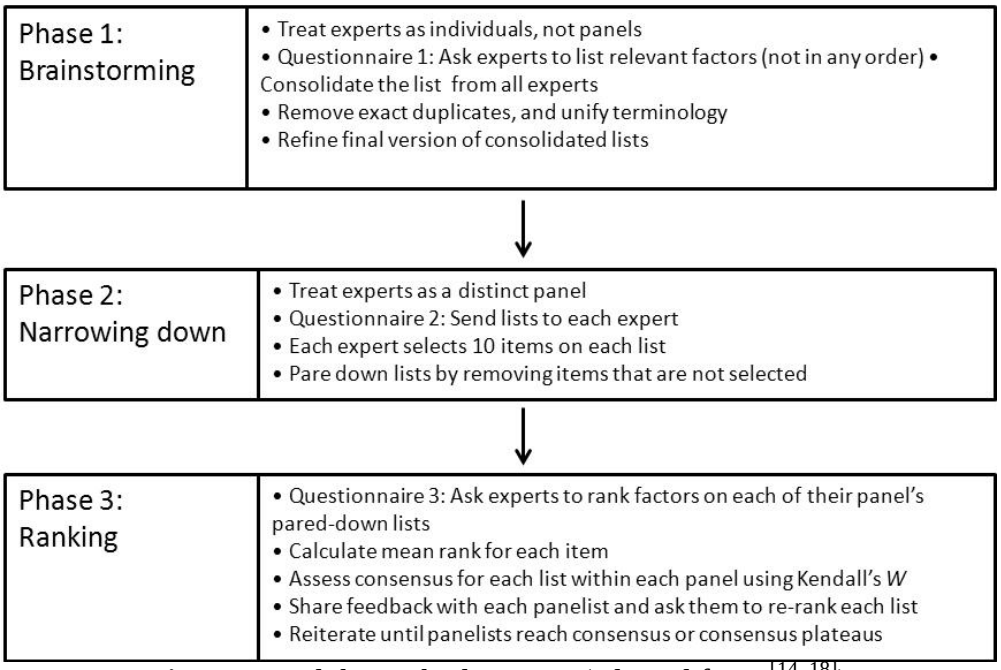

Figure 1. Delphi method process (adapted from [14, 18])

The first phase of the study, *brainstorming*, requires participants to individually list and describe the relevant factors. Once all participants have responded, the PI consolidates the list by removing duplicates and unify the terminology. *Narrowing down* requires the each participant to select the top ten factors. The PI then reviews the panel's selection and removes those items not selected. This process streamlines the rankings by limiting the number of choices allowing for fewer iterations to meet consensus. The *ranking* phase requires the participants to rank order the items on the list. It is common to require participants to provide written comments that provide rationale for their rankings [14, 16]. This encourages panels to achieve consensus more quickly [14, 19].

There are several approaches to analyzing the rankings that will determine when consensus has been achieved. Hsu et al. [16] recommend the use of measuring the stability of participant responses in successive iterations through the use of means, medians, and modes which identifies central tendency and the level of dispersion through standard deviation and inter-quartile. When using this approach, it is recommended that median and mode be used as they account for outliers and appear best to represent the convergence of opinion [16, 20]. Okoli et al. [14] recommends one of three stopping points: 1) Kendall's W is equal to 0.7 or greater, 2) the number of prescribed iterations has been achieved (usually between 3 and five [21]), or 3) the difference of mean rankings between rounds has not statistically significantly changed as measured by the McNamar test. Schmidt [22] has noted that the non-parametric statistic, Kendall's W (coefficient of concordance) is a strong indication of consensus among the panel. The values range from 0 to 1, where 0 indicates no agreement among panelists and 1 indicates perfect agreement. A value of 0.7 indicates that there is strong agreement among the panel and there is high confidence in the ranking of the means.

