A framework based on Gram-Schmidt Process for Interdisciplinary Collaboration in Education Process

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Abstract - In educational field, working together across different areas of expertise is really significant for coming up with new ideas and understanding things from different dimensions. This paper suggests that available mathematical idea called the Gram-Schmidt process can help different experts in education industry to work together in a better way. Just like how the Gram-Schmidt process manages things in mathematics, interdisciplinary collaboration in education brings together variety of ideas and methods to make a unified approach for research. By using this concept from mathematics in a more abstract way, this paper suggests a way to encourage teamwork among different experts in educational research. This paper suggests that how clear communication, bringing together different ideas, and working well together are all really important. A framework is recommended to apply this concept on Interdisciplinary education.

Keywords - Gram-Schmidt; Interdisciplinary; Orthogonalize

INTRODUCTION

Innovative answers to challenging problems in the ever-changing educational world necessitate a collaborative and multidisciplinary approach. The fundamental component of this approach is the integration of varied approaches, outlooks, and experience from many disciplines to obtain a comprehensive understanding of educational trends (Podgórska & Zdonek, n.d.). In order to improve interdisciplinary collaboration in the field of education, this research explores the potential use of the Gram-Schmidt process, a mathematical concept that is used to orthogonalize vectors (Rosita Dewi et al., 2020).The education sector encompasses a wide range of disciplines, including technology, sociology, psychology, and instructional strategies (Davidesco & Tanner, 2020). Every one of these disciplines contributes unique theories and methods of inquiry. Multidisciplinary collaboration isn't always easy, though. Diverse experts from different domains may face different problems, such as differences in language, approaches, or even fundamental comprehension (Daniel et al., 2022). Misunderstandings may arise because various disciplines can approach problem-solving in quite different ways. Furthermore, multidisciplinary collaboration is more difficult to achieve because traditional academic organizations frequently rank work within particular disciplines (Friedman, 2013). There are strategies to promote multidisciplinary cooperation in education despite these obstacles. Offering training and professional development opportunities for researchers and educators to learn about collaboration across disciplines is one way. Another is to create atmosphere that support collaboration, where people from different areas can come together to work on common goals, projects and purposes(Newman, 2024).The Gram-Schmidt process is a fundamental concept in linear algebra which can

be applied on versatile applications across various fields(Bansal et al., 2019). Different Machine learning algorithms uses the Gram-Schmidt process to preprocess data matrices, aiding in dimensionality reduction and feature extraction for improved model performance (Rosita Dewi et al., 2020). Moreover, in the field of economic modelling and financial analysis, it orthogonalizes variables and factors to reveal complex relationships and notify decision-making in financial markets. Just like the Gram-Schmidt process iteratively aligns and orthogonalizes vectors, interdisciplinary collaboration comprises an iterative process of discussion, blend, and enhancement to combine various perspectives and practices. This iterative approach allows researchers to construct upon each other's contributions, iterate on thoughts, and improve their understanding of complex educational trends (Klaassen, 2018).

Ultimately, goal of this paper is to promote a collaborative and interdisciplinary approach to educational research that embraces diversity, promotes innovation, and advances knowledge for the betterment of education practice and policy.

REVIEW OF LITERATURE

For promoting innovation in teaching and research, interdisciplinary collaboration plays crucial role (*Intersections Across Disciplines: Interdisciplinarity and Learning | SpringerLink*, n.d.). The significance of collaboration in enhancing the quality of education and encouraging student success cannot be nullified(Clark & Wallace, 2015).One of the primary challenges in interdisciplinary collaboration is overcoming disciplinary rules and regulations and raising effective communication and collaboration among educators from different disciplines(Robinson et al., 2018). The leadership role in development of interdisciplinary collaboration in education, emphasizing the role of leaders in creating a supportive environment for collaboration and innovation is also very important(Garcia & Lee, 2020). There is necessity for strong communication channels, common goals, and mutual respect among team members(Croucher, 2023). Technology plays a vital role in enabling interdisciplinary collaboration by offering tools and platforms for communication, data sharing, and collaboration(Tran, 2022). It has to be emphasized that appropriate technologies should be selected and training and support for educators is to be provided to use this technology effectively (Daniel et al., 2022). Professional development training programs are important for supporting educators in developing the competencies and skills needed for interdisciplinary collaboration(Sancar et al., 2021). There is requirement to create considerations and strategies for developing professional programs to support interdisciplinary collaboration among educators and researchers in education. It is also important to provide constant support and chances for reflection and feedback to different educators(Theodorio, 2024). Assessment is another significant aspect of interdisciplinary collaboration, as it allows educators to assess the efficiency of collaborative projects and determine student learning outcomes(Gao et al., 2020). These strategies must include diverse representation, inclusive decision-making processes, and equal resource allocation. These strategies should also emphasize on the importance of addressing different barriers and promoting social justice in education system(Ainscow, 2020). It also has implications for teacher education programs, as it requires educators to develop the competencies and skills needed to cooperate effectively with colleagues from different fields(Arneback & Blåsjö, 2017). Using depiction of mathematical concepts like the Gram-Schmidt process, researchers have proposed conceptual frameworks to guide interdisciplinary research integration. This symbolic application of mathematical principles offers a structured approach for alignment of diverse disciplinary perspectives and methodologies, hence improving the consistency and accuracy of interdisciplinary research efforts in education field(Hashim et al., 2022).

