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Online Research Community of a Philippine State University: A Social Network Analysis

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Abstract
Communities of researchers have begun to adopt online social networking sitesto interact and share research outputs. This paper attempted to visualize the online research community of fifty faculty researchers in a state university inNorthern Mindanao. Social network analysis, using Gephi, was used to uncoverthe modularity and centrality characteristics of the research networks among faculty researchers. Results revealed that five modularity classes emerged with varied group attributes: research leaders, multi-disciplinary teams, discipline experts, and less connected faculty researchers. Centrality patterns disclosed thatthe highly connected and influential faculty researchers are the university research leaders and those well-published and frequently cited. The university may continue its efforts to establish a culture of collaborative research among the faculty. Other universities may benchmark from this case and innovate their research practices.
Keywords: collaboration, learning communities, modularity, social networking sites

Introduction

Research publication and dissemination are becoming prevalent among Philippine Higher Education Institutions. State universities and colleges, as academic organizations, are considered producers of research and innovation (Añar et al., 2020). Research collaboration is needed to accomplish the university's targets: improve quality, collaboration, and research partnerships (Elisabeth et al., 2019). Consequently, faculty in higher education institutions use online academic communities like social networking sites, which include Google Scholar, ResearchGate, Academia, and the like to disseminate their published research, aside from their institutional repositories or Online Journal System (OJS).The Commission on Higher Education (CHED) has provided policies and mandates geared towards the competitiveness of higher education institutions (HEI) to improve research productivity. CHED has been pushing for stronger research orientation and culture among HEIs. It has established initiatives that encouraged institutions to develop various research and projects which will be funded and supported by the commission. Despite these initiatives, the current state of higher education research in the Philippines leaves much to be desired regarding quantity, quality, thrusts, and contribution to national development.

Faculty members in HEIs are expected to be the primary producers of research. Salazar- Clemena and Almonte-Acosta (2007) cited the status of research in 1,605 public and private HEIs in the Philippines showed a low turnout. Among these studies, those conducted by individuals (72%) far exceeded collaborative and institutional research. Graduate students did about 69% of these individual studies as part of their degree requirements. Increased involvement in research becomes more imperative for faculty with professorial ranks in higher education institutions (HEIs) than instructors. Published research is heavily considered for promotion, tenure, and other merit decisions (Royal et al., 2014). The Common Criteria for Evaluation (CCE) being implemented nationwide grants higher ranks mainly dependent on the quality of the candidate's paper publication. A paper publication was evaluated based on its practical value to partners and stakeholders. Currently, the emphasis is shifting to thecitation history of a research paper as determined by the h-index earned by the writer.

Each state-run institution is expected to have 10% of the faculty population to be granted the professorial items. It would mean the faculty must earn the necessary points to gain the position. Awareness of this requirement induces increased

research engagement among potential faculty candidates. For their part, SUCs have implemented specific initiatives to help accelerate the teachers' movements to the higher rungs in the academic ranking system. Part of this initiativeis to promote collaboration between highly skilled research writers and neophytes. It has implications for the expenditures dispensed by the institution to research work.

2.Literature Review

Vanderelst, (2015) social network analysis is a novel method for quantifying research output that captures aspects of scientific impact and importance not picked up by other metrics **Royal and colleagues (2014)** demonstrated how social network analysis could be used to determinefaculty research productivity and collaborations in highly combined and complex research networks. **Vanderelst (2015)** highlighted that social network analysis is an emerging trend in formulating research policy recommendations. Also, **Bonaiuti (2015)** attempted to explore the impact of online platforms in Italy, particularly academic social network sites, and their impact on scholarly practices. **Elisabeth et al. (2019)** used social network analysis to map and measure scientific actors' relationships to understand collaboration activities from various views of different elements and to build the author's research profile.

Jan and company (2019) did a systematic literature review to explore the use of social network analysis for investigating higher education online learning communities. **Veletsianos and Kimmons (2012)** cited that faculty members' participation in online networks requires further investigation after using phenomenological analysis to understand faculty members' lived experiences on social networking sites. Also, **Lou and Hsu (2009)** identified characteristics of research collaborators based on centrality measures. A researcher may be considered active and important if he ranks high in all indicators. On the other hand, a researcher is considered active with a strong partnership if he ranks high in degree centrality and is considered important if he ranks high in-betweenness and closeness centrality measures

State universities and colleges in the Philippines, aiming to be one of the research universities, allow its facultyresearchers to store their research works on social networking sites to be more visible and accessible. In ResearchGate, Google Scholar, and Academia, several faculty from a state university in Northern Mindanao, Philippines, shared their research in the online community where other researchers can read and download it. The researchers may follow one another, communicate, and be updated.

