Interprofessional Education and Research in the Health Professions: A Systematic Review and Supplementary Topic Modeling

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Abstract: Interprofessional education (IPE) has grown in popularity over the years because it is effective in training future health professionals and serves as the engine of productivity in healthcare-related research. The research team, consisting of higher education faculty in various health profession disciplines, conducted a systematic review of existent IPE literature targeting both graduate and undergraduate students. The main purpose of the systematic review was to categorize research and analyze IPE studies to determine sub-constructs that entail both barriers and facilitators often related to occurrences in primary provider, learner, and researcher IPE initiatives. If identified, IPE training and related curriculum plans were also analyzed in this review. The research team wanted to identify any/all potential instances of the use of research activities in coordination with IPE training to identify underlying constructs to support future college and program-specific andragogy initiatives. Review results demonstrate three categorical constructs related to IPE initiatives in higher education health professions programs (provider, learner, and researcher stakeholder perspectives). Results further demonstrate provider IPE challenges surrounding limited resources and a willingness to participate, while both patient experience and teamwork foci were identified as common IPE session themes. Further, the learners’ perspectives included a challenge related to a willingness to participate, as well as the patient experience focus. Review constructs were further validated using supplementary topic modeling. To the best of our knowledge, this is the first study that combined systematic review with a supplementary topic modeling. Findings support ongoing pedagogy and research efforts related to IPE activities for health professions programs in higher education.

Keywords: interprofessional education; IPE; interprofessional collaboration; teamwork; higher education; health professions; multidisciplinary; research

1. Introduction

Any healthcare setting requires the involvement of healthcare professionals from different disciplines. For example, the healthcare regimen for someone diagnosed with a stroke may involve a cardiologist, a neurologist, a radiologist, a speech and language therapist, a physical therapist, a nutritionist, and a counselor. Therefore, it is imperative that healthcare professionals undergo multidisciplinary education to be able to deliver a well-coordinated effective care and ensure positive health outcomes. Interprofessional education (IPE) in higher education healthcare programs continues to serve as a common andragogy method for future and current healthcare professionals. It has grown in popularity over the
years because it is effective in training future health professionals and serves as the engine of productivity in healthcare-related research. Individuals with complementary skills and expertise link together to work toward the same purpose and achieve the same outcome in healthcare. Therefore, IPE is well-suited to training and research in health professions that cross over multiple disciplines and facilitate them with a grander scope.

Motivated by reports from the Institute of Medicine and the World Health Organization highlighting the benefits of incorporating IPE into healthcare curricula, financial support for IPE research has emerged from government agencies as well as private foundations [1]. Researchers from the Centre for the Advancement of Interprofessional Education published a guide with tips for others seeking to expand the literature about IPE and interprofessional collaborative practice [2]. As programs of higher education continue to offer such teaching and research opportunities with collaboration across degree programs and healthcare disciplines, ongoing studies on IPE and related student, attendee, and instructor outcomes continue to be published in the peer reviewed literature. Combining expertise and resources through IPE can maximize the benefits of collaboration and its impact on policy and practice in healthcare training and research initiatives. While healthcare professionals deal with the complex needs of patients, effective communication, teamwork and interprofessional collaboration among healthcare professionals help ensure high quality patient care. Individuals with diverse backgrounds and perspectives offer unique ideas and expertise in healthcare-related issues. Therefore, it is essential to determine sub-constructs that entail both barriers and facilitators often related to occurrences in primary provider, learner, and researcher IPE initiatives.

The research team is coordinating the future submission of a higher education grant to further utilize IPE-related initiatives to support future enrollment in health profession graduate programs, to include a specific focus on IPE-related research initiatives. Prior IPE-related reviews specifically involving the topics of research (as part of the IPE activity itself, not research conducted about an IPE activity’s learning outcomes, etc.) was a review priority. Further, the activity needed to be conducted in a health professions higher education setting, and/or follow-on professional development program. In the end, this review was conducted to support the research team’s knowledge of IPE initiatives, best practices identified, as well as underlying themes as related to IPE initiatives, by stakeholders (learner, provider, and researcher).

2. Methods

This review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA). Specifically, the review team followed the guidelines set forth in the PRISMA 2020 checklist, while also utilizing the PRISMA 2020 flow diagram. The following methods sections address specific criteria in the PRISMA checklist to support the review team’s identified articles in databases and/or registers.

2.1. Eligibility Criteria

Articles were included in this review if they specifically met the initial eligibility search database criteria established by the research team. Several iterations of EBSCO (Elton B. Stephens Company)-host searchers were conducted in an attempt to maximize the volume of potential studies related to the review topic, querying multiple research databases. The articles had to be published from 1 January 2015, to-date (28 February 2022), be peer-reviewed, have full-text, and have an English language availability.