In summary, interdisciplinary collaboration is important for addressing complex challenges in education and raising innovation in teaching and learning. Strategies for encouraging interdisciplinary collaboration include leadership support, technology integration, professional development, and assessment alignment. This detailed literature survey provides insights into the current state of interdisciplinary collaboration in education and highlights key research papers and studies on this topic. By producing findings from multiple sources, this survey offers a broad overview of the benefits, challenges, strategies, and implications of interdisciplinary collaboration in education field. This survey also highlights different dimensions for inter disciplinary education which will be base for proposing framework.

RESEARCH METHODOLOGY

The research methodology for this research paper consists of mixed-methods to create and validate a framework for interdisciplinary collaboration in education, based on the principles of the Gram-Schmidt method. Initially, a comprehensive literature review was done to study existing frameworks and identify gaps in interdisciplinary collaboration required for educational scenarios. A conceptual framework is developed that maps the principles of orthogonalization and normalization to educational collaboration. Iterative refinements are performed to ensure the framework's validity and applicability, with the ultimate goal of increasing interdisciplinary collaboration in education(Theodorio, 2024).

FRAMEWORK FOR APPLICATION TO INTERDISCIPLINARY EDUCATION RESEARCH INTEGRATION

The suggested framework takes into consideration the interdisciplinary education research where different disciplinary perspectives signify vectors as in the Gram-Schmidt process. Each perspective highlights unique insights, procedures, and methodologies to understand educational trends. From the discussed literature we can say that just as the Gram-Schmidt process constructs an orthogonal basis, interdisciplinary education research integration directs to create a framework that supports diverse perspectives while maintaining independence. This framework serves as a theoretical basis for consistently integrating knowledge from several fields. Iterative swapping and merging are used in interdisciplinary education integration to build and combine many discipline perspectives. Scholars participate in cooperative discourse to identify shared themes, settle disagreements, and building comprehensive framework. Interdisciplinary education research integration matches and associates different methodological techniques from various fields, similar to orthogonalizing vectors. It is difficult for researchers to make sure that each methodology complements and adds independently to the suggested framework. Combining findings from multiple fields into a complete framework is the fundamental step in interdisciplinary education research integration.

This framework provides a complete understanding of educational phenomena and guides future practice, research, and policy efforts. Similar to the Gram-Schmidt process, where orthogonal vectors are independent yet coherent, interdisciplinary education research integration seeks to maintain the independence of disciplinary perspectives while promoting uniformity and interaction among them. This balance helps to ensure that each outlook contributes exclusively to the unified framework. The integrated framework resulted from this interdisciplinary education research integration helps in forming educational practice and policy by offering a comprehensive view on complex educational issues. Educators, policymakers, and stakeholders uses insights from the framework for designing effective interventions, make informed decisions, and address challenges in education. Steps of this framework are shown in figure 1.

Through the application of this framework, researchers can use the insights and expertise from diverse disciplines to address complex educational challenges and drive positive change in educational systems.

Fig. 1 Framework for application of Gram Schmidt Process

APPLICATION OF THE GRAM-SCHMIDT PROCESS IN ABOVE FRAMEWORK

The Gram-Schmidt process, originally a mathematical algorithm, can be metaphorically applied to interdisciplinary collaboration in education to align diverse disciplinary perspectives and methodologies.

Normalize Disciplinary Perspectives: It involves ensuring that each discipline's viewpoint or expertise is represented proportionally and equally within the collaborative framework. Mathematically, we achieve this by making sure that the magnitude (length) of each disciplinary perspective vector is 1, which turns it into a "unit vector." This ensures that each discipline's perspective contributes equally to the collaboration.

Orthogonalize Methodologies: It involves ensuring that different disciplinary methodologies complement each other rather than conflicting. Mathematically, this means adjusting the methodologies to be independent of each other. We do this by subtracting the projections of each methodology vector onto previously orthogonalized vectors.

Align Insights: It includes identifying common themes, principles, or underlying concepts that emerge from the integration of disciplinary perspectives and methodologies. This step creates a unified framework that integrates diverse insights into a cohesive understanding of the research topic.

Iterate and Refine: Iterating and refining the integrated framework involves continuously improving and adjusting the interdisciplinary collaboration based on feedback and new insights. This ensures that the collaboration remains effective and relevant to the research objectives.

Generate New Insights: Generating new insights involves creating the integrated framework to uncover novel perspectives or implications that emerge from the interdisciplinary collaboration. This step emphasizes the value of interdisciplinary research in producing innovative solutions and advancing knowledge.

Overall, normalizing disciplinary perspectives in a collaborative project involving STEM and humanities educators ensures that the research is informed by a wide range of perspectives and insights, leading to more robust and impactful outcomes.

CONCLUSION

In conclusion, this paper has examined the concept of interdisciplinary collaboration in education and proposed an application of the Gram-Schmidt process to enhance research integration among diverse disciplinary perspectives. Through this work, the importance of aligning disciplinary perspectives, orthogonalizing methodologies, and creating insights to promote effective interdisciplinary collaboration is highlighted. By treating disciplinary perspectives as vectors and methodologies as orthogonal bases, interdisciplinary teams can integrate diverse insights into a cohesive framework, leading to deeper understanding and innovative solutions in education.

Future research could involve empirical validation of the metaphorical application of the Gram-Schmidt process in interdisciplinary collaboration. This could include case studies or experimental studies to assess the effectiveness of the proposed framework in real-world educational settings. Exploring the role of technology in facilitating interdisciplinary collaboration could enhance the application of the Gram-Schmidt process. Qualitative data to validate model through interviews and focus groups with educators and administrators, while quantitative data will be gathered via surveys to assess the framework's effectiveness can be collected.

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