With these, this study attempts to visualize the research networks of a state university faculty because only a few studies on this were done at the said research space. Potential findings include determining the most influential faculty researcher in the online academic communities that may help disseminate other faculty research works. It may lead to institutional policy directions to improve the research productivity, visibility, and citations of the faculty and the university.

3. Objective of the Study

Specifically, the paper attempted to:

- Describe the modularity patterns of network relationships among faculty-researchers in an online research community of a state university.
- Determine the centrality patterns of network relationships among faculty-researchers in an online research community of a state university.
- Propose a plan of action based on the results of the study.

4. Methodology

The study will utilize social network analysis using Gephi as a visualization tool for illustrating modularity and centrality measures. Fifty faculty researchers from a state university in Northern Mindanao, Philippines, with Google Scholar and ResearchGate, or Academia accounts, were purposively selected for the study. Their research paper collaborators, followers, and those who follow them in the online communities will be considered nodes. The edge represents the relationship between the faculty researcher and the collaborator or follower. The weight of the relationship for a collaborator (2) is higher than for a follower (1).

The study will utilize modularity and two centrality measures to visualize and describe the faculty

researchers' online networking patterns. Modularity is a measure of network structure. It was created to assess the strength of a network's module division. High modularity networks have dense connections between nodes within modules but sparse connections between nodes from different modules (Ji et al., 2015).

Degree centrality will measure the incoming and outgoing connections held by an individual network member (Lou & Hsu, 2009). In this study, centrality measures refer to the closeness and degree of interconnectedness of online faculty researchers' academic networks. It will count how many direct connections each node has to other nodes in the network (Disney, 2020). It helps find very connected faculty researchers, popular researchers, and researchers who will likely hold the most information or can quickly connect with the broader network. A network can be active because of more partnerships with other members in the network. It is also anindicator of the strength of partnerships among network members.

Eigenvector centrality measures a node's importance and level of influence within a network (Lou & Hsu, 2009). It considers connections from significant nodes are worth more than links from insignificant nodes. Calculating the extended connections of a node can identify nodes with influence over the whole network, not just those directly connected to it (Disney, 2020). Thismeasure can identify the most influential faculty researcher in the group.

Ethical clearance from the university ethics board was secured before the conduct of the study. Since all the needed data are visible online for anybody and are accessible to all, data mining was done. The faculty names are not reflected in any part of the paper for confidentiality and anonymity. Only those with Google Scholar and Researchgate or Academia accounts, consisting of 50 faculty researchers, are considered in the study.

5. Results & Discussion

Modularity Measures

Figure 1 presents the online research community clusters of faculty researchers of a highereducation institution in the Philippines. Using Gephi to calculate the modularity of the gathered data, results revealed that there are emerging 5 clusters, shown in different colors.

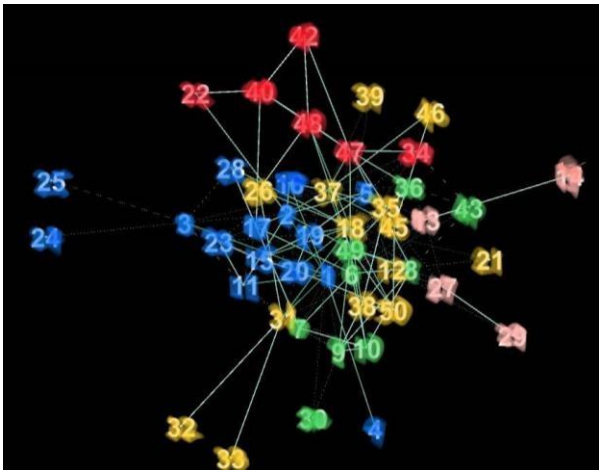

Figure 1. Online Research Community Clusters of Faculty-Researchers

The first cluster, in yellow, accounts for 28% of the faculty researchers considered. The said cluster comprises the university's most cited and published faculty researchers. Accordingly, they are considered research leaders or trainers who initiate research activities at the university.

The second cluster, in green, accounts for 18% of the participants. A second cluster is a research group connected as co-authors in various research works. They have helped one anotherin producing research outputs as collaborators. Rahmaida et al. (2019) discovered a co-authoring pattern formed

by a series of publications and the ability to predict future collaboration patterns.

The third cluster, in blue, accounts for the highest percentage at 30. This group has expertise in the sciences, not limited to Biology, Mathematics, and Information Technology. This group makes up a multi-disciplinary research team.

The fourth cluster (red) accounts for 12%, while the last cluster (pink) accounts for the smallest percentage at 8. The fourth cluster contains a team of language researchers, while the last cluster is faculty researchers with fewer collaborators and needs to connect with other faculty researchers in the university.