Initially, the research team attempted to exclude all publications outside of the United States, but this database search parameter was not utilized in an attempt to further increase the number of potential articles to be included in the review. Additionally, the EBSCOhost filter parameter of “academic journals” was used as an inclusion requirement in an attempt to further identify those studies specifically related to the field of higher education. All article types and/or research methods were included in the review, to include additional reviews identified on similar topics. Such instances were further mined for potential
article additions to this review’s included publications, such as similar systematic reviews previously conducted and their reference/citation lists.

2.2. Search and Information Sources

Several research databases, accessed at Texas State University via EBSCOhost, were queried and utilized in this review to identify the review articles: Medline (EBSCO), Scopus, Complimentary Index, and Cumulative Index to Nursing & Allied Health Literature (CINAHL) Complete. While a significant number of duplicate articles were identified, these four yielded the highest number of identified articles with the fewest count of duplicate articles. The broad sweep of potential articles that met the study criteria ensured that any/all potentially related articles were included in the review team’s initial review. The database search was conducted by the research team from 20 February through 28 February 2022.

Multiple iterations of EBSCOhost database searches were conducted by the research team to identify potential search strings with appropriate Boolean operators to yield the highest initial database search results. The articles were required to entail topic(s) as related to and/or specifically focusing on IPE in health profession programs in higher education institutions and/or conducted in accordance with such institutions. While the team’s brainstorming and individual database searches identified many synonyms for the IPE review topic, the EBSCOhost database search bar recommendations yielded the highest frequency and accuracy for this review topic and therefore were ultimately used in the search string. The review’s inclusion of research activities in the search parameters was also required as a search topic.

The final search string identified by the re-search team was:

[“health professions education”] AND [“interprofessional collaboration” OR “interprofessional teamwork” OR “multidisciplinary”] AND [“research”]

While the EBSCO host provided suggested search terms for many of the other search string terms, the review team identified the highest yield of articles using the search string above. This included deciding against the use of recommended terminology/results from the database host’s suggested synonyms, etc., that auto-populated in the “start your research” search tool.

2.3. Initial Article Selection

Multiple team meetings were conducted to identify any/all articles in the initial database search that further met the review criteria. An MS (Microsoft) Excel spreadsheet and other files were utilized via an MS Teams group site to enhance collaboration and ongoing analysis of the team’s findings. Multiple review methods were utilized in this review, including initial abstract screening, full-text review, and the review of articles’ literature review/reference sections (especially for systematic reviews also identified in the search process). At least two review team members had to agree to exclude an article from the review during the initial title/abstract screening, and there were no disagreements among the review team regarding the final set of articles identified to be included in the review.

3. Results

3.1. Study Selection

Figure 1 (PRISMA flow diagram) demonstrates the review team’s study selection process, follow-on exclusion parameters, and related frequency of articles at each stage of the study selection process. The review team identified additional articles not originally included in the original database search results from two systematic reviews found in the initial search efforts. As a result, the team included 14 additional, applicable references from these two systematic reviews into the current review process (“other sources,” n = 14) in Figure 1.
The EBSCOhost search website assisted in identifying (and therefore excluding) 111 duplicate articles across all four research databases. Further review exclusion criteria (ex. English only, applicable publication date range, academic journal, etc.) were also conducted via EBSCOhost search website options (removing an additional 16,412 articles). In addition to removing the 16,523 articles for not meeting the study criteria, the full text review of the remaining articles resulted in an additional 11 articles being excluded from the review. These additional 11 articles were removed for the following reasons:

- Review articles (2 articles);
- Additional duplicate articles (2 articles);
- Not germane to topic (5 articles);
- Not available in the English language (database selection error) (2 articles).
Studies included in the review had to involve IPE activities and/or related initiatives as conducted in health profession programs in higher education institutions to support the research team’s inquiry into potential constructs identified in the literature to assist with follow-on grant proposal initiatives. The inclusion of “research” in the review criteria further supported this goal, but was not a mandatory requirement (could simply be addressed in the full-text review of the manuscript).

A rigorous review of the 41 identified articles was conducted by the authors after having been identified by the database search and exclusion process (Figure 1). Internal numbering of the identified articles was completed on a MS Teams site and full-text article reviews ensued. Each article identified was reviewed at this level by two or more researchers (Table 1). Researcher collaboration meetings were conducted via webinar and in-person on multiple occasions for coding and construct identification for assigned articles.

| Article Assignment | Reviewer 1 | Reviewer 2 | Reviewer 3 | Reviewer 4 | Reviewer 5 | Reviewer 6 |
|-------------------|------------|------------|------------|------------|------------|------------|
| 1–10              | X          |            |            |            |            |            |
| 11–20             |            | X          |            |            |            |            |
| 21–30             |            |            | X          |            |            |            |
| 31–41             |            |            |            | X          |            |            |

This study’s information came from secondary data sources (library research database). All of the literature included in this research is publicly available and any individual research subjects (if present) are unidentifiable. As a result, this systematic review qualifies under “exempt” status in 45 Code of Federal Regulations (CFR) 46. An institutional review board review was not required, and no consent was necessary.