Table 1. Interpretation of Kendall's W [22]

W	Interpretation	Confidence in Ranks
0.1	Very weak agreement	None
0.3	Weak agreement	Low
0.5	Moderate agreement	Fair
0.7	Strong agreement	High
0.9	Unusually strong agreement	Very High

One of the critical aspects of the Delphi method is the selection of participants as this selection directly relates to the quality of the results generated [16, 20, 23, 24]. The approach typically requires participants to be classified as experts in their discipline. While the term expert may be difficult to evaluate, Pill [25] and Oh [26] have recommended that participants have related background and experiences with the targeted issue, are capable of contributing helpful inputs, and are willing to revise their perceptions in order to achieve group consensus [16].

Participants

Delphi methodology suggests between 15 and 20 participants, but no more than 50 [14]. Initially, 15 individuals were recruited to participate in this study. All individuals received a PhD in engineering education or in a traditional engineering disciple where their dissertation heavily focused on engineering education content and issues. After the recruitment, 9 of these individuals had agreed to participate.

Four of the participants (44%) were female. All had received PhD's within the past 4 years and, therefore, have experienced a similar process to achieve their PhD. Since we are focusing on the formation of a successful committee (one in which the student graduates) they can be considered experts in forming a committee for an engineering education focused PhD.

Data Collection & Analysis

The Delphi study followed the three phase process described in Figure 1. The participants were first requested to "*list the positive characteristics of members you had on your committee or wish that you had and define them"*. Once participants had responded the PI's removed duplicate entries, unified terminology among the responses, and categorized the responses into one of 3 major categories: *technical*, *personal*, and *professional* characteristics. An additional category, *overall committee*, consisted of other attributes that described the committee interactions as a whole rather than the characteristics of an individual. A list of these items and their definitions can be found in Appendix A. As a result of the brainstorming phase, several participants noted that qualities they would want in an advisor could be different than the other committee members.

Once compiled, the participants were sent and electronic survey that allowed them to rank order the items with "1" being classified as the most important characterisitic. The participants were requested to complete this questionnaire twice; first for the primary advisor and then for the

committee members. Once all survey responses were collected, the advisor personal characteristic of being a "Passive Observer" and advisor professional characteristic of being an "Outsider" were removed due to all but one participant selecting those items as the least important. As part of the narrowing down phase, this was the only removal as each list only had a maximum of 11 items and the distribution of initial responses did not emphasize any other items to be removed. The results of this second questionnaire were sent to the respondents with the rank of items, the panel's rank average, the participant's individual rank, and the Kendall's W for each list.

As consensus was not achieved, the next questionnaire was sent to the participants that included the mean rank of the item from the previous round and an opportunity to add feedback on their ranking at the end of each list. Once again the data was compiled and with the next questionnaire participants received the results of the previous two rounds, their responses from the previous round, the Kendall's W for each list, and the feedback from all participants. This third ranking of items returned a Kendall's W greater than 0.7 for all lists except advisor professional characteristics, which had a moderate agreement of 0.54. As this round was the maximum number of rounds requested by the participants and the acceptable Kendall's W was achieved for most lists, the survey was discontinued.

Findings

The results of the Delphi study indicate that the panel identified the same technical expertise for the advisor and committee, whereas they preferred a different set of characteristics for personal and professional characteristics (Table 2). While the panel achieved strong consensus (Kendall's $W > 0.7$) in all of the categories, except for a moderate consensus on the professional characteristic of advisors (Kendall's $W = 0.54$), several of the panel participants indicated that the rankings can change based on the individual needs of a specific doctoral student.

Table 2. Top ranked characteristics of advisors and committee members

	Advisor	**Committee**
Technical Expertise	Education Research Methods (direct)	Education Research Methods (direct)
	Area of Study Content and Context	Area of Study Content and Context
	Learning Theories	Learning Theories
Personal	Champion	Supportive of Professional Success
	Reflective	Reflective
	Supportive of Professional Success	Optimistic
	Optimistic	Open-minded to Research Paradigms
Professional	Invested in Engineering Education	Invested in Engineering Education
	Access to funding	Connection to relevant networks
	Familiar with navigating dissertation process	Familiar with dissertation expectations
	Strong publication ability	Familiar with navigating dissertation process
	Familiar with dissertation expectations	Connection to future employers
Whole Committee	Collaborative & Cooperative	
	Mutual respect among the members	
	Allow to work at own pace	
	Diverse Disciplines	