Since modularity is a measure of the strength of a network in clusters, cluster 3 has the densest connections among faculty researchers, while cluster 5 has the least dense connections. The modularity measure showed vulnerable spots in the faculty-researchers network and the need for interventions or innovations, including research linkages and collaborations. The results are supported by the findings of Pratama and Shobaruddin (2022) that clusters develop unique characteristics due to differences in scientific fields, frequency, links between researchers, and research schemes.

Further, the clusters acknowledged senior faculty members who are central to the network and may be well-positioned to mentor and support junior faculty members. It can develop the skills and productivity of junior faculty members and contribute to the overall research productivity of the faculty. The observed collaboration showed mentoring relationships between senior and beginning researchers. Collaboration also serves as a means of knowledge transfer, allowing beginning researchers to expand their capabilities, as cited by Lu and colleagues (2021).

Centrality Measures

Degree Centrality

Figure 2 shows the degree of centrality visualization of faculty researchers' networks. The larger the number symbolizing a faculty-researcher means, the higher the degree of researcher connections. Results revealed that faculty researchers 1, 18, 37, 49, and 2 are very connected to other faculty researchers. They are much connected because most are designated in the Office of the Vice President for Research, Extension, and Innovations. They are also the researchers who are likely to hold the most information or can quickly connect with the more comprehensive faculty researcher network as part of the nature of their designation. They are alsoactive in collaboration and partnership with other network members. Similarly, Elisabeth et al. (2019) discovered that the most popular researchers influence research themes and bridge the relationship among faculty researchers.

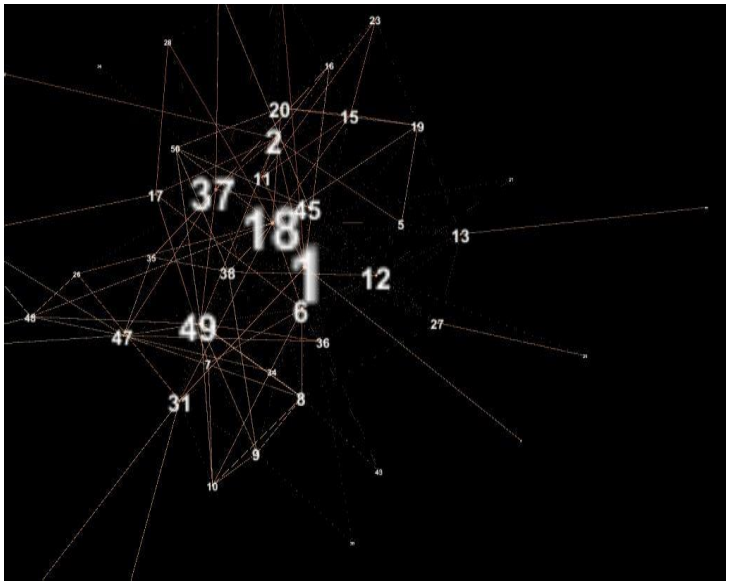

Figure 2. Degree Centrality Visualization among Faculty-Researchers

A few research teams act as the clusters' hubs, parallel to Lou and Hsu's (2009) result. When we look at the structure of the clusters in greater detail, some researchers have acted as bridges that connect otherwise disconnected groups. They are considered to be the keys to forminglarger research groups. In addition, the results identified faculty members who are central to the research network and may have access to valuable resources, such as funding, data, or expertise. This information can allocate resources more effectively and maximize the faculty's research output.

Eigenvector Centrality

The eigenvector centrality visualization in Figure 3 illustrates the most influential faculty researchers in the network. It shows that the top three influential faculty researchers, namely faculty researchers 1, 18, and 37, are highly connected to other faculty researchers in the network. These researchers are also considered research leaders in the university, which explains their high level of influence.

Furthermore, the fact that these influential faculty researchers are the most published and cited researchers in the university suggests that their research work is highly regarded and influential in their respective fields. As a result, their research output and expertise positively impact the whole university's research productivity.

The finding that highly productive and cited researchers have a positive impact on the growth of other researchers is consistent with the research of Lu et al. (2021), which highlights the importance of collaboration and knowledge transfer in academic networks. Thus, the visualization provides valuable insights into the importance of research leadership and collaboration in academic networks and the need to support and promote the work of influential researchers in the network.