3.2. Study Characteristics

Article reviews utilized a systematic approach to identify underlying characteristics (constructs) as related to the use of IPE and potential research activities in higher education health professions programs of study articles are listed in alphabetical order by the first author’s last name (Table 2).

3.3. Additional Analysis

Results of the review team’s consensus meetings demonstrates several underlying constructs (themes) identified in the literature to support IPE practices in higher education health profession programs (Figure 2). Within each main construct, researchers were then able to sub-classify additional sub-themes within each of the three main constructs identified. Each construct is not mutually exclusive, therefore any single article may be found under multiple constructs.

The research team was quick to identify the literature falling into three main constructs: IPE perspective and/or study results as related to the healthcare provider, the healthcare learner, and/or the healthcare researcher (or IPE research initiative. Sub-constructs were then used to code articles that focused on specific IPE-related initiatives identified to support further information deduced from the review, while also supporting the research team’s future grant application purposes.
Table 2. Summary of included articles in the systematic review (n = 41).

| Reference Number | Author(s)/Year        | Article Title                                                                 | Journal/Publication                         | Learners                                                                 | Article Type                                      |
|------------------|-----------------------|------------------------------------------------------------------------------|---------------------------------------------|-------------------------------------------------------------------------|--------------------------------------------------|
| [3]              | Baerg et al., 2012    | Survey of Interprofessional Collaboration Learning Needs and Training Interest in Health Professionals, Teachers, and Students: An Exploratory Study | Journal of Researching Interprofessional Practice and Education | Practicing professionals and students from the sectors of health and education | Survey with descriptive analysis                  |
| [4]              | Baker et al., 2008    | Simulation in interprofessional education for patient-centered collaborative care | Journal of Advanced Nursing                 | 101 nursing students, 42 medical students and 70 junior medical residents | Action research approach                          |
| [5]              | Baker et al., 2015    | Teamwork education improves trauma team performance in undergraduate health professional students | Journal of Educational Evaluation for Health Professionals | Teams of undergraduate health professional students from four programs: nursing, physician assistant, radiologic science, and respiratory care | Pre- and post-test analysis                       |
| [6]              | Christian et al., 2020| Evaluating Attitudes Toward Interprofessional Collaboration and Education Among Health Professional Learners | Medical Science Educator                   | Pharmacy, optometry nursing, occupational therapy, physiotherapy, social work working professionals | Quantitative pre-post analysis on learning attitudes following a workshop |
| [7]              | Connaughton et al., 2019 | Health professional student attitudes towards teamwork, roles and values in interprofessional practice: The influence of an interprofessional activity | Focus on Health Professional Education: A Multi-Professional Journal | Medical, physiotherapy, and nursing students | Quantitative pre- and post-surveys conducted using the Interprofessional Attitude’s Scale (IPAS) |
| [8]              | Cooper et al., 2011   | Design and evaluation of simulation scenarios for a program introducing patient safety, teamwork, safety leadership, and simulation to healthcare leaders and managers | Simul Healthcare                            | Individual participants who attended simulation training focused on teamwork and safety leadership | Mixed Methods: Thematic analysis of Qualitative data |
| [9]              | Cooper et al., 2005   | Design, implementation and evaluation of an inter-professional education intervention for first year undergraduate students | Journal of Interprofessional Care           | First year undergraduate students studying medicine, nursing, physiotherapy and occupational therapy | Evidence-based interprofessional educational (IPE) intervention |
| Reference Number | Author(s)/Year        | Article Title                                                                 | Journal/Publication                                | Learners                                                                 | Article Type                                      |
|------------------|-----------------------|-------------------------------------------------------------------------------|---------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------|
| [10]             | Curran et al., 2010   | A longitudinal study of the effect of an interprofessional education curriculum on student satisfaction and attitudes towards interprofessional teamwork and education | Journal of Interprofessional Care                  | Health and human service professional students                           | Time series study design                         |
| [11]             | da Motta & Pacheco, 2014 | Integrating Medical and Health Multiprofessional Residency Programs: The Experience in Building an Interprofessional Curriculum for Health Professionals in Brazil | Education for Health                               | Medicine, nursing, nutrition, psychology, physiotherapy, and social service residency students | Descriptive analysis of program interprofessional characteristics |
| [12]             | Di Prospero & Bhimji-Hewitt, 2011 | Teaching collaboration: A retrospective look at incorporating teamwork into an interprofessional curriculum | Journal of Medical Imaging and Radiation Sciences   | Interprofessional education (IPE) curriculum has been integrated health professional programs | Retrospective collaborative inquiry               |
| [13]             | Eccott et al., 2012   | Evaluating students’ perceptions of an interprofessional problem based pilot learning project | Journal of Allied Health                           | Convenience sample of 24 students from medicine, pharmacy, nursing, physical therapy, and occupational therapy | Pre-post mixed-methods                           |
| [14]             | Freeth et al., 2009   | Multidisciplinary obstetric simulated emergency scenarios (MOSES): Promoting patient safety in obstetrics with teamwork-focused interprofessional simulations | Journal of Continuing Education for Health Professions | Midwives, obstetricians and anesthetists                                  | Mixed Methods: Thematic analysis of Qualitative data |
| [15]             | Greenfield & Kiernan, 2012 | Engaging in patient decision-making in multidisciplinary care for amyotrophic lateral sclerosis: the views of health professionals | Patient Preference and Adherence                  | Medical providers participating in patient decision-making in multidisciplinary care for amyotrophic lateral sclerosis (ALS) | Individual and group interviews                  |
| Reference Number | Author(s)/Year       | Article Title                                                                 | Journal/Publication                           | Learners                                                                 | Article Type                                      |
|------------------|----------------------|-------------------------------------------------------------------------------|-----------------------------------------------|--------------------------------------------------------------------------|-------------------------------------------------|
| [16]             | Hyun et al., 2020    | Psychosocial support during the COVID-19 outbreak in Korea: Activities of multidisciplinary mental health professionals | Journal Korean Medical Science                 | Multidisciplinary team of mental health professionals                     | Case study/report of mental health processes and outcomes |