Technical Expertise Characteristics

The top technical characteristics for both the advisor and the committee members preferred by the panel included educational research methods directly related to the dissertation topic, expertise in the content and/or context of the dissertation, and educational learning theories (Table 3). Among panel participants, they indicated that these areas of expertise were needed due to the lack of depth and exposure that new students in engineering education may have with these topics.

However, there were several arguments for a decrease on emphasis on document writing and editing. Several participants indicated that students could hire an editor to review their dissertation if needed. An alternative perspective indicated that while you can hire an editor, they may not have the experience or knowledge of publishing within the field of interest or in engineering education as a whole. Other participants indicated a higher need for relevant teaching experience as: "the teaching experience was an invaluable and irreplaceable source of inspiration and intuition about student learning in that area."

Table 3. Ranking important technical expertise characteristics of advisors and committee members

Advisor		**Committee**	
Characteristic	*Mean Rank*	*Characteristic*	*Mean Rank*
Education Research Methods (direct)	1.33	Education Research Methods (direct)	1.44
Area of Study Content and Context	2.33	Area of Study Content and Context	2.00
Learning Theories	2.89	Learning Theories	2.89
Document Writing & Editing	3.56	Relevant Teaching Experience	4.28
Education Research Methods (indirect)	5.00	Document Writing & Editing	4.78
Relevant Teaching Experience	5.89	Education Research Methods (indirect)	5.61
Kendall's W:	.82	*Kendall's W:*	.78

A key difference between the selection of advisor and committee characteristics, as noted by the panel, is that the committee should "fill the gaps in knowledge that your advisor doesn't have". While the advisor may not meet all of these characteristics, at least some of the committee members should have in-depth understandings in methods, learning theories, and the context of the study.

Personal Characteristics

One of highest rated personal characteristics desired in an advisor was being a champion (Table 4). One participant noted that an advisor's belief in your ability will help you succeed and without it, their role as an advisor could be compromised. Several participants also noted that by having a champion as an advisor this also limits the need to rank availability higher. An advisor that is a champion will ensure that they are available to meet with their students despite the flexibility of the student's schedule. Reflectiveness targeted helping the student parse out their

ideas and optimism and was viewed by the panel to help the student feel better about their work and progress when the task became difficult.

Table 4. Ranking of personal characteristics of advisors and committee members

Advisor		**Committee**	
Characteristic	*Mean Rank*	*Characteristic*	*Mean Rank*
Champion	1.11	Supportive of Professional Success	2.00
Reflective	2.33	Reflective	2.33
Supportive of Professional Success	3.22	Optimistic	3.44
Optimistic	4.56	Open-minded to Research Paradigms	3.44
Available	5.22	Available	4.56
Open-minded to Research Paradigms	5.67	Champion	5.33
Supportive of Personal Life	5.89	Passive Observer	7.11
Passive Observer	N/A	Supportive of Personal Life	7.78
Kendall's W:	.71	*Kendall's W:*	.75

While champion was not as highly rated for the committee, supportive of professional success assumed a similar role. Without their support of the student's work, it will be difficult for students to graduate. A large portion of the participant feedback focused on the need for committee members that are reflective and open-minded to research paradigms. A lack of respect by a committee member for a specific research paradigm could greatly inhibit the success of a dissertation. One specific example noted that committee members familiar with quantitative methods would need to be open to qualitative approaches if they are to be used in the dissertation. While not ideal because they are more trouble than they are worth, it was noted that a passive observer is the next best thing to having a committee member that is open-minded to other research paradigms to ensure that there are no unnecessary roadblocks to earning a PhD.