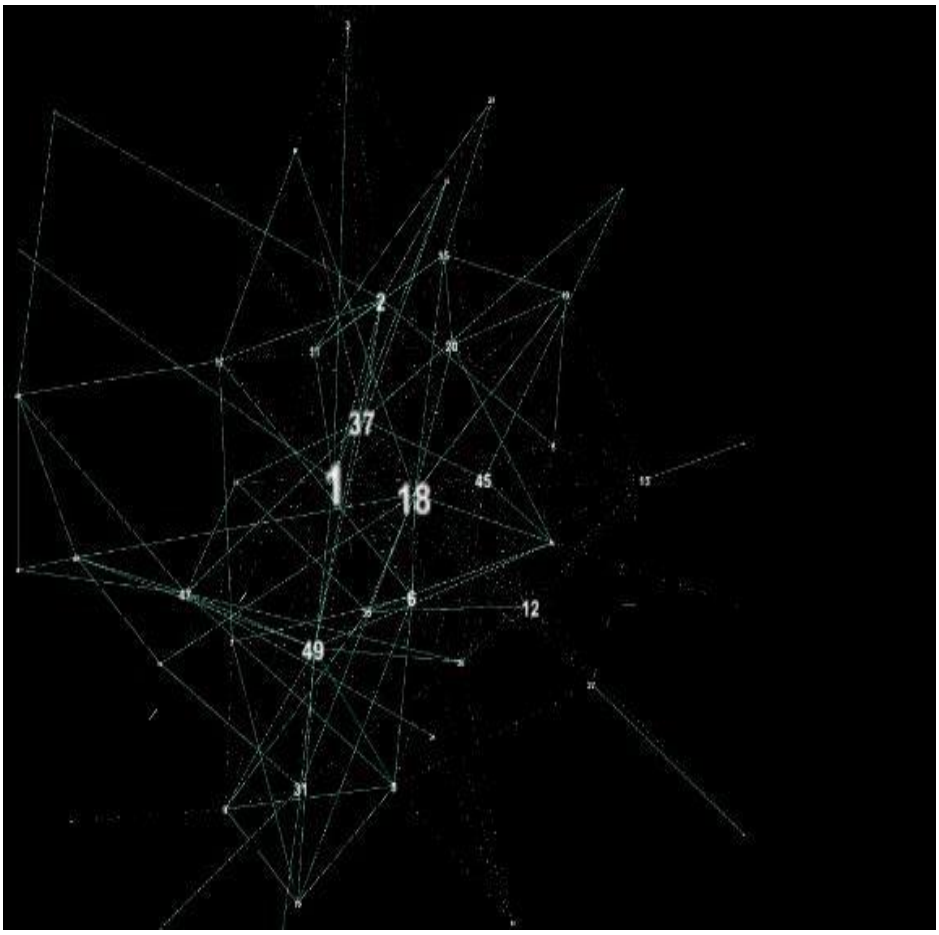

Figure 3. Eigenvector Centrality Visualization among Faculty-Researchers

Overall, the modularity and centrality results identified opportunities for research collaboration, knowledge sharing, resource allocation, and mentorship within the faculty network. It also provided valuable insights into the structure and dynamics of the faculty researchers' network in the university to inform interventions and innovations, such as promoting cross-disciplinary collaboration, fostering mentorship and leadership, and promoting knowledge transfer to enhance research productivity and impact in the university.

Proposed Plan of Actions

The following actions are proposed based on the results of the social network analysis:

a. Design and implement strategic research capability training for beginningresearchers.

b. Provide research writing and workshop opportunities for senior researchers toflourish.

c. Create programs, projects, or a physical or virtual space for faculty researchers to converse and collaborate.

d. Sustain the innovative "training of research trainers" as its impact is veryevident in the research productivity profile of the university.6. Conclusions & Limitations

The social network analysis of the online research community of faculty researchers in a state university provided rich evidence of interaction and collaboration. It is not only limited to a team of parallel disciplines, but also there is a presence of a multi-disciplinary group. Research leaders and trainers also collaborate to produce research outputs. However, it was also disclosed that there are isolated faculty researchers whose works are single-authored or co-authored outside the university's faculty-researchers circle. The efforts toward establishing collaborative research culture must continue and generate more impactful results.

A collaborative research process may be institutionalized so that the research teams expand and look cohesive. These network maps show and help us understand whether the university's research program helps to form more affluent, more diverse research networks that join researchers from different research fields. Since the research groups and influential faculty researchers were identified, the information can be used to develop efficient research networks and intentionally support them.

Highly connected and significantly influential faculty researchers may help reach and motivate other faculty members to do research. The leaders may initiate capability training for beginning researchers and writing workshops for senior researchers. Mentoring activities may be implemented for senior researchers to guide the beginning researchers. Research space, physical or virtual, may be designed to promote conversations and collaborations among faculty researchers. It is suggested to continue sustaining the innovative activities and programs to generate more researchers and make a difference in the community. It may lead to institutional policy directions to improve the research productivity, visibility, and citations of the faculty and the university.

The study has limitations. The faculty researchers considered are those with Google Scholar and Researchgate or Academia accounts. Due to this boundary, some faculty researchers are not included in the data gathering. Another study may be conducted of similar nature but may go beyond visualization. Much in-depth exploration or investigation is suggested. The method presented here should be considered only as the starting point. Several potential improvements canbe made.

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