| [17]             | Irajpour & Alavi, 2014 | Health professionals’ experiences and perceptions of challenges of interprofessional collaboration: Socio-cultural influences of IPC | Iranian Journal of Nursing and Midwifery Research | Samples of HPs from various disciplines including nurses, medical doctors (MDs) from variety of specialties, social workers, and psychologists from health system in Iran and Germany | Pilot qualitative descriptive study               |
| [18]             | Jafelice & Marcolan, 2017 | Perception of Mental Health Professionals About the Multiprofessional Work with Residents | Journal of Nursing UFPE On Line               | Recently graduate mental health professionals                             | Exploratory descriptive study with a qualitative approach |
| [19]             | Jones & Jones, 2011  | Improving teamwork, trust and safety: An ethnographic study of an interprofessional initiative | Journal of Interprofessional Care             | No specific number identified in paper. Participants selected from approximately 250 staff | Ethnography                                      |
| [20]             | Kebe et al., 2019    | Profiling mental health professionals in relation to perceived interprofessional collaboration on teams | SAGE Open Medicine                            | Mental health professionals working in primary care and specialized mental health local service networks | Cluster analysis                                 |
| [21]             | Kuipers et al., 2013 | Do structured arrangements for multidisciplinary peer group supervision make a difference for allied health professional outcomes? | Journal of Multidisciplinary Healthcare        | Allied health professions participating in peer group supervision activities | Descriptive analysis                             |
| [22]             | Lackie et al., 2021  | Interprofessional collaboration between health professional learners when breaking bad news: a scoping review protocol | JBI Evidence Synthesis                        | Studies included involved health care professional curriculum focusing on how to teach the delivery of bad news to stakeholders | Review protocol                                  |
| Reference Number | Author(s)/Year       | Article Title                                                                 | Journal/Publication                              | Learners                                                                 | Article Type                                                                 |
|------------------|----------------------|--------------------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------|----------------------------------------------------------------------------|
| [23]             | Laursen et al., 2017 | Health professionals perceive teamwork with relatives as an obstacle in their daily work - a focus group interview | Scandinavian Journal of Caring Sciences           | Healthcare providers in the outpatient/clinic setting                    | Focus group interview                                                     |
| [24]             | Lestari et al., 2018 | Understanding attitude of health care professional teachers toward interprofessional health care collaboration and education in a Southeast Asian country | Journal of Multidisciplinary Healthcare          | Medicine, nursing, midwifery, and dentistry faculty members at 17 institutions | Qualitative/explanatory, sequential mixed-methods design                    |
| [25]             | Marshall et al., 2016| Survey of research activity among multidisciplinary health professionals       | Australian Health Review                          | Health service employees                                                 | Mixed methods study using a cross-sectional online survey and interviews    |
| [26]             | Morales-Romero et al., 2021 | Effectiveness of an Educational Intervention with High-Fidelity Clinical Simulation to Improve Attitudes Toward Teamwork Among Health Professionals | The Journal of Continuing Education in Nursing    | Interprofessional group of health professionals                          | quasi-experimental study with an educational intervention                  |
| [27]             | Nango & Tanaka, 2010 | Problem-based learning in a multidisciplinary group enhances clinical decision making by medical students: A randomized controlled trial | Journal of Medical and Dental Sciences            | Medical students                                                         | Randomized controlled trial                                               |
| [28]             | Nilsson et al., 2013 | Experiences by patients and health professionals of a multidisciplinary intervention for long-term orofacial pain  | Journal of Multidisciplinary Healthcare          | Patients and multidisciplinary health professionals associated with long-term orofacial pain | Group interview, qualitative content analysis                            |
| [29]             | Okato et al., 2018   | Hospital-based child protection teams that care for parents who abuse or neglect their children recognize the need for multidisciplinary collaborative practice involving perinatal care and mental health professionals: a questionnaire survey conducted in Japan | Journal of Multidisciplinary Healthcare          | Members of a hospital-based child protection team                      | Exploratory factor analysis, correlation analysis                           |
| Reference Number | Author(s)/Year          | Article Title                                                                 | Journal/Publication                      | Learners                               | Article Type                                                                 |
|------------------|-------------------------|--------------------------------------------------------------------------------|------------------------------------------|----------------------------------------|-----------------------------------------------------------------------------|
| [30]             | Paans et al., 2013      | What constitutes an excellent allied health care professional? A multidisciplinary focus group study | Journal of Multidisciplinary Healthcare  | Allied health care professionals       | Focus group discussions and a Delphi panel survey analysis                  |
| [31]             | Rainsford et al., 2021  | ‘Traversing difficult terrain’. Advance care planning in residential aged care through multidisciplinary case conferences: A qualitative interview study exploring the experiences of families, staff and health professionals | Palliative Medicine                     | Medical providers, staff, and patients/family | Qualitative study with semi-structured interviews                          |
| [32]             | Rice et al., 2010       | An intervention to improve interprofessional collaboration and communications: a comparative qualitative study | Journal of Interprofessional Care       | 12 health professionals in a rehabilitation ward | Ethnography                                                                |
| [33]             | Robertson et al., 2010  | The use of simulation and a modified TeamSTEPPS curriculum for medical and nursing student team training | Journal of the Society for Simulation in Healthcare | Two hundred thirteen students participated in a 4-h team training program | Pre-post mixed-methods                                                      |
| [34]             | Rosell et al., 2020     | Health Professionals’ Views on Key Enabling Factors and Barriers of National Multidisciplinary Team Meetings in Cancer Care: A Qualitative Study | Journal of Multidisciplinary Healthcare  | Multidisciplinary health professionals involved in the treatment of specific types of cancers | Conventional content analysis                                               |
| [35]             | Sandahl et al., 2013    | Simulation team training for improved teamwork in an intensive care unit        | International Journal of Health Care Quality Assurance | 152 ICU staff consisting of medical staff and nurses | Action Research                                                            |
| [36]             | Scherer et al., 2013    | Interprofessional simulation to foster collaboration between nursing and medical students | Clinical Simulation in Nursing          | Nursing and medical students           | Quasi-experimental pilot study using a prepost test design                 |
Table 2. Cont.