Professional Characteristics

While the professional characteristics of the advisor only had a moderate consensus (Kendall's $W = 0.548$), whereas the committee characteristics had a strong consensus (Kendall's $W = 0.724$), the responses addressed characteristics that will help the student achieve their immediate goal of achieving a dissertation (Table 5). The top advisor characteristics are targeted towards helping the student earn their PhD. More specifically, the rankings indicate a need to make the process smoother by having familiarity with navigating the dissertation process and having familiarity with dissertation expectations. The number one ranked characteristic, "invested in engineering education," was emphasized due to the faculty's familiarity with the engineering education field and relevant issues that can be addressed in a dissertation. In addition, it was noted that having an advisor that had access to funding would limit the stress associated with the process. A participant's contrary view noted that advisor's with access to funding and access to data may push a student to working on a project that they may not be interested in.

Table 5. Ranking of professional characteristics of advisors and committee members

Advisor		Committee	
Characteristic	*Mean Rank*	*Characteristic*	*Mean Rank*
Invested in Engineering Education	2.11	Invested in Engineering Education	1.22
Access to funding	3.56	Connection to relevant networks	3.44
Familiar with navigating dissertation process	3.67	Familiar with dissertation expectations	3.56
Strong publication ability	4.78	Familiar with navigating dissertation process	4.89
Familiar with dissertation expectations	4.89	Connection to future employers	5.44
Connection to relevant networks	5.44	Strong publication ability	5.78
Strong reputation in engineering education	7.22	Strong reputation in engineering education	6.22
Connection to future employers	7.89	Outsider	7.56
Strong grant writer	8.00	Political influence at institution	8.67
Access to data	8.56	Strong grant writer	9.33
Political influence at institution	9.89	Access to funding	10.89
Outsider	N/A	Access to data	11.00
Kendall's W:	.55	*Kendall's W:*	.72

In comparison to the advisor characteristics that emphasize easing the dissertation process, the committee characteristics had more emphasis on advancing the career of the student once they graduated. These professional characteristics included “connection to relevant networks” and “connection to future employers.” It was noted by several participants that the reputation of the committee is an attribute that can help once a student graduates and that “the committee is best to be connected and networked”.

The other top professional characteristics of the committee followed a similar theme as the advisor characteristics that will help the student achieve their immediate goal of achieving a PhD. By having committee members that were “familiar with the dissertation process and expectations” and are “invested in engineering education,” the committee will be more focused on the technical issues and merits of the study rather than logistical concerns.

Overall Committee Characteristics

The committee as whole should be “collaborative and cooperative” with their interactions (Table 5). As such there is a need for “mutual respect among the members” of the committee to ensure that meetings are productive and that the dissertation work continues with the full support of the committee. While “diverse disciplines” was listed in the top 4 for overall committee characteristics, panel feedback from earlier rounds indicated a split view on having a committee with diverse disciplines. Several participants saw the benefit in a committee with diverse disciplines as a way to refine the students’ knowledge, identify gaps and oversights in the study, and explore the research as a whole from different perspectives. This opportunity led to making the student more reflective and providing an opportunity for committee members to reach across

disciplines that they may not have the opportunity to do otherwise. In contrast, it was also noted that a committee with diverse disciplines may not always work effectively and could make the dissertation process harder if the committee was not collaborative, cooperative, and lacked mutual respect among each other.

Table 6. Ranking of whole committee characteristics

Overall Committee Characteristics	
Characteristics	*Mean Rank*
Collaborative & Cooperative	1.00
Mutual respect among the members	2.11
Allow to work at own pace	3.67
Diverse Disciplines	4.33
Sociable	4.67
Prior work experience with one or more members	6.11
Diverse Academic Ranks	6.67
Diverse Personalities	8.00
Push to get work done faster	8.44
Kendall's W:	.86

While less elaborated on by the panel, allowing student to “work at one’s own pace” was ranked third among the group. However, it was noted that the push to get work done faster may be needed in order to ensure a timely completion of the dissertation.