| Reference Number | Author(s)/Year          | Article Title                                                                 | Journal/Publication                          | Learners                                                                 | Article Type                       |
|------------------|-------------------------|-------------------------------------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------|-----------------------------------|
| [37]             | Steiner et al., 2021    | Hospital Parenting Support for Adults with Incurable End-Stage Cancer: Multidisciplinary Health Professional Perspectives | Health & Social Work                         | 12 multidisciplinary healthcare providers                               | Exploratory study                 |
| [38]             | Titzer et al., 2012     | An Interprofessional Simulation Promoting Collaboration and Problem Solving among Nursing and Allied Health Professional Students | Clinical Simulation in Nursing              | Interprofessional simulation involving nursing, radiologic technology, respiratory, and occupational therapy students | Post training/simulation debriefing |
| [39]             | VanderWielen et al., 2014 | Interprofessional Collaboration Led by Health Professional Students: A Case Study of the Inter Health Professionals Alliance at Virginia Commonwealth University | Journal of Research in Interprofessional Practice and Education | Students at Virginia Commonwealth University (VCU) student healthcare organization/members | Qualitative post-IPE survey for student participants |
| [40]             | Wakefield et al., 2006  | Breaking bad news: Qualitative evaluation of an interprofessional learning opportunity | Medical Teacher                            | Nursing and medical students                                            | Mixed method                      |
| [41]             | Wieczorek et al., 2016  | The struggle for inter-professional teamwork and collaboration in maternity care: Austrian health professionals’ perspectives on the implementation of the Baby-Friendly Hospital Initiative | BMC Health Services Research                | Multidisciplinary (physicians, midwives, and nurses) involved in hospital maternity care | Qualitative, semi-structured interviews conducted |
| [42]             | Winship, 2013           | Multidisciplinary health professionals’ assessments of risk: how are tools used to reach consensus about risk assessment and management? | Journal of Psychiatric and Mental Health Nursing | All health professionals in an acute care and community psychiatric service for elderly patients | Semi-structured interviews         |
| [43]             | Zaheer et al., 2018     | Importance of safety climate, teamwork climate and demographics: understanding nurses, allied health professionals and clerical staff perceptions of patient safety | BMJ Open Quality                            | Nursing and allied health professionals and unit clerks working in intensive care, general medicine, mental health, and/or the emergency department | Cross-sectional survey analysis    |
3.3. Additional Analysis

Results of the review team’s consensus meetings demonstrate several underlying constructs (themes) identified in the literature to support IPE practices in higher education health profession programs (Figure 2). Within each main construct, researchers were then able to sub-classify additional sub-themes within each of the three main constructs identified. Each construct is not mutually exclusive, therefore any single article may be found under multiple constructs.

Figure 2. Themes (constructs) identified in IPE programs by the review team.

3.4. Supplementary Analysis–Topic Modeling Validation

3.4.1. Latent Dirichlet Allocation (LDA) Method

The research team conducted supplementary topic modeling as an additional analysis on this review’s identified articles to further validate identified constructs (themes) shown in Figure 2. This is a time-consuming process that manually reviews a large number of articles for researchers. With the advancement of machine learning, some studies argue that computer-aided text analysis (CATA) can increase reliability and reduce the cost of time in natural language processing [36,44–46]. This study employed a CATA technique, topic modeling, to review the health professional IPE articles identified in the review process. Numerous methods of topic modeling have been developed that consider all kinds of relationships and restrictions within datasets [47]. However, latent Dirichlet allocation (LDA) is a state-of-the-art and preferred method for topic modeling [48].

In topic modeling, LDA assumes that a document is a collection of several topics and the words in the document can be used to learn the topics of a document. Using the probabilistic inference approach, LDA can be used to identify latent structures (e.g., topics) from observed words and word clusters. One advantage of LDA is that it does not require presetting the criteria or keywords for coding [49–51]. The technique is also noted for its ability to arrive at quite distinct and precise topics [52].

The research team compiled a program with the python Gensim library for this LDA analysis, which was applied to forty-one (41) health professional IPE articles’ abstracts. Article abstracts were cleaned by deleting hard returns or paragraph marks copied from
the pdf files, and the subtitles, including backgrounds, methods, results, conclusions, etc. All 41 abstracts were combined into one .txt file.

3.4.2. Latent Dirichlet Allocation Results
In the initial analysis, the keywords, “health(care)”, “professional(s)”, “students” and “team(work)/study”, are shown in all topics. This is predictable finding since these are keywords used in the initial review article selection—thus suggesting that our selection process was successful. However, the initial results did not specifically meet the research team’s topic analysis purpose. The research team wanted to know further detailed topics under the “healthcare professional student team” theme. Therefore, the analysis was re-run after deleting those words. The raw LDA outputs show the most frequently appearing words and their weights. For example, the keywords for the first topic include, among others, medical (0.8%), patient (0.6%), clinical (0.5%), and skills (0.5%). After examining the original abstracts and these keywords, the research team decided that “Medical/clinical skills for patients” was a reasonable label for the first topic. With this approach, the team labeled the top five topics from the LDA outputs. The topics and their proportions are listed in Table 3.

| Topic                                | Proportion |
|--------------------------------------|------------|
| Medical/clinical skills for patients | 33.00%     |
| Group training and collaboration      | 25.80%     |
| Training/practice on patients        | 14.80%     |
| Research support                     | 13.30%     |
| Simulation and learning              | 13.10%     |

In the above topics, medical/clinical skills and training/practice on patients can be categorized under provider perspectives. Simulation, group training, collaboration, and learning are related to learner perspectives while research support matches researcher perspectives. As a result, the topics identified via the LDA analysis are consistent with the team’s systematic review findings (identified constructs from manual review), suggesting that the LDA analysis is an effective tool in identifying articles’ topics in literature review studies. These results further provide evidence that researchers can benefit from machine learning techniques in validating the sample selection process and identifying textual topics.

4. Discussion
The research team was able to identify sub-constructs as related to primary provider, learning, and researcher IPE initiatives. Each of these sub-constructs (or sub-themes) entails both inhibitors (or barriers) to IPE initiatives, and/or facilitators of IPE initiatives. Further, constructs (and their sub-constructs identified by the research team) are not mutually exclusive and are often related occurrences in IPE initiatives.

4.1. Provider IPE Perspective
Providers or administrators of IPE activities in higher education easily demonstrate a lack of resources for facilitating meaningful collaboration among interdisciplinary teams. While not mutually exclusive variables, time, opportunity costs, and overall willingness to collaborate have been noted as barriers to providers of IPE in higher education, as related to limited resources [23]. Opportunity costs of being away from other daily activities by the learner demonstrate a need for conveyance and perception of value for the IPE activity by session participants. While these articles identified in the review focus specifically on healthcare professionals participating in IPE activities [23], similar limitations are believed to extend to student IPE activities in higher education as well.
Participants of IPE learning activities must expect and experience an overall benefit of the activity to encourage and enhance their willingness to participate. Multiple reasons were identified by the review team surrounding reasons why IPE participants (or potential IPE participants) questioned such collaborative activities at the interdisciplinary level. For example, medical providers (specifically physicians) suggested that planned IPE activities at their organization suggested a hidden or otherwise referendum on their clinical skill sets [30]. Further, professional autonomy was questioned across all provider types in similar IPE initiatives, affecting their willingness to participate [30]. These findings support the need for proper interprofessional attitudes and overall teamwork initiative necessary for a successful IPE event [29].