Conclusion

There are many challenges when pursuing an engineering education PhD, especially given the interdisciplinary nature of the field and the relative youth of the degree. The ability to choose a committee and advisor that will aid a student in achieving their degree becomes a critical component to their success and overcoming those challenges that other degrees may not face. This study highlighted the preferred characteristics of a doctoral committee based on the experiences of nine recent graduates who were successful in navigating their way to an engineering education PhD.

Based on the perspective of the participants, the advisor should be a champion for the student’s success with knowledge of the process and expectations for receiving a PhD. A committee should comprise members who can work together in a collaborative and cooperative way to support the student’s professional success with connections to future employers and relevant networks. Both the advisor and committee should be supportive of engineering education and have knowledge of relevant educational research methods.

Implications

While, these findings may seem generalizable to any doctoral degree program, this study only focused on degrees and research in engineering education. The findings from this paper are meant to help guide new graduate students pursuing engineering education degrees when choosing a committee. These characteristics will vary from student to student, but we hope to provide an overview based on previous students' experiences.

This study can also aid departments with students who are interested in pursuing engineering education PhDs. If the department has an orientation program, this study can help to frame a conversation with new students about forming a successful committee. Or if a potential advisor is approached by a student looking to pursue engineering education, this paper can offer an outline to help form a committee that will help the student succeed.

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Appendix A: Characteristics and definitions generated by panel participants

Technical Expertise
Characteristics

Area of Study Content and Context - Contain a strong knowledge of the context of the problem under investigation or the content that is being explored.

Education Research Methods (direct) - Understands and applies the methodology you intend to use in your dissertation

Education Research Methods (indirect) - Understands a set of methodology that you do not plan on using for your dissertation but could be interested in using in the future.

Learning Theories - Has a strong understanding of traditional and contemporary learning theories

Relevant Teaching Experience - Has taught in courses that you are planning on investigating as part of your dissertation or plan on teaching in the future.

Document Writing & Editing - Has a strong understanding of writing styles, structure, grammar, and/or stating arguments.

Personal
Characteristics

Reflective - Thinks broadly about your work and how it is connected to the field

Champion - Will be an advocate for you and the work you will be doing for your dissertation and will defend you from other committee members when necessary

Available - Reasonably open calendar for scheduling committee meetings

Optimistic - Thinks you will do good work, finish your dissertation, and be a success once you graduate

Passive Observer - Will participate in committee discussions, but will not throw up any major road blocks for graduation

Supportive of Professional Success - Wants you to achieve success professionally: getting the job you want, publishing, receiving grants, etc. and will support those efforts throughout the process.

Open-minded to Research Paradigms - Willing to explore utilize new methodology, theoretical frameworks, and contexts.

Supportive of Personal Life - Wants you to succeed beyond the professional spectrum. Wants you to be happy, healthy, and achieve all personal goals

Professional Characteristics

Outsider - Someone from outside the engineering education community (i.e. engineering industry representative, business, law, etc.)

Familiar with navigating dissertation process - Has served on similar dissertation committees before and is familiar with the different steps that are taken during the process.

Familiar with dissertation expectations - Understands the typical technical quality, length, and formatting is for your dissertation.

Political influence at institution - Has a high rank within the department or institution or works closely with those individuals.

Connection to future employers - Has contacts and influence that will aid in securing a job after graduation.

Connection to relevant networks - Has access to networks that you wish to become part of or that you wish to collect data on as part of your dissertation

Strong reputation in engineering education - Has published within engineering education and has a professional presence within the field

Access to data - Has worked with or created a set of data that you would like to use in for your dissertation.

Access to funding - Has funding opportunities that will pay for your dissertation?

Strong publication ability - Has a high publication (conference and journal) acceptance rate.

Strong grant writer - Has written several grants that have been funded.

Invested in Engineering Education - Either works within engineering education or is in some way supportive of the work of the engineering education community

Committee Whole
Characteristics

Diverse Personalities

Diverse Academic Ranks

Diverse Disciplines

Allow to work at own pace

Push to get work done faster

Sociable

Collaborative & Cooperative

Prior work experience with one or more members

Mutual respect among the members