A lack of time and overall motivation to simply engage in IPE training events was a primary barrier in both the professional realm as well in higher education [30,31]. Not mutually exclusive, lack of time as an influence on an unwillingness to support IPE initiatives is confounding with all other variables identified by the research team for this sub-construct (willingness to participate). As a result, the scheduling of IPE activities by organizational leadership and/or program faculty during high workload periods demonstrates a significant challenge of professional power upon workers/students [31], while also further highlighting the opportunity cost and related workload stress on IPE participants [6,28,31].

Since patient experience has emerged as an important factor leading to positive health outcomes [30] several IPE studies have focused on patient experience enhancement. Findings from the reviewed articles have led the research team to categorize patient experience articles in several categories. Some IPEs were focused on specific patient demography, such as children and elderly, as well as disease, such as end-stage cancer, advance care planning to improve the quality of life of patients in palliative care, patients with severe asthma, mental health problems, amyotrophic lateral sclerosis [5,15,42], long-term orofacial pain [28], and patients admitted in intensive care unit [35]. Other studies focused on caregiver/family experiences [5], patient experience using a virtual toolkit that patients can access, breaking bad news to the patient [22], risk assessment and management [42], care coordination [38], patient safety [8,43], trauma resuscitation [33], child abuse [29], and patient engagement in decision making [15]. However, the providers or administrators of IPEs have mentioned the scarcity of IPE studies targeting patient and caregiver experiences [5]. Regardless, healthcare does not need to reinvent the wheel because valuable tools like TeamSTEPPS that has been widely used by healthcare organization is a valuable can be used in healthcare IPEs [33].

The research team also found some IPE articles that specifically targeted teamwork. This also makes sense because the provision of healthcare services is implicitly teamwork-based [30]. Some articles focused on teamwork to address mental health [16,18]. For instance, Hyun et al. (2020) reported the immediate establishment of a multidisciplinary team of mental health professionals, by the South Korean government, during COVID-19 outbreak [16]. Several government agencies worked together to establish a guideline to provide psychosocial support at different stages from isolation facilities to the public. Jafelice and Marcolan (2017) found that mental health professionals were not able to distinguish between multiprofessional, interprofessional, and transprofessional work [16]. Other articles on teamwork focused on the education of medical students, nurses, and other health professional students [11,33,35,36,38,40]. For example, some articles focused on the establishment of an interprofessional curriculum for health medical students and other health professionals to care for the elderly [11,12]. In the same vein, interprofessional simulation was used to train nursing and medical students and nursing and allied health professional students in multidisciplinary collaboration [8,35,36,38].

The review of literature on teamwork studies published between 1990 and 2013 suggested that organizational culture, expectations, and understanding how teams function affect health professionals’ experience of teamwork education [30]. The study conducted in a hospital in Southern Ohio suggested that health professionals’ perception of senior leadership support for safety and teamwork were associated with health professionals’
overall perception of patient safety [43]. Ethnographic study indicated that an interprofessional initiative on teamwork improved teamwork, trust among team members, and patient safety [19].

The reviewed studies highlight the myriads of options and possibilities regarding the types of teamwork training and their impact on teamwork participants and patient safety.

4.2. Learner Perspective

It is reasonable to conclude that most individuals are more willing to engage in an activity when there is a positive view of the activity. From the literature we surveyed, there appears to be a positive attitude among medical professionals toward interprofessional education (IPE) [3,6,7]. Several factors contribute to the positive attitude and willingness to participate in IPE events. Christian et al. (2020) [6] noted smaller class sizes created more favorable feelings toward the IPE experience compared to larger class sizes. One-day IPE events were more popular than multi-day events [3]. Additionally, student health professionals demonstrated a greater interest in IPE events compared to health professions faculty [3]. Connaughton (2019) revealed collaboration among medical profession students and case studies relevant to the students’ field influenced their willingness to participate in IPE activities [7]. When the IPE case study marginalized a health profession, those students viewed the activity less favorably and felt the experience was wasted [7]. Students valued the collaborative work between health professions and the opportunity to engage in IPE.

Collaboration can drive research activities. Marshall et al. [25] surveyed health service employees in Australia on their research activities. The inter-related concepts identified by the authors were collaborative partnerships, skilled mentorship, embedding research into clinical activities, and support from the organization. Collaboration between academic researchers and healthcare clinicians was identified as a strong and vital link. These collaborative experiences also created mentorship opportunities and a source of support for beginning researchers. The authors concluded, “Structural processes, such as organizational support and opportunities for skilled mentorship, may be necessary to build health service employees’ research knowledge, skills, and confidence.” [25]. Another driver of collaborative activities is the familiarity of the various healthcare professionals. Eccott et al. [13] conducted a mixed-methods study of students from five different health disciplines on their perception of an interprofessional problem-based learning module. Students indicated the module increased their understanding of interprofessional teamwork and positively impacted their view of collaboration [13]. Students believed the module fostered open communication and mutual trust within the groups [13]. The problem-based learning module provided an opportunity for students to learn the roles of other providers and appreciate the different scopes of practice represented [13].

One common theme appearing across multiple reviewed articles was the IPE learners’ focus on benefits to patients as an element of quality healthcare delivery [7,33,35]. For example, one study by Robertson et al. [31] brought 213 medical and nursing students together for a 4 h TeamSTEPPS training class with the specific goal of addressing patient safety. Another study involving medical and nursing students by Baker et al. specified a goal of enhancing patient welfare for an action research study of simulation-based training [4]. IPE can be effective at reducing the negative impact on patient experiences caused by repeated procedures, miscommunication, and uncoordinated care [35]. These examples are consistent with the [53] of patient experience encompassing a broad range of patient interactions with healthcare professionals from scheduling appointments, through communicating with clinicians, and continuing after discharge.

IPE is sometimes initiated by learners motivated to improve the patient experience. Students at one institution recognized the value of interprofessional education and formed an “Inter Health Professionals Alliance (IHPA)” as a student-run organization which grew from the six founding students to over 350 members in three years. A study of the IHPA members identified helping patients to be a key benefit and expectation of learner participation [35]. Specifically, the study determined that student members believed that their patients would
receive more comprehensive and effective care resulting from improved knowledge and skills, role clarity, professional competency, and the interprofessional network generated from the interdisciplinary collaboration.

Learners in another study reported that IPE activities helped them be a better practitioner from their improved ability to help patients get the services they need from other professions [7]. Participation in IPE fostered respect for the capabilities of other professions and reinforced that the patient experience benefits from a team approach.

4.3. Research IPE Perspective

Our systematic review and machine learning results obtained with topic modeling (latent Dirichlet allocation) showed that research on interprofessional education is lacking in the literature. We found only two published research projects on interprofessional education. One of these studies evaluated the effect of multidisciplinary education on the clinical decision-making of medical students and reported that the involvement of pharmacy and nursing students in clinical decisions improved medical students’ decision-making [27]. The second study was survey research, which investigated research activity, engagement, and experiences among multidisciplinary health professionals in one Australian healthcare institution [25]. The findings of this study showed that healthcare professionals recognized the importance of research. While the study respondents had the necessary research skills, knowledge, and experience, they also identified several facilitators to build research capacity in their institution. These facilitators include improving organizational support for interprofessional research in clinical settings, building research collaborations among healthcare professionals, providing mentorship to less experienced clinicians, and embedding research in clinical practice [25].

Research on interprofessional education and collaboration among healthcare professionals have many benefits. For instance, faculty, students, and clinicians may have opportunities to investigate how approaches from different disciplines can be applied to existing problems in healthcare. They can gain new perspectives on this area of research, build relationships with colleagues in the fields, and develop innovative solutions to healthcare problems. Whereas most important issues in healthcare can be solved by working together as a team from different backgrounds, research collaboration in interprofessional education require coordination between the researchers, institutions, and communities. Therefore, providing organizational support and the necessary infrastructure is essential in improving research activity and success within the healthcare institution.

Future research may focus on the effect of interprofessional collaboration on patient assessments and outcomes, clinical decision-making, interdisciplinary relations, and communication in healthcare settings. Thus, the development, engagement, and integration of different disciplines in this area of research can improve communication, collaboration, and clinical outcomes in healthcare.

5. Conclusions

Given the evidence from the included studies, three categorical constructs, provider, learner, and researcher stakeholder perspectives, were identified for IPE initiatives in higher education health professions programs. While both the provider and learner IPE perspectives highlight a willingness to participate and patient experience on IPE, the provider perspective also emphasizes team focus and limited resources for IPE initiatives. While this field is developing, further rigorous studies are warranted to understand the impact of IPE on patient assessment and outcomes, clinical decision-making, interdisciplinary relations, and communication in healthcare settings. Additionally, IPE-related concepts surrounding collaborative roles, coordination of services, and team leadership should be investigated. Further efforts to infuse research-related activities into IPE-related activities are needed in the health professions. Review constructs were validated using supplementary topic modeling that can be used as an effective tool in identifying articles’ topics in future systematic reviews.
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